

TITLE OF THE INVENTION

Conveyor Equipment

BACKGROUND OF THE INVENTION

The present invention relates to a conveyor equipment for continuously conveying workpieces at a constant pitch, and more particularly though not exclusively to a conveyor equipment suitable for carrying out a plurality of working processes in a production facility, such as carrying out

characteristic measurement, selection, taping, and other processes on a small workpiece such as an electronic component conveyed by means of an automatic mechanism.

Conventionally when producing a taped type electronic component whose wire type lead terminals are held on a base tape formed with notches beforehand, an electronic component element is attached to the lead terminals to complete the electronic component on the base tape as disclosed in United State Patent No. 4,954,207. Electronic components produced as described above are subject to characteristic measurement and selection while being conveyed as held on the base tape and further to a taping process. The above-mentioned method has the advantage that the electronic component is stably held on the base tape while being conveyed, however, since the electronic component cannot be taken out directly upward apart from the base tape, the taping operation is difficult and the base tape once used cannot be used any more after the taping operation is completed.

When an electronic component having plate type lead terminals formed from a sheet material is selected as a workpiece, after completing an electronic component by attaching an electronic component element to lead terminals (lead frame) formed from a sheet material, the electronic component is separated from others and transferred to a conveyor equipment. Therefore, any base tape as described

in the wire type lead terminals cannot be used. In order to convey this electronic component with plate type lead terminals, there is a conveying method in which workpiece holders with recess portions opening upward are attached at a constant pitch to an endless chain driven intermittently and electronic components are put in each of these recess portions.

However, since the electronic component is merely put in the recess portion of a workpiece holder, the electronic component is possibly displaced on the workpiece holder or falls off the workpiece holder due to an inertia force effecting at the time of intermittent feed. Furthermore, when the electronic component is conveyed vertically or in a circular arc direction, the electronic component cannot be prevented from being displaced or falling off the workpiece holder. For the above reasons, the workpiece conveyance direction is almost limited to horizontal directions, which allows a little latitude with regard to the workpiece conveyance direction.

Conventionally when a plurality of processes having different processing times are included in a production facility, the processing speed of the entire production facility is generally adjusted to the process requiring the longest processing time. Therefore, any other process requiring a short processing time cannot start its operation until an operation of the process requiring the longest processing time is completed, which also results in slow processing speed and low efficiency of the entire production facility. Particularly when the processing times of the processes differ extremely, the above-mentioned problem is much more serious.

Furthermore, in view of the recent growing trend of multi-sort small-quantity production, when a component requiring a different processing time is transferred to the production facility line or when the processing time of the

process requiring the longest processing time is changed, the processing time of the entire production facility must be changed, which results in requiring much time for adjustment procedures.

5 SUMMARY OF THE INVENTION

It would be desirable to provide conveyor equipment which is capable of stably conveying a workpiece at high speed and conveying more freely in regard of the workpiece conveyance direction.

10 It would be desirable to provide conveyor equipment which is capable of increasing the processing speed of the entire production facility and permits a simple and space-saving mechanism construction.

15 It would also be desirable to provide conveyor equipment capable of easily coping with change of the processing time of each process.

In a first aspect, the invention provides conveyor apparatus for conveying a workpiece with a magnetically attractable portion, comprising:

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an endless workpiece conveyance means;

workpiece retaining means uniformly spaced on said endless workpiece conveyance means, for positioning one or more workpieces in a feed direction of said workpiece conveyance means;

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drive means for moving said workpiece conveyance means intermittently by a prescribed pitch; and

magnet means for attracting said magnetically attractable portion of a said workpiece toward said workpiece retaining means.

5 Referring to the preferred embodiment, although the workpiece retaining means does not retain the workpiece in a direction perpendicular to the plane in which the workpiece is conveyed, the workpiece is prevented from being lifted on the workpiece retaining means, since magnetic means attracts the magnetic
10 portion of the workpieces toward the workpiece retaining means.

The workpiece is attracted to the workpiece retaining means when being conveyed, therefore, the workpiece may be conveyed not only in a horizontal
15 direction but also in a vertical or circular arc direction to allow larger latitude with regard to the workpiece conveyance direction. It is desirable that the attraction force of the magnet means is made sufficiently greater than the weight of the workpiece
20 or the inertia force effecting onto the workpiece at the time of intermittent feed. Attraction force of the magnet does not deteriorate even when used many times unlike an adhesive nor damages the workpiece unlike any mechanical clamp. Furthermore, the
25 workpiece retaining means does not have to clamp the workpiece in a direction perpendicular to the plane in

which the workpiece is conveyed, which allows the workpiece to be easily loaded onto or unloaded from the workpiece retaining means.

