

PATENT SPECIFICATION

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(54) APPARATUS FOR HANDLING A SERIES OF INDIVIDUAL PARTS

(71) We, MOTOROLA, INC., a corporation organised and existing under the laws of the State of Delaware, United States of America, of 1303 East Algonquin Road, Schaumburg, Illinois 60196, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to an apparatus for the handling of a series of individual parts, and more particularly to an apparatus for the high-speed handling of packaged integrated circuit parts.

The apparatus will separate the parts and pick one at a time from a column of parts, move the part quickly into electrical contact for test, move the tested part out of the contacts to a sort mechanism, and then deposit the part in the proper bin.

The improved through-put speed of the apparatus results from a number of elements each of which speeds up a portion of the operation.

According to the invention there is provided apparatus for handling a series of individual parts, presenting them to a test fixture (not forming part of the apparatus) for test, and conveying them to reservoirs (also not forming part of the apparatus) of similar parts, which apparatus comprises a first vertical wheel provided with slots disposed around its periphery for separating the parts, presenting them at the test fixture for testing, and moving them away from the test fixture and a second horizontal wheel positioned below the first wheel and having holes provided about its periphery for accepting tested parts dropped from said first wheel and for conveying each of the tested parts to selected ones of said reservoirs of similar parts.

In an embodiment of the invention for the best utilization of time, multiple operations are carried out simultaneously with the two wheels operating in concert. As one part is being tested, another is being picked from

the reservoir of untested parts, and still another is being moved by the second wheel to the proper bin. As one part is being moved to the test fixture, another is being moved from the test fixture to the second wheel. The procedure continues with parts being picked one at a time from a reservoir, tested, and dropped into the second wheel. Neither the first vertical wheel nor the second horizontal wheel must return to a start position after completing an operation. Parts are held in the wheels by the force of acceleration, not through the use of gates or shutters. Parts fed or emptied under the influence of gravity have to fall only through a distance equal to their own length. Wiping contacts are used in the test fixtures so no motion is needed for contact closure. Electronic rather than mechanical means are used to control the speed and position of the wheels.

The invention will now be described by way of example only with particular reference to the accompanying drawings wherein:—

Figure 1 is a side view of the apparatus;

Figure 2 is a perspective view showing the wiping contacts used in the test fixture and

Figure 3 is a plan view of the apparatus.

The first function of the apparatus is to pick a single integrated circuit part from a reservoir of untested parts and move it to a position where it can be tested. After the part is tested, the apparatus moves the tested part to a sorting mechanism. These functions are accomplished by the first vertical wheel.

Figure 1 shows the first vertical wheel 20 which is a low mass wheel mounted on a horizontal axis 21 and having eight slots 22—29 located at 45° increments around its periphery. The wheel 20 can be, for example, about 5.5 inches in diameter and 0.1 inches in thickness. It can be made of aluminum or other lightweight metal. Additionally, the mass of the wheel 20 can be further reduced by cutting away unnecessary material from the interior of the wheel. The slots 22—29 in wheel 20 are lined with plastics inserts (not shown) to provide electrical isolation between

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integrated circuit parts which ride in the slots and the wheel 20. A gravity feed reservoir 30 of untested parts 31 is provided at the top of the wheel 20. The integrated circuit parts 31 can be packaged in any of the plastics or ceramic dual-in-line packages commonly used in the semiconductor industry. The parts 31 can have eight or more leads on a package, depending on the integrated circuit contained therein. Because different circuits may require packages of different sizes, adjustable stops are provided in slots 22-29 so that these slots can be adjusted to have a depth just equal to the length of the packages used. This allows the same handling apparatus to accommodate different parts at different times. In Figure 1 part 32 is shown to have dropped into slot 22. Because slot 22 has been adjusted in depth so as to be the same as the length of part 32, other parts 31 in reservoir 30 are held out of the slotted wheel 20. The leads of part 32 straddle the edges of slot 22 and are electrically isolated from wheel 20 by the plastics inserts. In like manner, part 33 which previously dropped from reservoir 30 is held in slot 29. Wheel 20 is rotated through 45° in the direction shown by the arrow. A low inertia, high torque DC motor 34 used with a servo drive amplifier controls the speed and position of slotted wheel 20. As the wheel rotates, its acceleration is sufficient to force parts 32 and 33 outward against stop 35. This provides alignment of part 33 with the electrical test fixture the position of which is shown by dashed line 36. Test fixture 36, which is shown more clearly in Figure 2, is mounted on stop plate 35. Fixture 36 uses spring loaded wiping contacts 37 which straddle wheel 20 and which provide an electrical interface between the part to be tested and the testing apparatus. Spring loaded wiping contacts are used so that no time is lost effecting a contact closure. After wheel 20 has rotated through 45°, slot 23 is in the vertical position and another part 31 drops from the reservoir 30 into slot 23. Part 33 is now in contact with test fixture 36, part 32 is in an intermediate position between the test fixture 36 and reservoir 30, and another part 31 has dropped into the wheel.

After the testing of part 33 is completed, wheel 20 again rotates through 45° in the direction of the arrow. While wheel 20 is rotating, all parts are kept in their respective slots by stop 35. The rotation of wheel 20 through 45° moves part 33 away from the test fixture, moves part 32 into contact with the test fixture for test, moves the part in slot 23 to an intermediate position and allows another untested part 31 to drop from reservoir 30 into slot 24. After the testing of part 32 is completed, the wheel 20 again rotates through 45°. After wheel 20 rotates through 45°, part 33 drops from slot 29 into slot 40 in second horizontal wheel 38. Simul-

taneously, the part in slot 23 moves to the test fixture and another untested part drops into slot 25. The sequence continues in this manner with individual parts being picked from the reservoir, tested, and dropped into the wheel 38.

