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POLYHEDRON INSPECTION FEEDER AND POLYHEDRON INSPECTION APPARATUS

BACKGROUND OF THE INVENTION



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Field of the Invention

The present invention relates to a polyhedron inspection feeder and a polyhedron inspection apparatus, and in particular, to a polyhedron inspection feeder and a polyhedron inspection apparatus, which are suitable for inspecting a surface accuracy of inspection object such as chips of electronic components.

Description of the Related Art

Conventionally, in the case of inspecting finish surface accuracy of electronic components such as chips, each surface of these chips has been inspected by a worker using a loupe or the like. However, in the above-mentioned inspection, the worker takes these chips by his hand one by one, and then, visibly inspects them; for this reason, there are many cases where defects such as micro scratch and deformation have been overlooked. As a result, this is a factor of mixing defectives in products. Further, the worker is fatigued with the inspection; for this reason, he has a heavy workload. In addition, a problem arises such that great unevenness is caused in inspection accuracy depending upon worker's skill.

In view of the above problem, the inventor of the present invention proposed a polyhedron inspection feeder (Japanese Patent Application No. 2001-127248) which is suitable for automatically inspecting finished surface accuracy of an inspection object in a process for moving the inspection object

in a predetermined direction. The feeder comprises a passage forming member provided with a groove capable of moving the inspection object by giving a predetermined vibration in a state that the inspection object is received. The groove of the passage forming member includes a rotating feed section in which the right and left inclined angles change along the moving direction of the inspection object. With this rotating feed section, it is made possible for the polyhedron inspection object to move while rotating along the spiral track, and inspection of a certain level of accuracy can be obtained by taking images of the finished surface by inspection cameras.

However, in the proposed polyhedron inspection feeder described above, although inspection objects are supplied one by one from a predetermined supply means, the reliability to maintain the intervals between the inspection objects along the moving direction to a predetermined distance is not satisfactorily ensured. Accordingly, for example, when two or more inspection objects are moved in succession in such state that the front end face of the following inspection object is brought into contact with the rear end surface of an inspection object which is positioned ahead in the moving direction, the inspection cameras fail to recognize the position of a second or later inspection object resulting in an inspection failure causing such problem as defective products can not be reliably rejected.

SUMMARY OF THE INVENTION

The present invention has been proposed in view of the problems. Accordingly, an object of the present invention is to provide a polyhedron inspection feeder and a polyhedron

inspection apparatus, which can reliably move inspection objects one by one, and can ensure the reliability of the inspection accuracy.

Another object of the present invention is to provide a polyhedron inspection feeder and a polyhedron inspection apparatus, which can reject a polyhedron object to avoid misjudgment when the posture of the polyhedron object being moved is not proper.

In order to achieve the above-mentioned objects, the polyhedron inspection feeder according to the present invention comprises a passage forming member provided with a groove for forming a passage for an inspection object, and a conveying means which is disposed movably along the groove and engages with the inspection object in a state that inspection surface of the inspection object is exposed to the outside of the groove to convey the same in the groove,

the passage forming member includes a rotating feed section for rotating the inspection object by a predetermined angle in a process that the inspection object is moved, and

the conveying means is provided with an engagement area at every predetermined interval which engage with the inspection objects one by one in a state that the rotation of the inspection object is permitted. With this arrangement, a state, in which inspection objects engaged with the respective engagement areas are positioned being separated at a certain interval from each other in accordance with the interval between the engagement areas, can be obtained. Accordingly, such possibility that plural inspection objects continue in succession can be reliably prevented. Hence, the reliability of the inspection accuracy in each inspection object can be ensured.

In the present invention, the following structure is adopted, that is, the conveying means is formed from a belt, which is mounted to wrap a pair of pulleys around therebetween, the engagement areas are formed in the plane of the belt by forming perforations for receiving the inspection objects. With this structure, the inspection object can rotate smoothly along the inner surface shape of the groove. Additionally, the inspection object can be moved along the groove without covering the inspection surface of the inspection object. Further, in the case that the inspection is made using cameras, since diffused reflection of illumination by background in taken image, i.e., the groove can be eliminated, rejection of non-defective products due to inspection failure can be prevented.