When a radial-lead component is selected as a workpiece, it is desirable that the workpiece conveyance means is a non-magnetic timing belt, and the workpiece retaining means are retainer grooves provided widthwise at a constant pitch on the external surface of the timing belt to retain the lead terminals in the retainer grooves. When a permanent magnet is mounted as magnet means to a rail for slidably guiding the timing belt, the permanent magnet exerts a magnetic force for attracting the workpiece toward the workpiece retaining means to stably retain the workpiece while being conveyed along the rail. The timing belt has internal teeth to be engaged with a drive pulley, so that the workpiece can be conveyed with high accuracy in accordance with the rotatory angle of the drive pulley. The timing belt is able to have a light-weight construction in comparison with any other workpiece conveyance means such as a chain, whereby the entire workpiece conveyance equipment is able to have a small inertia force and a high-speed workpiece conveyance capability together with reduction of vibration and noise. Further, the timing belt is preferably made of an elastic material such as

rubber or polyurethane, so that any possible mechanical impact onto the electronic component generated at the time of intermittent feed can be reduced, which causes little damage to the electronic component. The timing belt can also be an insulating material to be suitable for characteristic measurement of the electronic component.

When a chain is selected as the workpiece conveyance means, it is desirable to mount workpiece holders to the chain at a constant pitch, which holders have both retainer grooves to retain the lead terminals of electronic components and permanent magnets to attract the lead terminals toward the retainer grooves. By means of the above described construction, the electronic components can be prevented from falling off or being displaced when the electronic components are conveyed intermittently or the workpiece conveyance direction is changed. If one of the workpiece holders should be damaged in the case of above-mentioned chain, it is only necessary to replace the damaged workpiece holder, while the other parts can be reused to permit a repair cost reduction.

Furthermore, the present invention may be provided with means for absorbing the pitch difference between adjoining processes while maintaining the tension of the endless workpiece conveyance means,

i.e., buffer means in order to increase the processing speed of the entire conveyor system.

For instance, there may exist two processes having processing times different by ten times, for example, in a case that a drive means belonging to the short-time process is driven by 1-pitch, a drive means belonging to the long-time process is driven by 10-pitch. Further, workpieces may be processed one by one in the short-time process, and the workpieces may be processed in units of ten simultaneously in the long-time process. Furthermore, buffer means for absorbing the pitch difference of at least

10-pitch may be provided between the short-time process and the long-time process. By means of the above construction, a plurality of processes having different processing times can be integrated in one workpiece conveyance system, in which the processing time of the entire conveyor system can be adjusted to the short-time process, whereby a high-speed processing can be achieved. Furthermore, the workpiece conveyance means can be continuously driven without being slackened by virtue of the buffer means so that the conveyance means prevents the workpieces from falling off.

The buffer means can include a variety of modifications depending on the style of the workpiece conveyance means. When a radial-lead component is conveyed as retained in retainer grooves of the timing belt, it is desirable to mount a rotatable support pulley for supporting the internal surface of the timing belt to a lift member movable vertically and provide urging means for urging the lift member upward against the weight of the lift member.

A spring or a weight exerting a force greater than that of the lift member can be selected as the urging means. It is desirable to provide a pair of presser pulleys near both sides of the lift member in order to press downwardly the external surface of the timing belt being lifted by the support pulley of the lift member. Since this buffer means is constructed vertically, it can absorb a great difference in workpiece feed pitches in a small floor occupation area. Therefore, two processes having a great difference in processing time can be arranged adjacent each other resulting in that a great latitude is allowed in regard of process arrangement.

The buffer means has a portion where the moving direction of the timing belt, i.e., the workpiece conveyance direction is vertical. When a workpiece is merely put on the timing belt in the above case, the workpiece may fall off. Therefore, the timing belt is

required to have a workpiece retaining means for retaining a workpiece one by one at a constant pitch. When the workpiece includes a magnetic portion, the workpiece retaining means may be constructed by mounting a magnet to the timing belt or by providing a retainer groove in a non-magnetic timing belt together with providing a magnet to a guide rail for the timing belt to attract and retain the workpiece onto the timing belt. The workpiece retaining means may also be made of a rubber material and formed with a recess portion to elastically hold the entire body or a part of the workpiece in the recess portion. By providing a workpiece retaining means to the timing belt as described above, the workpiece is stably conveyed without falling off from the timing belt resulting in that a great latitude is allowed in regard of workpiece conveyance style.

When a workpiece requiring a different processing time is supplied to the production facility line or when the processing time is changed halfway, the process having a long processing time (requiring a great feed pitch) necessitates a large space in comparison with a process having a small processing time (requiring a small feed pitch), therefore, the total line arrangement must be changed. On the contrary, at least one drive means can be changeable in feed pitch and the drive means and buffer means can be shifted integrally in the workpiece conveyance direction by means of a shifting mechanism. In this case, it is possible to readily cope with change of processing times of the preceding and succeeding processes of the drive means and to effectively utilize the spaces of the adjoining processes without changing the arrangement of the entire production facility line.

