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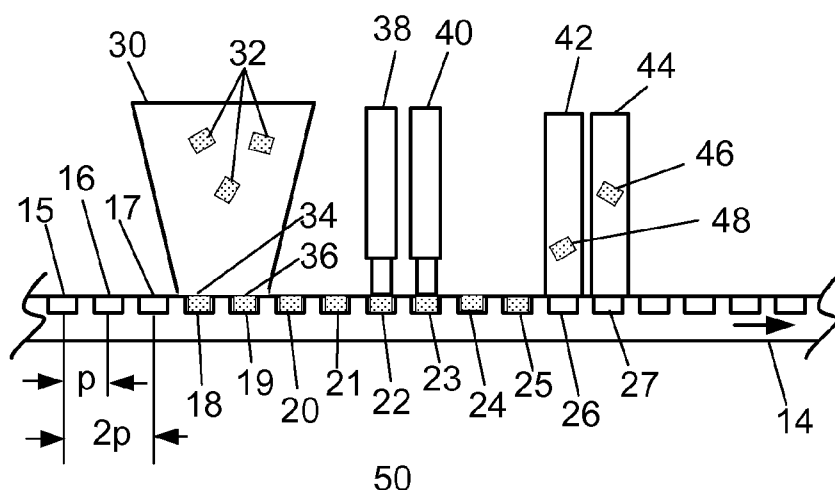


Fig 2

(57) Abstract: An improved method of testing and sorting electronic devices (34,36) uses two or more test stations (38,40) and two or more sorting stations (42,44) applied to a single track (14) to improve system throughput. Applying two or more test stations (38,40) and two or more sorting stations (42,44) to a single track (14) accomplishes improved system throughput while increasing system cost less than would be expected if a duplicate track was installed for each test station (38,40).

SYSTEM AND METHOD FOR IMPROVED TESTING OF ELECTRONIC DEVICES

Technical Field

[0001] The present invention regards improved systems and methods for testing and sorting electronic devices. In particular it regards systems and methods for testing electrical and/or optical properties of miniature electronic devices. In more particular it regards a system and method for testing at least two miniature device properties at high speed in parallel and sorting them into categories according to those properties using two separate testing stations and one test track.

Background of the Invention

[0002] Many electronic devices are tested for electrical and/or optical properties during manufacturing by automated test systems. Typical automated test systems use precision electrical and/or optical test equipment to find values associated with electrical and optical properties of a device and either accept, reject or sort it into an output category depending upon the measured values. For miniature devices, automated test systems are often designed to handle bulk loads, where the manufacturing process creates a volume of devices which have substantially identical mechanical characteristics such as size and shape but differ in electrical and/or optical characteristics. It is common practice to build a volume of devices with electrical and optical properties which generally fall within a range and rely on testing to sort the devices into commercially useful groups with similar characteristics. Typical electronic devices tested and sorted in this fashion include passive components such as resistors, capacitors and inductors and active electronic devices such as digital or analog integrated circuits or light emitting diodes.

[0003] These devices are often supplied to the automated test system as containers filled with devices. Typically the automated test system must extract a single device from the bulk load of devices in a process called singulation, orient the device and fixture it so the test equipment can perform the desired tests. Testing often requires probing the device, wherein electrical leads are brought into contact

with device to permit signals and power to be applied to the device and to monitor responses to the inputs. The task of the automated test system is to determine the electrical characteristics of devices and sort the devices into groups depending upon those characteristics. The automated test system typically singulates devices onto a track where the devices are indexed past one or more test stations where various electrical and/or optical properties of the device are tested and the results stored. As the devices are subsequently indexed past the sorting stations, the devices are removed from the track and deposited in one of a number of bins depending upon the results of the preceding tests. A typical prior art automated test system is shown in Fig 1, where a track 2 with locations 3, 4 spaced "p" = pitch distance apart are indexed by the track 2 in the direction of the arrow to the loader 5 where bulk parts 6 are loaded 7 onto the track. The device 7 is indexed by the track 2 to location 10 where it is tested by test station 9 and the results stored on a controller (not shown). The device 7 is subsequently indexed by track 2 to location 11 where the sort tube 12 removes the device 13 from the track 2 for sorting.