It is preferred that the belt is disposed so as to pass through the inside of the groove of the passage forming member in a state that the surface of the belt is generally vertical. With this configuration, when the inspection object is rectangular or the like, the inspection surface can be exposed symmetrically to each side of the belt, therefore the inspection can be carried out efficiently.

Further, the present invention comprises a passage forming member provided with a groove for forming a passage for an inspection object, and a conveying means which is disposed movably along the groove and engages with the inspection object in a state that inspection surface of the inspection object is exposed to the outside of the groove, characterized by including

a supplying means for the inspection object attached to the conveying means at the upstream side of the passage forming member, the supplying means being provided with a plurality of supply passages for supplying inspection objects at a plurality

of points in the moving direction of the conveying means. In the configuration as described above, it is possible to reduce such situation that no inspection object is supplied to the engagement area of the conveying means as little as possible to allow decrease of inspection efficiency to be reduced.

Furthermore, it is preferred to provide a means for rejecting an inspection object when the inspection object to be engaged with the conveying means is not in a proper engagement posture. With this arrangement, only the inspection objects that are always held in a predetermined posture are sent to the passage forming member. In this point also, it is possible to reduce the decrease of the inspection efficiency.

Still further, it is preferred to adopt such structure as providing a posture holding means for holding the inspection surface at a predetermined position when the inspection object has reached a predetermined inspection position. With this structure, such possibility as tottering of the inspection surface can be prevented. As a result, a high accuracy inspection can be obtained.

The rotating feed section in the present invention is constituted of a groove including, in cross sectional configuration, a generally V-letter type, a generally U-letter type, and an intermediate type that is positioned therebetween and gradually changes its shape and continues thereto. Preferably, the inspection object is a rectangular or cubic solid; however, other solids are not excluded from the object.

The terms indicating direction or position in this specification are used presuming FIG. 1 as the standard, if not otherwise specified.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a front view schematically showing an entire structure of a polyhedron inspection apparatus according to one embodiment of the invention, FIG. 2 is a top plan view schematically showing the polyhedron inspection apparatus, FIG. 3 is a top plan view schematically showing a supply means, FIG. 4 is a perspective view schematically showing principal parts of the supply means, FIG. 5 is a perspective view schematically showing the supply means from which a front block is omitted, FIG. 6 is a perspective view schematically showing the inside of the front block, FIG. 7 is a cross sectional view showing a state that chips are supplied in a proper posture, FIG. 8 is a cross sectional view showing a state that chips are supplied in an improper posture, FIG. 9 is a cross sectional view showing a state that chips are moved through a passage forming member, FIG. 10 is a perspective view schematically showing a rotating feed section of a passage forming member, FIG. 11 is an exploded perspective view showing the rotating feed section, FIG. 12 is a view illustrating rotation movement of a chip in the rotating feed section, FIG. 13 is a cross sectional view showing principal parts of a retrieve means of chips determined as defectives, and FIG. 14 is a view schematically showing the structure of a retrieve means of chips determined as non-defective products.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

One embodiment of the present invention will be described below.

FIG. 1 is a front view showing a polyhedron inspection apparatus according to one embodiment of the invention, and FIG. 2 is a top plan view thereof. As shown in FIGs. 1 and 2, the

polyhedron inspection apparatus 10 comprises a supply means 11 arranged on an upper portion of a frame F, a conveying means 12 provided to the supply means 11, a polyhedron inspection feeder 13 for moving an inspection object, a generally rectangular ceramic chip capacitor in this embodiment (hereinafter, referred to as chip W), working in combination with the conveying means 12, first to fourth cameras 14,15,16 and 17 used as inspection means disposed along the polyhedron inspection feeder 13, and a retrieve means 18 for retrieving the chips W in accordance with the inspection result, that is, non-defective products or defective products.

The supply means 11 comprises a hopper 20 that receives the chip W, and a shooter 22 that is connected to the upper open end of the hopper 20 and allows the chip W to slide down to the supply passage forming block 21 side. The hopper 20 is a bowl feeder whose inner side is provided with a spiral passage 20A, which is formed so that the passage comes outward as it comes upward. It is adapted so that the chip W is ejected in succession from upper side when vibration is given to many chips W received in the hopper 20 by a vibrator (not shown).