The shifting mechanism may be constructed by providing a guide mechanism for movably supporting the drive means and shifting the drive means in the workpiece conveyance direction manually or automatically by a motor, a cylinder,

or the like means.

The invention also provides a method for conveying a workpiece having a magnetically attractable portion, the method wherein the workpiece is received by retaining means provided at a uniform spacing on a workpiece conveyance means, the conveyance means being moved intermittently by a prescribed feed pitch, the workpiece being held relative to the workpiece retaining means by magnetic attraction of the magnetically attractable portion, and the workpiece retaining means holding the workpiece positively in position in the feed direction of the workpiece conveyance means.

The above and further features of the present invention are set forth with particularity in the appended claims and should become clearer from consideration of the following detailed description of exemplary embodiments of the invention given with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1A is a schematic front view of a conveyor equipment in accordance with the present invention;

FIG. 1B is a plan view of the conveyor equipment in FIG. 1A;

FIG. 2 is a perspective view of a timing belt in accordance with an embodiment of the present invention;

FIG. 3 is a front view of the commencing end of the conveyor equipment in FIG. 1A;

FIG. 4 is an enlarged section view of the conveyor equipment taken along the line IV - IV in FIG. 3;

FIG. 5 is an enlarged section view of the conveyor equipment taken along the line V - V in FIG. 3;

FIG. 6 is an enlarged right side view of the upper portion of buffer means;

FIG. 7 is an enlarged section view of the conveyor equipment taken along the line VII - VII in FIG. 3;

FIG. 8 is an enlarged section view of the conveyor equipment taken along the line VIII - VIII in FIG. 3;

FIG. 9 is a front view of the middle portion of the conveyor equipment in FIG. 1A;

FIG. 10 is a front view of the terminating end portion of the conveyor equipment in FIG. 1A;

FIG. 11 is a schematic front view of a conveyor equipment in accordance with a second embodiment of

the present invention;

FIG. 12 is a plan view of the conveyor equipment in FIG. 11;

5 FIG. 13 is a perspective view of a timing belt and a workpiece in accordance with the second embodiment of the present invention;

10 FIG. 14 is a schematic front view of a conveyor equipment in accordance with a third embodiment of the present invention;

FIG. 15 is a section view of the conveyor equipment taken along the line XV - XV in FIG. 14;

FIG. 16 is a side view of workpiece conveyance means in accordance with another embodiment of the present invention; and

FIG. 17 is a perspective view of workpiece conveyance means in accordance with yet another embodiment of the present invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS

FIG. 1A and FIG. 1B show schematic views of the entire system of a conveyor equipment in accordance with a first embodiment of the present invention.

The conveyor equipment comprises a workpiece receiving process A for receiving elongate lead frames with a plurality of electronic component elements from the preceding process, a separating process B for separating the electronic components from the elongate portion of the lead frame, measuring processes C and D for measuring the electric characteristics of the electronic components, a marking process E for printing marks on the electronic components by means of a laser marker or the like means, an NG (no-good) component removing process F for removing electronic components having deteriorated characteristics, a ranking process G for distributing the electronic components into several ranks, and a taping process H for taping the lead terminals of the electronic components.

An endless timing belt 1 as shown in FIG. 2 is provided throughout the above-mentioned processes. The timing belt 1 is made of a non-magnetic rubber material and formed with internal teeth 2 provided at a constant pitch P_t on the internal surface of the timing belt 1 and retainer grooves 3 which are grouped in units of three and provided widthwise at a constant pitch on the external surface of the timing belt 1. The retainer grooves 3 of each group horizontally retain three plate-type lead terminals 6 of

a radial-lead type electronic component 5 selected as an object to be conveyed in the present invention.

The timing belt 1 is driven in a direction as indicated by the arrows in FIG. 1A. at different pitches by means of five drive pulleys 10 through 14. Among these drive pulleys, the pulleys 10, 12, and 13 are driven intermittently by a drive motor 15 via a shaft 16 and index heads 17 through 19, where the pulleys 10 and 13 are driven intermittently by 2-pitch (2P.) while the pulley 12 is driven by 1-pitch (1P.). The pulley 11 is driven intermittently by a pulse motor 20 by 40-pitch (40P.) while the pulley 14 for the taping process is driven continuously by the drive motor 15 via the shaft 16 and a belt 21. Therefore, several processes having different feed pitches are included in one conveyor equipment in such way as follows: the timing belt is driven by 2-pitch at the workpiece receiving process A through the measuring process C, by 40-pitch at the measuring process D, by 1-pitch at the marking process E, by 2-pitch at the NG component removing process F and the ranking process G, and continuously at the taping process H. It is to be noted that the average driving speed of each process is identical.