[0004] US patent No. 5,842,579 ELECTRICAL CRICUIT COMPONENT HANDLER, inventors Douglas J. Garcia, Steven D. Swendrowski, Mitsuaki Tani, Hsang Wang, Martin J. Twite, III, Malcolm Hawkes, Evert David Shealey, Martin S. Voshell, Jeffrey L. Fish and Vernon P. Cooke, Dec 1, 1998, assigned to the assignee of this invention, discloses a rotary disk test machine with multiple tracks able to test multiple parts at once. Another exemplary system that uses duplicate tracks to test devices in parallel is the MT20 LED tester manufactured by Mirae Corporation, Chungcheongnam-Do 331-220, Korea. The track holding the devices does not have to be rotary. US patent No. 4,747,479 DEVICE FOR THE TESTING AND/OR PROCESSING OF SMALL COMPONENT PARTS, inventor Jakob Herrman, May 31, 1988 discloses a linear belt to hold parts under test. What these disclosures do not consider is the possibility of testing more than one device in parallel without having to duplicate the tracks that feed parts to the test stations whether they are rotary or linear.

[0005] What is needed, then, is an automated test system for testing and sorting miniature electronic devices that can test at least two devices in parallel and sort them at high speed using a single track to deliver devices to the test stations.

Summary of the Invention

[0006] Aspects of the instant invention provide an improved method of testing and sorting electronic devices based on electrical and/or optical properties using an automated test system which carries parts to be tested on a track. The improvements include providing the test system with first and second test stations adjacent to the track and testing a portion of the devices on the first test station and testing another portion of the devices on the second test station. The devices are then sorted based on the test with a sorting mechanism according to the test results. The system tests and sorts said electronic devices with two test stations on one track. The instant invention performs these tests in parallel, thereby increasing the throughput over systems which test devices serially, and at less expense than systems which test parts in parallel by duplicating the track mechanism.

[0007] Aspects of this invention index the track and the devices in order to process the devices. Indexing refers to stop/start type motion where the track is moved to a position, stopped for a period of time and then moved to a next position. In the case of automated test systems, the track is typically indexed from load position, where the devices are put in the track, to test position where the device is tested, to sort position where the devices are removed from the track and sorted into bins and then back to load position in a series of steps. The instant invention is able to process devices in parallel on a single track by offsetting the positions of the test stations so that when the track is indexed by a predetermined amount greater than the pitch between adjacent devices, one device will be presented to the first test station, while another device will be presented to the second test station. Since the track is indexing twice as far per unit time, the system throughput will be nearly doubled.

[0008] To achieve the foregoing and other objects in accordance with the purposes of the present invention, as embodied and broadly described herein, a method and apparatus is disclosed.

Brief Description of the Drawings

[0009] Fig 1. Prior art automated test system

[0010] Fig 2. Automated test system showing duplex device arrangement.

Detailed Description of Preferred Embodiments

[0011] Embodiments of this invention are improved systems and methods for testing and sorting of miniature electronic devices. Embodiments of the instant invention provide an improved method of testing and sorting electronic devices based on electrical and/or optical properties using an automated test system which carries parts to be tested on a track. The improvements include providing the test system with first and second test stations adjacent to the track and testing a portion of the devices on the first test station and testing another portion of the devices on the second test station. The devices are then sorted based on the test with a sorting mechanism according to the test results. The system tests and sorts said electronic devices with two test stations on one track. The instant invention performs these tests in parallel, thereby increasing the throughput over systems which test devices serially, and at less expense than systems which test parts in parallel by duplicating the track mechanism.

[0012] Embodiments of this invention employ tracks having locations which fixture or hold securely electronic devices for testing. Embodiments of this invention index the track and the fixtured devices in order to process the devices. Indexing refers to stop/start type motion where the track and the fixtured devices is moved to a position, stopped for a period of time and then moved to a next position.