As shown in FIGs. 3 to 8, the supply passage forming block 21 is formed using a plurality of members, that is, a rear-side block 24 positioned immediately below the shooter 22 and given with vibration by the vibrator, a front block 25 positioned at the opposite side of the rear-side block 24, i.e., at the near side, and an inter-block 26 disposed between the blocks 24 and 25. In the rear-side block 24, the upper surface located at the inside of the outer frame 27 is formed into a slope surface 28 so that the upstream side comes to the upper position. It is adapted so that the chip W runs up the slope surface 28 in

succession by means of the vibration given to the rear-side block 24. As shown in FIG. 5, the inter-block 26 is formed into a slope surface 29 in which the upstream side comes at a slightly upper position with respect to the downstream side, and at three points in the longitudinal direction thereof, supply grooves (supply passages) 31 for the chip W are formed along tracks that draw a gentle curve respectively. One end (rear-end) of these supply passage 31 comes to the slope surface 28 side of the rear-side block 24, while the other end (front-end) comes to the front block 25 side. The inter-block 26 is arranged so that the chip W moves in the opposite direction of the movement of the chip W in the rear-side block 24, i.e., from the upstream side to the downstream side (refer to FIG. 4), by means of the vibration of the vibrator (not shown). When the chip W, which dropped from the slope surface 28, drops into the supply groove 31, the chip W moves toward the front block 25 side along the supply groove 31. On the other hand, it is arranged to repeat such cycle that the chip W, which has failed to be supplied to the conveying means 12 from the supply passage 31, transfers from the downstream side area to the rear-side block 24, and runs up the slope surface 28 of the rear-side block 24. Further, as shown in FIG. 7, between the upper portions of the front block 25 and the inter-block 26, a slot 35 is formed, which is connected to the support surfaces 33 and 34 whose upper ends become a v-letter like shape; and it is arranged so that the slot 35 receives a roughly lower half of a belt B included in the conveying means 12, the belt B running along the direction perpendicular to the paper in FIG. 7.

AS shown in FIG. 1, the belt B is provided to wrap around a drive pulley 36, which is coupled with the output shaft of

a motor M disposed at the upper portion of the downstream end and turns in a generally horizontal plane, and a driven pulley 37, which is positioned at the upstream end and turns in a generally same plane as the drive pulley 36. Accordingly, the belt B moves in such posture that the surface of the belt is aligned along the approximately vertical plane. As shown in FIGs. 4 to 6, in the plane of the belt B, perforations 38 of the same size are formed as engagement areas in an endless manner at the same intervals. Length of each perforation 38 along the moving direction of the belt B is determined so that it is slightly longer than the longitudinal length of the chip W, and that two chips W in a longitudinal state are not permitted to enter into one perforation 38 at the same time. Further, the vertical width of the perforation 38 is adapted so that, in a state shown in FIG. 7, the chip W is permitted to rotate. Accordingly, it becomes possible that the chip W slides through any one of the three supply passages 31 and enters into the inside of the perforation 38 while the belt B goes through the slot 35. At this time, the proper posture of the chip W is such that the longitudinal side of the chip W lies along the right-and-left direction with respect to the perforation 38 (a posture shown in FIG. 7), and the upper two surfaces of the chip W are supported by the support surfaces 33 and 34 formed at the upper end of the slot 35 and the chip W is sent toward the downstream side. On the other hand, as shown in FIG. 8, disposed on the front block 25 is a rejecting means 39 for rejecting the chip W when the chip W is postured in such manner that the longitudinal direction crosses the perforation 38; it is determined as improper posture.

The rejecting means 39 comprises a nozzle 39A for

constantly blowing air through an air pump (not shown). The nozzle 39A is adapted so as to blow air to a portion of the chip W, which largely protrudes from the perforation 38, from above the chip W, and it is arranged so that the chip W can be dropped off from the perforation 38 to the inter-block 26 side with this air pressure. A projection 26A is formed at the left side of the inter-block 26, and formed immediately under the nozzle 39A in the projection 26A is a cut 26B for facilitating the drop off of the chip W.