Between adjoining processes having a great feed pitch difference, i.e., at the border sections between the measuring process C and the measuring process D as well as between the measuring process D and the marking process E, there are provided large-scale buffer means 22 and 23 for absorbing the great feed pitch difference of 40-pitch. Between adjoining processes having a small feed pitch difference, i.e., at the border sections between the marking process E and the NG component removing process F as well as between the ranking process G and the taping process H, there are provided small-scale buffer means 24 and 25 for absorbing the small feed pitch difference of 2-pitch.

The following describes the specific construction of

the above-mentioned conveyor equipment.

At the commencing end of the conveyor equipment, there are provided three pulley units 30, 31, and 32 as shown in FIG. 3. The lowermost pulley 30 is suspended by an arm 33 being swingable forward and backward and urged by a spring 34 forward (in a direction as indicated by the arrow in FIG. 3), whereby a constant tension is applied to the returning portion of the timing belt 1. The returning portion of the timing belt 1 is guided from the pulley 30 via the intermediate pulley 31 and the toothed guide pulley 32 to the receiving process A, where a guide rail 35 having a construction as shown in FIG. 4 is provided horizontally.

The rail 35 is constructed by fixing a non-magnetic rail guide 37 onto a mounting base 36 and further fixing thereon a non-magnetic head guide 38. Beside the rail guide 37, there are fixed two yokes 39 and 40 with interposition of a permanent magnet 41. The upper portions of the yokes 39 and 40 protrude slightly above the permanent magnet 41 so as to guide the timing belt 1 smoothly along a rail groove formed by the yokes 39 and 40 and the permanent magnet 41.

The lead terminals 6 of an electronic component 5 retained in the retainer grooves 3 of the timing belt 1 are put close to the yokes 39 and 40 without contact. Therefore, a closed magnetic circuit is formed from the permanent magnet 41 via the yoke 39, lead terminals 6, yoke 40 to the permanent magnet 41, so that the lead terminals 6 are strongly attracted toward the retainer grooves 3. Hence, the yokes 39 and 40 concurrently serve as guide members for the timing belt 1 and as magnetic circuit forming members. The leftward movement of the electronic component 5 in FIG. 4 is checked by the head guide 38, while the rightward movement of the electronic component 5 is checked by widened portions 6a of the lead terminals 6 and a side edge of the retainer groove 3, whereby the lateral displacement of the electronic component 5 is prevented.

At the hindmost end of the rail 35, there is provided a drive pulley 10 as shown in FIG. 5. The drive pulley 10 is provided with a drive shaft 43 which is driven intermittently by 2-pitch by the index head 17. On the drive shaft 43, there are successively fixed a non-magnetic head guide 44, a yoke 45, a permanent magnet 46, and another yoke 47. Meanwhile, a non-magnet sprocket 48 is fixed outside the periphery of the permanent magnet 46 between the yokes 45 and 47. The sprocket 48 is engaged with the internal teeth 2 of the timing belt 1 so as to rotatively drive the timing belt 1. Also in the above construction, a magnetic circuit is formed from the permanent magnet 46 via the yoke 45, lead terminals 6, and the yoke 47 to the permanent magnet 46, so that the electronic component 5 is retained stably in the retainer grooves 3 of the timing belt 1. Just above the drive pulley 10, there is provided a fixed guide plate 49 whose circular arc surface 49a guides the external surface of the timing belt 1, whereby the electronic component 5 is prevented from falling off or being displaced when the workpiece conveyance direction changes from straight into a circular arc direction. It is to be noted that since the other drive pulleys 11 through 13 have the same construction as that of the drive pulley 10, no description is presented for those pulleys herein.

The timing belt 1 which has passed through the drive pulley 10 is driven downward along a rail 50 (refer to FIG. 3) and then turned upward by a presser pulley 51. The rail 50 has the same construction as that of the rail 35 shown in FIG. 4 so that the electronic component 5 conveyed downward is prevented from falling off the timing belt 1 by means of the attraction power of a permanent magnet. The presser pulley 51 is continuously pushed downward by means of a spring 51a, absorbing an inertia force generated in the 40-pitch operation of the succeeding measuring process D, and preventing the timing belt 1 from overrunning. A shock

absorber 52 is provided in order to elastically receive the upward movement of the pulley 51.