[0013] For example, Fig 2 shows an embodiment of this invention, comprising a single track automated test system 50 with a track 14, which indexes in the direction of the arrow, arranged according to an embodiment of this invention. The track 14 has locations 15-27 operative to fixture electronic devices 34, 36. Fig 2 shows two adjacent locations 15, 16 which are a distance "p" = pitch apart. Note that locations 15 and 17 are a distance 2p apart, or twice the pitch. Bulk electronic devices 32 are loaded into a feeder 30 which loads parts 34, 36 into locations 18, 19 on the track 14. Note that the loader must load at least two parts since the track 14 will next index a distance of 2p thereby bringing two new empty locations 16, 17 to the loader 30 and indexing electronic devices 34, 36 to locations 20, 21. Two loaders could also be employed. With the next 2p index of the track 14 the electronic devices are brought to locations 22, 23 where they are tested by test stations 38, 40 in parallel. Following testing and storing of test results in the

controller (not shown), the track 14 indexes the electronic devices in steps of size $2p$ to locations 26, 27 where the electronic devices 46, 48 are removed from the track 14 by sorting tubes 42, 44.

[0014] Since the track 14 is indexed by $2p$ rather than p , it makes half as many stops and therefore dwells, accelerates and decelerates half as many times, thereby speeding up system throughput by nearly a factor of two. In addition, the concept can be extended to more than two sets of load, test and sort stations. For example, with three sets of load, test and sort stations, the stations would be arranged so that the system could index three times the pitch or $3p$ with each index in order to test and sort all of the devices in a single pass. Embodiments of this invention use rotary tracks, where a disk-like assembly rotates with one or more tracks on or in its surface or linear tracks which may be flexible belts or other arrangements that permit the track to recirculate locations past stations.

[0015] Bulk devices can be singulated and loaded into the track using rotary feeders, vibratory bowl feeders, gravity, special mechanisms or a combination of these. The track may comprise a series of specially shaped recesses or holes arranged in a circular pattern on a rotary plate or more complex mechanisms including load fences and fluid ports, the common property being that they fixture devices so that the device can be indexed into position, probed, tested, and then ejected into one of a number of bins while the track indexes. The track is indexed from load position, where the devices are put in the track, through possible intermediate positions, then to test positions where the device is tested, through more possible intermediate positions and finally to sort position where the devices are removed from the track and sorted into bins. The track is then indexed back to load position in a series of steps. The instant invention is able to process devices in parallel on a single track by offsetting the positions of the test stations so that when the track is indexed by a predetermined amount greater than the offset, one portion of the devices will be presented to the first test station, while another portion of the devices will be presented to the second test station. Since the track is indexing twice as far per unit time, the system throughput will be nearly doubled. This arrangement of indexing at greater than the device pitch and placing two or more sets of loaders, test heads and sort bins at appropriate positions adjacent to the track permits the automated test system to process nearly twice as many parts per unit time with less

hardware and less space than would be required if the track mechanisms were duplicated to provide the same throughput.

[0016] It will be apparent to those of ordinary skill in the art that many changes may be made to the details of the above-described embodiments of this invention without departing from the underlying principles thereof. The scope of the present invention should, therefore, be determined only by the following claims.

We claim:

1. An improved method of testing and sorting electronic devices using an automated test system, said automated test system having a track for transporting said electronic devices, the improvements comprising:

providing said automated test system with a first test station, a second test station, a first sort station and a second sort station, all adjacent to said track;

transporting a first portion of said electronic devices to a position adjacent to said first test station with said track, and transporting a second portion of said electronic devices to a position adjacent to said second test station with said track, said transporting of said first and second portions of said electronic devices occurring substantially simultaneously,

performing first testing on said first portion of said electronic devices with said first test station to obtain first test results and performing second testing on said second portion of said electronic devices with said second test station to obtain second test results, said first and second testing occurring substantially simultaneously;

transporting said first tested portion of said electronic devices adjacent to said first sort station and transporting said second tested portion of said electronic devices adjacent to said second sort station;

sorting said first tested portion of said electronic devices with said first sorting station according to said first test results and sorting said second tested portion of said electronic devices according to said second test results, said sorting occurring substantially simultaneously, thereby testing and sorting said electronic devices with said first and second test stations on one said track.