The polyhedron inspection feeder 13 is connected to the downstream side of the supply means 11. The polyhedron inspection feeder 13 comprises, as shown in FIGs. 1 and 2, an upstream side passage forming member 40, a rotating feed section 41 connected to the downstream side of the upstream side passage forming member 40, and a downstream side passage forming member 42 connected to the downstream side of the rotating feed section 41. The upstream side passage forming member 40 and the downstream side passage forming member 42 are formed into the same configuration. Accordingly, the description will be made about the upstream side passage forming member 40. As shown in FIGs. 9 and 10, the upstream side passage forming member 40 is constituted by combining a pair of blocks 45 and 45. That is to say, each block 45 includes a base block 46 and an uprising block 47, which is oriented upward from an end side of the base block 46, and the cross section thereof is formed into a shape close to a L-letter. Formed at the upper end of the uprising block 47 are an outer slope surface 47A and an inner slope surface 47B. Accordingly, by disposing the uprising blocks 47 and 47 of the two blocks 45 and 45 so as to back on to each other, the upstream side passage forming member 40 forms a groove 48 forming

a generally V-letter at the upper end side, thereby a passage for the chip W is formed along the groove 48. At this time, each of the blocks 45 and 45 are disposed so that a space S, which has a slightly larger dimension than the thickness of the belt B, is formed between these uprising blocks 47 and 47, thereby the belt B is permitted to move in the space S. Further, in the upstream side and downstream side passage forming members 40, vacuum holes 49 communicating to a lower area of perforation 38 are formed to constitute a posture holding means in areas corresponding to the lens portions of first to fourth cameras 14-17 in the uprising block 47. With this arrangement, the position of the inspection surface is held in a predetermined state by decreasing the pressure within a groove 48 via the vacuum hole 49 to suck the chip W at a level that the chip W is not prevented from moving.

As shown in FIGs. 10 to 12, the rotating feed section 41 comprises a groove 50 capable of allowing the chip W to rotate in the process that the chip W is sent being engaged with the perforation 38 of the belt B. The rotating feed section 41 is the same as the upstream side passage forming member 40 and the downstream side passage forming member 42 except that the configuration of the groove 50 is different from that of the groove 48. Accordingly, the blocks forming the rotating feed section 41 are given with the same reference numerals as those given to the upstream side passage forming member 40, and the description thereof will be omitted.

The slope surfaces 50A and 50A opposing to each other so as to form the groove 50 of the rotating feed section 41 is formed into substantially the same inner surface configuration as that of the previously proposed Japanese Patent Application No.

2001-127248. Accordingly, here, detailed description of the cross sectional configuration will be omitted. Roughly speaking, the cross sectional shape of the groove 50 is formed so that the inner surface shapes of the generally V-letter type and the generally U-letter type are continued alternately along the moving direction of the chip W, and the inner side surface in the intermediate portion, which shifts to the inner surface between the generally V-letter and the generally U-letter, is formed into a gently curved configuration, thereby the chip W passing through the groove 50 goes straightly while smoothly rotating along a spiral track. In this embodiment, the rotating feed section 41 is formed in such manner that, when the chip W passes through, the slope surfaces 50A and 50A continue while gradually changing with a rotation by approximately 180° from the initial position (refer to the position of "0°" in FIG. 12). However, when the chip W is allowed to rotate, the configuration of the inner surface of the groove 50 is not limited to the structure shown in the figures.

The first to fourth cameras 14, 15, 16 and 17 are supported via stands (not shown) respectively on the upstream side and downstream side passage forming members 40 and 42. As shown in FIGs. 1 and 2, the first and second cameras 14 and 15 are located on the upstream side passage forming member 40, and each of the lens portions thereof are disposed so as to face alternately inspection surfaces of the chip W each other. That is to say, it is arranged so that the first camera 14 inspects the inspection surface S1 (refer to FIG. 12) of the chip W; on the other hand, the second camera 15 inspects the inspection surface S2 of the chip W. Also, the third and fourth cameras 16 and 17 are located on the downstream side passage forming member 42 and are adapted

so as to perform the inspection of the chip W, which has been rotated by approximately 180°. That is to say, the lens portion of the third camera 16 is oriented to the inspection surface S3 of the chip W and inspects the inspection surface S3; on the other hand, the lens portion of the fourth camera 17 is oriented to the inspection surface S4 of the chip W and inspects the inspection surface S4. The images of the cameras 14-17 are subjected to a predetermined image processing inspection by an image processor to determine whether the product is non-defective or defective.