A large-scale buffer means 22 comprises a pillar 54 stood uprightly and a lift member 55 attached vertically slidably on the front surface of the pillar 54. The upper end of the lift member 55 is connected to a chain 56 which is connected to a weight 59 provided behind the pillar 54 via two sprockets 57 and 58 mounted at the uppermost end of the pillar 54 as shown in FIG. 6. The weight 59 is fixed to a slide plate 69 attached vertically slidably on the back surface of the pillar 54. The weight 59 is designed to have a weight greater than the total weight of the lift member 55 including pulleys 60 and 61 and rails 70 and 71 as described in detail hereinafter, whereby the lift member 55 is continuously urged upward. At the uppermost and lowermost end portions of the lift member 55, there are provided rotatable support pulleys 60 and 61 respectively. To the both sides of the lift member 55, there are fixed a pair of rails 70 and 71 extending vertically. As shown in FIG. 7, the upper support pulley 60 is rotatably mounted by a bearing 63 to a shaft 62 which is fixed to the lift member 55. The upper support pulley 60 has a non-magnetic head guide 64, a non-magnetic flange 65, yokes 66 and 67 and a permanent magnet 68 which is provided between the yokes 66 and 67, where the flange 65 and the yoke 66 form a groove for guiding the timing belt 1. Since the timing belt 1 is wound tightly around the pulley 60 due to the weight of the aforesaid weight 59, the timing belt 1 is guided by the flange 65 in order to prevent the permanent magnet 68 from being damaged. When the timing belt 1 moves around the support pulley 60, the lead terminals 6 of the electronic component 5 are stably retained in the retainer grooves 3 by a magnetic force exerted from the permanent magnet 68 so as to prevent the electronic component 5 from falling off the timing belt 1.

The lower pulley 61 is employed to apply downward tension to the returning portion of the timing belt 1, and it does not have such permanent magnet as provided in the upper pulley 60.

As shown in in FIG. 8, a non-magnetic rail guide 74 is fixed in front of the lift member 55 via a spacer 72 by means of a bolt 73, and the rails 70 and 71 are provided at both sides of the rail guide 74. The rail 70 has non-magnetic head guide 75, yokes 77 and 78, and a permanent magnet 81 which is interposed between yokes 77 and 78, where a rail groove for guiding the timing belt 1 is formed by the yokes 77 and 78 and the permanent magnet 81. In the same manner, the rail 71 has head guide 76, yokes 79 and 80, and a permanent magnet 82. By the means of the above construction, when the timing belt 1 moves vertically along the rails 70 and 71, the lead terminals 6 of the electronic component 5 are retained stably in the retainer grooves 3 of the timing belt 1 by magnetic forces exerted from the permanent magnets 81 and 82. It is to be noted that the rail 70 has a length slightly greater than the rail 71.

The timing belt 1 which has passed through the rail 71 of the buffer means 22 is guided into a horizontal direction by a presser pulley 84 to be driven along a rail 85 through the measuring process D. The rail 85 has the same construction as the rail 35 shown in FIG. 4. After a measuring operation is completed, the timing belt 1 enters into the marking process E via buffer means 23 as shown in FIG. 9. The buffer means 23 has the same construction as that of the above-mentioned buffer means 22, thus no description is presented for the buffer means 23 herein.

The timing belt 1 is fed by 2-pitch before the buffer means 22, by 40-pitch between the buffer means 22 and the buffer means 23, and by 1-pitch after the buffer means 23.

Therefore, just before the drive pulley 11 carries out a 40-pitch operation, the forward buffer means 22 (lift member

55) is positioned at the uppermost end thereof, whereas the backward buffer means 23 (lift member 23a) is positioned at the lowermost end thereof. When the drive pulley 11 starts to operate, the forward buffer means 22 moves down, whereas the backward buffer means 23 moves up simultaneously. When the 40-pitch operation is completed, the forward buffer means 22 becomes positioned at the lowermost end thereof, whereas the backward buffer means 23 becomes positioned at the uppermost end thereof. Afterwards, while the drive pulley 11 stops, the forward buffer means 22 moves up gradually applying a certain tension force to the timing belt 1 fed from the measuring process C by 2-pitch, whereas the backward buffer means 23 moves down gradually feeding the timing belt 1 toward the marking process E by 1-pitch.

In this way, the two buffer means 22 and 23 move in the opposite direction to absorb the feed pitch differences.

Through the marking process E, the timing belt 1 is fed by 1-pitch along the rail 86 by the drive pulley 12. The drive pulley 12 has the same construction as the pulley 10 shown in FIG. 5, while the rail 86 has the same construction as the rail 35 shown in FIG. 4. Succeeding the marking process E, small-scale buffer means 24 as shown in FIG. 9 is provided before the NG component removing process F. This buffer means 24 comprises a rotatable buffer pulley 88 located below the drive pulley 12 and a guide pulley 89 located at the same level as the drive pulley 12. The buffer pulley 88 is vertically movable while being urged downwardly by a spring 91. Therefore, the buffer pulley 88 can absorb the pitch difference while keeping the tension of the timing belt 1. Forward and backward of the buffer pulley 88, there are provided a pair of vertical rails 92 and 93 having a permanent magnet in the same manner as the rail 35 shown in FIG. 4, so that these rails prevent the electronic component 5 from falling off when the timing belt 1 passes through the buffer means 24.