2. The method of claim 1 wherein said electronic device is a passive electronic component.

3. The method of claim 1 wherein said electronic device is a light emitting diode.
4. The method of claim 1 wherein said track is rotary.
5. The method of claim 1 wherein said track is linear.
6. The method of claim 1 wherein said automated test system has more than one track.
7. An improved automated test system for testing electronic devices, said improvements comprising:
 - a track operative to transport said electronic devices by indexing;
 - first and second test stations arranged adjacent to said track;
 - first and second sort stations arranged adjacent to said track;
 - wherein said track is operative to transport electronic devices so that one portion of said electronic devices is adjacent to said first test station while a second portion of said electronic devices is adjacent to said second test station.
8. The system of claim 7 wherein said electronic device is a passive electronic component.
9. The system of claim 7 wherein said electronic device is a light emitting diode.
10. The system of claim 7 wherein said track is rotary.
11. The system of claim 7 wherein said track is linear.
12. The system of claim 7 wherein said improvements comprise more than one track and first and second test stations adjacent to each track and first and second sort stations arranged adjacent to each track.

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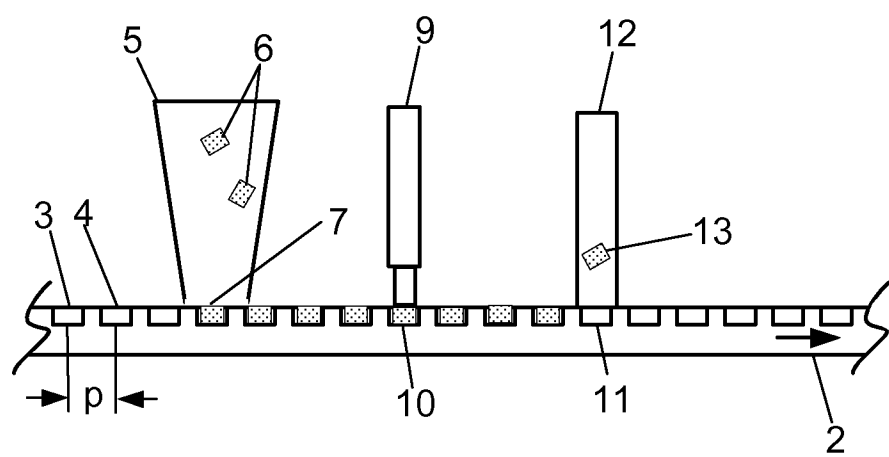


Fig 1
Prior Art

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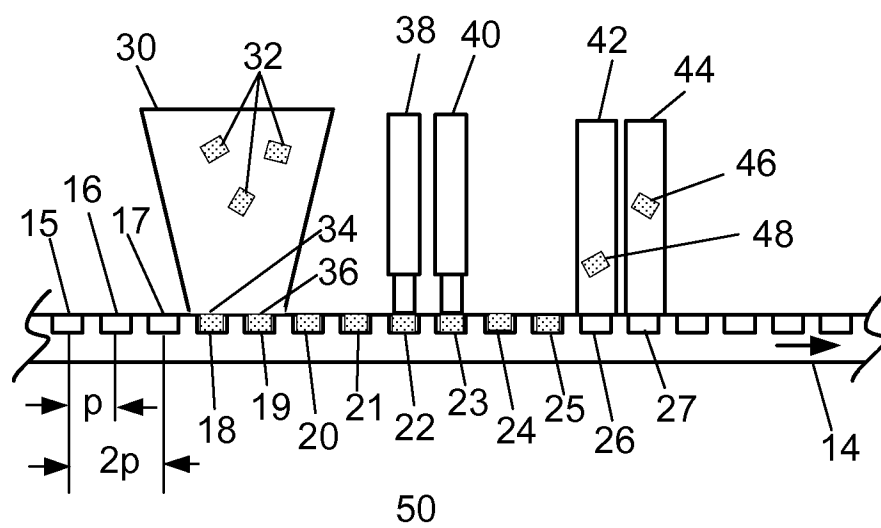


Fig 2