As shown in FIG. 1, FIGs. 13 and 14, the retrieve means 18 comprises a first suction pipe 50 disposed at the downstream side immediately adjacent to the second camera 15 within the area of the upstream side passage forming member 40, a second suction pipe 51 at the downstream side immediately adjacent to the fourth camera 17 within the area of the downstream side passage forming member 42, and a third retrieving unit 53 at the downstream side of the second suction pipe 51. The first and second suction pipes 50 and 51 are provided for retrieving defective products; the third retrieving unit 53 is provided for retrieving non-defective products. As shown in FIG. 13, formed in the block 45, which is at the opposite side corresponding to the position of a leading end opening of the first and second suction pipes 50, 51, is an air supply port 55 communicating with the groove 48. It is arranged so that the air supply port 55 blows air to blow away the chip W toward the suction pipes 50, 51 side, and that the chip W which has been determined as defective is retrieved by the suction pipes 50, 51 into retrieve boxes 56, 57 respectively. At this time, it is arranged so that the first and second suction pipes 50 and

51 are always maintained in a state of suction, and that, on the other hand, the air supply port 55 blows air when a defective product is determined. Accordingly, in a state that the air supply port 55 does not blow the air on the chip W, the chip W is not sucked by the suction force of the first and second suction pipes 50, 51, and is maintained in a state that the chip W can be moved in the groove 48.

As shown in FIG. 14, the third retrieving unit 53 is located generally on a line that the belt B goes through, and comprises a cylindrical member 60 provided with an opening 60A at a position under the belt B. It is arranged to blow air from above the cylindrical member 60. Receiving the air blow force, the chip W as a non-defective product positioned in a perforation 38 of the belt B, losing the support by the downstream side passage forming member 42, falls down into the cylindrical member 60, and is retrieved in a retrieve box 62. Reference numeral 63 in FIG. 14 denotes a counter. The number of the non-defective products can be counted in succession by the counter.

Next, the entire operation of the polyhedron inspection apparatus 10 according to the embodiment will be described.

By turning on a predetermined power supply, the belt B used as the conveying means 12 turns in the counterclockwise direction in FIG. 2. At the same time, chips W are supplied from the hopper 20 of the supply means 11 onto the rear-side block 24 via the shooter 22. The chips W on the rear-side block 24 run up the slope surface 28 and fall down onto the supply grooves 31 of the inter-block 26 in succession. At this time, the belt B is in a state of running at the front end of the supply groove 31, and each of the chips W, which has passed through the supply grooves 31, enters into the perforation 38 of the belt B in

succession and is engaged therewith. Since plural supply grooves 31, three lanes in this embodiment, are provided, feeding failure of chip to the perforations 38 rarely occurs.

When a chip W in the perforation 38 is not in a proper posture, i.e., as shown in FIG. 8, in such a case that a chip W enters in a posture crossing the perforation 38, air is blown from the nozzle 39A of the rejecting means 39 to the protruding area, and the chip W falls down from the perforation 38. Accordingly, every chip W that has passed through the position of the rejecting means 39 is moved being held in a proper posture to the polyhedron inspection feeder 13 connected to the downstream side.

In the area of the upstream side passage forming member 40 of the polyhedron inspection feeder 13, a state, in which two inspection surfaces S1 and S2 are exposed over the groove 48 as shown in FIG. 12, is obtained. In this state, the first and second cameras 14 and 15 take images and the image processor carries out a predetermined inspection. Here, when it is determined that any one of the inspection surfaces S1 and S2 is defective, air is blown from the air supply port 55 into the groove 48. Accordingly, the chip W is blown out of the groove 48, sucked by the suction pipe 50 which is always in a state of suction, and retrieved into the retrieve box 56.