As shown in FIG. 10, after passing through the buffer means 24, the timing belt 1 is fed by 2-pitch from the NG component removing process F to the ranking process G along a rail 95 which has the same construction as the rail 35 shown in FIG. 4. At the hindmost end portion of the rail 95, there is provided small-scale buffer means 25 having the same construction as that of the buffer means 24. After passing through the buffer means 25, the timing belt 1 is continuously fed into the taping process H via a rail 96 which has the same construction as the rail 35 shown in FIG. 4. In the taping process H, the electronic component 5 is transferred from the timing belt 1 to the taping pulley 14 to be subject to a taping process between the taping pulley 14 and another pulley (not shown). The timing belt 1 which has released the electronic component 5 passes through the lower portion of the conveyor equipment to return to the commencing end.

FIGS. 11 and 12 show schematic views of a conveyor equipment in accordance with a second embodiment of the present invention.

The conveyor equipment comprises a first process I, a second process J and a third process K for carrying out prescribed processes on a workpiece of radial-lead type electronic component 5. As shown in FIG. 13, an endless timing belt 100 is employed throughout the above-mentioned processes. This timing belt 100 is made of a non-magnetic rubber material and formed with internal teeth 101 provided at a constant pitch on the internal surface thereof and retainer grooves 102 which are grouped in units of three and provided widthwise at a certain pitch on the external surface thereof. The retainer grooves 102 horizontally retain three plate-type lead terminals 6 of an electronic component 5. Rod-shaped permanent magnets 103 are embedded widthwise inside the internal teeth 101 in order to attract the lead terminals 6 toward the retainer

grooves 102. Due to the above construction, even when the workpiece conveyance direction is vertical, the electronic component 5 can be prevented from falling off the timing belt 100. Furthermore, there is no need to mount any magnet to relevant pulleys or rails, whereby simplified constructions of the conveyor equipment and buffer means are permitted.

The timing belt 100 is driven by three drive pulleys 110, 111, and 112 at different pitches in the direction as indicated by the arrows in FIG. 11. Among these pulleys, the first drive pulley 110 is always driven by a motor 113 at a constant pitch, while the second and third drive pulleys 111 and 112 are driven by motors 114 and 115 being capable of varying feed pitches respectively. Particularly the second drive pulley 111 is installed on a movable plate 118 together with buffer pulley 116 and guide pulley 117. The movable plate 118 is guided slidably horizontally by a guide rail 119 and is horizontally movable by means of a motor 120 and a ball screw 121 which constitute a shifting mechanism. The buffer pulley 116 is movable vertically while being urged downwardly by urging means 122 such as a spring or a weight in order to absorb the feed pitch difference between the preceding and succeeding processes of the drive pulley 111. The guide pulley 117 is provided to change the feed direction of the timing belt 100 into horizontal direction after passing through the buffer pulley 116.

Just after the first and third drive pulleys 110 and 112, there are also provided buffer pulleys 123 and 124 and guide pulleys 125 and 126 respectively. At the forward and backward end portions of the conveyor equipment, there are provided guide pulleys 127, 128, 129, 130, and 131 and tension pulleys 132 and 133 so as to apply a certain tension force to the returning portion of the timing belt 100.

The following describes the operation of the conveyor

equipment having the above-mentioned construction. Supposing that the second process J has the shortest processing time, the processing time of the first process I is four times as long as that of the process J and the processing time of the third process K is two times as long as that of the process J. The timing belt 100 is driven by 4-pitch in the first process I, by 1-pitch in the second process J, and by 2-pitch in the third process K. At the same time, workpieces 5 are processed in units of four simultaneously in the process I, one by one in the process J and in units of two simultaneously in the process K. In this way, all the processes can be synchronized so as to increase the processing speed of the entire conveyor system.

In this case, the feed pitch difference between the processes I and J is absorbed by the buffer pulley 123, the feed pitch difference between the processes J and K is absorbed by the buffer pulley 116, and the feed pitch difference between the processes K and I is absorbed by the buffer pulley 124.

It is now assumed that the feed pitch of the second process J is changed from 1-pitch into 2-pitch and the feed pitch of the third process K is changed from 2-pitch into one-pitch. In this case, the feed pitch of the second motor 114 is changed to 2-pitch and the feed pitch of the third motor 115 is changed to one-pitch. At the same time, the motor 120 is driven to move the movable plate 118 rightward to the position as indicated by the two-dot chain lines in FIG.11. With the above operation, the space X_1 of the second process J is extended to a space X_2 , on the contrary, the space Y_1 of the third process K is reduced to a space Y_2 . This change of space is required because the process having a large feed pitch necessitates a large space in order to process a greater amount of workpieces simultaneously, whereas a small space is enough for the process having a small feed pitch. The construction as

described above leads to a high space usability as well as a high capability of coping with change of feed pitch.

Although the movable plate 118 in the second embodiment is provided with two pulleys (buffer pulley 116 and guide pulley 117) as buffer means, it may be provided with three pulleys in the same manner as the buffer means 22 or 23 in the first embodiment.

FIGS. 14 and 15 show schematic views of a conveyor equipment in accordance with a third embodiment of the present invention.