In this particular embodiment, integrated circuit parts are classified into from two to eight categories by the test procedure. The actual number of categories is selected for the particular type of part being tested. Because this embodiment can accommodate as many as eight categories, eight tracks are provided. One of these tracks is shown as 56 in Figure 1. It is the function of the wheel 38 to move the tested part to the appropriate track through which the part can be moved to a reservoir of similar tested parts.

Wheel 38 is a low-mass wheel which rotates about a vertical axis 39. The speed and position of wheel 38 are controlled by a low inertia, high torque DC motor 57 used with a servo drive amplifier. Figure 3 shows that the wheel 38 has sixteen evenly spaced holes, 40 to 55, provided around its circumference. These holes extend completely though the thickness of wheel 38.

The wheel 38 can be, for example, about five to six inches in diameter and 0.1 inches in thickness. It can be made of aluminum or other lightweight metal. The spaced holes 40 to 55 are provided with plastics inserts (not shown) about 0.75 inches in height which serve to keep the integrated circuit parts in a substantially upright position.

A stop plate 58 is rigidly mounted in a position about one-sixteenth inch below hole 40 in wheel 38. Eight tracks 56 are arranged beneath wheel 38 with one track positioned directly below each of the holes 41 to 44 and 52 to 55. When tested part 33 drops into hole 40 it is stopped by stop plate 58. This part 33 has been classified by the testing procedure into one of the eight selected categories. The wheel 38 then rotates, either clockwise or counter-clockwise, and stops over the appropriate track 56. While the wheel 38 is rotating, the part 33 is held in hole 40 by forces of acceleration which force the part against the edges of the hole. When wheel 38 stops, the only force acting on part 33 is gravity, and the part 33 drops under the force of gravity into the track below. The wheel 38 is now ready to accept another part from the wheel 20. The wheel 38 does not have to return to its original position as there will automatically be one of the sixteen holes, 40 to 55, in the correct position to receive another part from the wheel. The sort procedure performed by the wheel 38 is accomplished in the same time interval that another integrated circuit part is being tested, so no additional time is required to do the sorting.

The interrelation between the function of the wheel 20, an external computer tester, and

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the wheel 38 can be controlled, for example, by a microprocessor unit. An "end-of-test" signal provided by the tester would be supplied to the wheel 20 servo drive amplifier to cause the wheel 20 to rotate. Likewise, information concerning the categorization of a tested part would be relayed to the wheel 38 servo drive amplifier to cause the wheel 38 to rotate to the correct track location. Analog tachometers are used with both the wheel 20 and the wheel 38 to monitor the rates of change of position of the two wheels. Digital tachometers are used to monitor the positions of the two wheels.

15 WHAT WE CLAIM IS:—

1. Apparatus for handling a series of individual parts, presenting them to a test fixture (not forming part of the apparatus) for test, and conveying them to reservoirs (also not forming part of the apparatus) of similar parts, which apparatus comprises a first vertical wheel provided with slots disposed around its periphery for separating the parts, presenting them at the test fixture for testing, and moving them away from the test fixture and a second horizontal wheel positioned below the first wheel and having holes provided about its periphery for accepting tested parts dropped from said first wheel and for conveying each of the tested parts to selected ones of said reservoirs of similar parts.

2. Apparatus as claimed in Claim 1 wherein said first wheel is a low-mass wheel which rotates about a horizontal axis in discrete partial revolutions to allow said series of individual parts in continuous sequence to drop into said slots, to be rotated into position for test, and to be further rotated to drop into the holes in said second wheel.

3. Apparatus as claimed in Claim 2 wherein an analog tachometer and a digital tachometer are used to monitor the speed and rotational position, respectively, of said first wheel, and said first wheel is rotated by a high torque DC motor controlled by a servo drive amplifier.

4. Apparatus as claimed in Claim 1 wherein said second wheel is a low-mass wheel which rotates about a vertical axis to position one of said holes above a predetermined track allowing said part contained in said hole to drop into said track.

5. Apparatus as claimed in Claim 4 wherein said part is held in said hole during said rotation by the forces of acceleration.

6. Apparatus as claimed in Claim 4 wherein an analog tachometer and a digital tachometer are used to monitor the speed and rotational position, respectively, of said second wheel, and said second wheel is rotated by a high torque DC motor controlled by a servo drive amplifier.

7. Apparatus as claimed in Claim 1 wherein said first wheel and said second wheel work in concert so that in the time interval when said second wheel is moving one of said tested parts, said first wheel is separating, presenting for test, and moving away from the test fixture others of said individual parts.

8. Apparatus as claimed in Claim 1 and for handling integrated circuit parts packaged in dual-in-line packages.

9. Apparatus for handling a series of individual parts and substantially as herein before described and as shown in the accompanying drawings.

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7. Apparatus as claimed in Claim 1 wherein said first wheel and said second wheel work in concert so that in the time interval when said second wheel is moving one of said tested parts, said first wheel is separating, presenting for test, and moving away from the test fixture others of said individual parts.

8. Apparatus as claimed in Claim 1 and for handling integrated circuit parts packaged in dual-in-line packages.

9. Apparatus for handling a series of individual parts and substantially as herein before described and as shown in the accompanying drawings.

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