The chips W, which have been determined as non-defective at the upstream side passage forming member 40, are turned over by approximately 180° during passing through the rotating feed section 41 (refer to FIG. 12). Then, in a state that the inspection surfaces S3 and S4 are exposed, the chips W move into the groove 48 of the downstream side passage forming member 42. Here, the third and fourth cameras 15 and 16 carry out the same

inspection as that made in the area of the upstream side passage forming member 40. While the chips W, which have been determined as defective, are likewise retrieved into the retrieve box 57 via the suction pipe 51, the chips W, which have not been sucked by the suction pipe 51, i.e., non-defective products are retrieved into the third retrieving unit 53 after being counted by the counter 63 in succession.

Hence, according to the embodiment as described above, the structure, in which the chips W are moved one by one using the belt B, is adopted, therefore such a situation that plural chips W are moved in contact with each other in succession is perfectly prevented. As a result, surface accuracy of each chip W can be inspected effectively and highly precisely.

In the above embodiment, the perforations 38 for engaging with chips W to move them are formed. However, the upper portion of the belt B may be formed into notches having a concave shape respectively. The conveying means 12 is enough when it allows chips W to move one by one at a predetermined interval and is not limited to the belt B. Also, the supply grooves 31 in the supply means 11 are not limited to three lanes. The number of the lanes may be more or less than three.

As described above, according to the polyhedron inspection feeder described in claim 1, in accordance with the interval between the engagement areas formed in the conveying means, a state, in which the inspection objects received and engaged with each engagement area are given at the predetermined interval therebetween, is obtained. Accordingly, compared to the conventional structure in which the inspection objects are sent by being given with vibration, such possibility that plural inspection objects are sent in contact with each other in

succession can be reliably prevented. With this arrangement, the reliability on the inspection accuracy of each inspection object can be ensured.

Also, according to the polyhedron inspection feeder described in claim 2, the inspection object can rotate smoothly along the inner shape of the groove. And, the inspection object can be moved along the groove with uncovered inspection surface thereof.

Further, according to the polyhedron inspection feeder described in claim 3, when the inspection object is rectangular or the like, since the inspection surface can be exposed symmetrically with respect to the belt, the inspection can be carried out efficiently.

Further, according to the polyhedron inspection apparatus described in claim 4, since it is possible to reduce such situation that no inspection object is supplied to the engagement area of the conveying means as little as possible, decrease of the inspection efficiency can be prevented.

Further, according to the polyhedron inspection apparatus described in claim 5, only the inspection objects that are held in a predetermined posture are always sent to the passage forming member. In this point also, decrease of the inspection efficiency can be prevented.

Further, according to the polyhedron inspection apparatus according to claim 6, a high accuracy inspection can be carried out while holding the position of the inspection surface of the inspection object at a fixed posture.

WHAT IS CLAIMED IS

1. A polyhedron inspection feeder comprising a passage forming member provided with a groove for forming a passage for an inspection object, and a conveying means disposed movably along said groove and engages with the inspection object in a state that inspection surface of said inspection object is exposed to the outside of said groove, wherein

said passage forming member includes a rotating feed section for rotating the inspection object by a predetermined angle in a process that the inspection object is moved, and

said conveying means is provided with engagement areas at every predetermined interval which engage with the inspection objects one by one in a state that said rotation of said inspection object is permitted.

2. The polyhedron inspection feeder according to claim 1, wherein said conveying means is formed from a belt mounted to wrap a pair of pulleys around therebetween, said engagement areas being formed in the plane of the belt by forming perforations for receiving said inspection objects.

3. The polyhedron inspection feeder according to claim 2, wherein said belt passes through the inside of the groove of said passage forming member in a state that the surface of the belt is approximately vertical.

4. A polyhedron inspection feeder comprising a passage forming member provided with a groove for forming a passage for an inspection object, and a conveying means disposed movably

along said groove and engages with the inspection object in a state that inspection surface of said inspection object is exposed to the outside of said groove, wherein

the polyhedron inspection feeder includes supplying means for inspection object attached to said conveying means at the upstream side of said passage forming member, the supplying means being provided with a plurality of supply passages for supplying inspection objects at a plurality of points in the moving direction of said conveying means.

5. The polyhedron inspection apparatus according to claim 4, comprising means for rejecting an inspection object when the inspection object to be engaged with said conveying means is not in a proper engagement posture.

6. The polyhedron inspection apparatus according to claim 4 or 5, comprising posture holding means for holding said inspection surface at a predetermined position when said inspection object has reached a predetermined inspection position.