The conveyor equipment of the present embodiment comprises a first process L, a second process M and a third process N. A timing belt 100 which has the same construction as that in the second embodiment is provided throughout those processes. The second process M employs a vertical furnace 140 such as a heat treating furnace or an ultraviolet ray irradiating furnace in which a support pulley 141 being movable vertically is inserted. This support pulley 141 for supporting the internal surface of the forwarding portion of the timing belt 100 is rotatably mounted to the front surface of the uppermost end portion of the lift plate 143. To the front surface of the lowermost end portion of the lift plate 143, there is rotatably mounted a presser pulley 142 for pressing the internal surface of the returning portion of the timing belt 100. As shown in FIG. 15, a nut member 144 is fixed to the rear surface of the lift plate 143. This nut member 144 is engaged with a ball screw 146 driven by a lift motor 145 and is guided by a guide rail 147 slidably vertically.

Therefore, when the lift motor 145 is driven, the lift plate 143 is moved vertically by the ball screw 146, so that the support pulley 141 and the presser pulley 142 can be moved vertically integrally.

A buffer pulley 149 is arranged forward the lift plate 143, while a presser pulley 150 is arranged backward the

lift plate 143. Forward the buffer pulley 149, there is provided a drive pulley 148 which determines the feed pitch of the timing belt 100 passing through the first process L.

The buffer pulley 149 is vertically movable and urged by a spring 149a so as to apply a constant tension force to the timing belt 100, whereby excessive tension or slackening applied to the timing belt 100 accompanied by the vertical movement of the lift plate 143 is absorbed.

Backward the vertical furnace 140 in the second process M, there are provided a drive pulley 151, a buffer pulley 152, and a guide pulley 153. The drive pulley 151 determines the feed pitch of the timing belt 100 passing through the vertical furnace 140. Furthermore, succeeding the third process N, there are provided a drive pulley 154, a buffer pulley 155, and a guide pulley 156. The drive pulley 154 determines the feed pitch of the timing belt 100 passing through the third process N.

It is to be noted that the numerals 160 through 166 denote guide pulleys, and the numerals 167 and 168 denote tension pulleys.

In case that the processing time of the vertical furnace 140 in the above-mentioned embodiment needs to be changed, it is only necessary to vertically move the lift plate 143. For instance, by moving the lift plate 143 upwardly, the length of the timing belt 100 inside of the vertical furnace 140 is so increased that the workpiece stays inside of the vertical furnace 140 for a longer time.

Since the length of the forwarding portion of the timing belt 100 may be insufficient in the above case, the insufficiency in length of the timing belt 100 may be compensated with the presser pulley 142 for the returning portion of the timing belt 100.

Although the support pulley 141 and the presser pulley 142 are mounted commonly to the lift plate 143 in the above-mentioned embodiment, the construction is not limited to the

above-mentioned one. For example, it is possible that only the support pulley 141 is mounted to the lift plate 143 whereas the presser pulley 142 is omitted.

The present invention is not restricted to the aforesaid embodiments and includes a variety of modifications within the scope of the present invention.

As a means for retaining a workpiece on the timing belt other than the method of using an attraction force of a permanent magnet, as shown in FIG. 16, retainer grooves 201 having narrow openings may be formed on the external surface of the timing belt 200 to retain the lead terminals of an electronic component. In order to take out the lead terminals from the retainer grooves 201, the timing belt 200 can be bent so that the external surface of the belt becomes convex to widen the openings of the retainer grooves 201, or the electronic component may be pulled sideward from the timing belt. In another way, retainer holes having no openings may be formed widthwise in the timing belt.

Instead of a timing belt, a chain 210 having attachments 210a as shown in FIG. 17 may be used to mount a workpiece holder 211. The workpiece holder 211 is made of a non-magnetic insulating material with an upright rib 212 provided at a side portion thereof. This rib 212 is formed with retainer grooves 213 into which the lead terminals 6 of an electronic component 5 can be inserted to be retained. At a upper portion of the workpiece holder 211, there is formed a carrier surface 214 for carrying the body of the electronic component 5, and a permanent magnet 215 is embedded in the holder 211. With the above construction, the lead terminals 6 of the electronic component 5 are attracted to the carrier surface 214 by the permanent magnet 215, whereby the electronic component 5 can be held stably in the workpiece holder 211 against any inertia force possibly generated when the timing belt is

driven intermittently or against the change of the feed direction.

It is to be noted that the construction of the workpiece holder is not limited to the construction of the above-mentioned embodiment where the retainer grooves 213 for retaining the lead terminals 6 are provided. For example, a workpiece holder may be provided with both a recess portion for storing the body of an electronic component 5 and a permanent magnet embedded under the recess portion.

It is further to be noted that the objective workpiece of the present invention is not limited to an electronic component. Also the electronic component is not limited to a radial-lead component having plate-type lead terminals. Any radial-lead component having round-bar type lead terminals, any chip component having magnetic external electrodes, and any electronic component having a magnetic casing are acceptable. For instance, in order to convey a chip component having magnetic caps on both sides, a recess portion to hold the chip component may be provided at a constant pitch on the external surface of a timing belt, or may be formed on a workpiece holder.

A belt having perforations provided at a certain pitch may be selected as the workpiece conveyance means instead of a timing belt or a chain. Any of these conveyance means is suitable for intermittently feeding a workpiece with high positional precision. In order to retain a workpiece to the workpiece conveyance means, a workpiece holder may be attached to a timing belt or a belt with perforations instead of forming retainer grooves integrally on the external surface of a timing belt.

The magnet means is not limited to a permanent magnet, and an electromagnet may be used instead. It is easy to mount an electromagnet instead of the permanent magnet particularly to stable rails.

Although the present invention has been fully described by way of example with reference to the accompanying drawings, it is to be noted here that various changes and modification will be apparent to those skilled in the art. Therefore, unless otherwise such changes and modifications depart from the scope of the present invention as defined by the appended claims, they should be construed as included therein.

A divisional application (GB 9419214.3) has been filed that corresponds to this application.

CLAIMS:

1. Conveyor apparatus for conveying a workpiece with a magnetically attractable portion, comprising:

an endless workpiece conveyance means;

5 workpiece retaining means uniformly spaced on said endless workpiece conveyance means, for positioning one or more workpieces in a feed direction of said workpiece conveyance means;

drive means for moving said workpiece conveyance means intermittently by a prescribed pitch; and

magnet means for attracting said magnetically attractable portion of a said workpiece toward said workpiece retaining means.

2. Apparatus according to Claim 1, wherein said
15 workpiece conveyance means comprises a timing belt having uniformly spaced teeth on an inner surface thereof and said drive means comprises a drive pulley having teeth for engaging said teeth of said timing belt.

20 3. Apparatus according to Claim 2, wherein said apparatus is adapted for a workpiece in the form of a radial-lead component having a plurality of lead terminals arranged in parallel, wherein said workpiece retaining means comprises one or more sets of retainer
25 grooves formed widthwise on an outer surface of said



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timing belt with a spacing for receiving said lead terminals therein.

4. Apparatus according to claim 3, wherein the grooves of a set are uniformly spaced.

5 5. Apparatus according to Claim 2 or 3, further comprising a guide rail for slidably guiding said timing belt, said magnet means comprising a magnet provided in the guide rail.

10 6. Apparatus according to claim 4, wherein said guide rail comprises a pair of yokes between which the magnet is arranged, the yokes and the magnet together defining a rail groove along which the timing belt is guided.

15 7. Apparatus according to Claim 2 or 3, wherein said magnet means comprises magnets embedded in said timing belt at uniformly spaced apart positions.

20 8. Apparatus according to Claim 1, wherein said workpiece conveyance means comprises an endless chain, said workpiece retaining means comprises a plurality of non-magnetic workpiece holders uniformly spaced on said chain, and said magnetic means comprises a magnet for each workpiece holder for attracting the magnetically attractable portion of a said workpiece towards said workpiece holder.

25 9. Apparatus according to claim 8, wherein the apparatus is adapted for a workpiece having lead



terminals, a said workpiece holder comprising retainer grooves for receiving the lead terminals therein.

10. Apparatus according to any of claims 2 to 7, comprising a plurality of drive means for moving said workpiece conveyance means by different feed pitches, and further comprising buffer means between adjoining ones of said drive means having different feed pitches, said buffer means, in use, absorbing a difference in feed pitch between said adjoining drive means and maintaining a tension of said workpiece conveyance means.

11. Apparatus according to claim 10, further comprising continuous drive means for moving the conveyance means continuously at a substantially constant speed, and buffer means for absorbing, in use, a difference in feed pitch between said continuous drive means and an adjoining drive means, and for maintaining a tension of said workpiece conveyance means.

12. Apparatus according to claim 10 to 11, wherein said buffer means comprises:

a lift member movable substantially vertically;
a support pulley for guiding a first surface of said timing belt and being rotatably mounted on said lift member;
a pair of presser pulleys positioned in the feed



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direction respectively before and after the support pulley for pressing a second surface of said timing belt; and

5 urging means for urging said lift member in a substantially vertical direction away from said presser pulleys.

13. Apparatus according to claim 12, wherein said urging means comprises means for urging said lift member upwardly with a force greater than the combined
10 weight of said lift member and said support pulley.

14. Apparatus according to claim 12 or 13, further comprising a magnet provided substantially around the entire periphery of the support periphery, for attracting said magnetically attractable portion of a
15 said workpiece, and a pair of substantially vertical rails for slidably, guiding the inner surface of the timing belt, the rails being positioned at both sides of said lift member and being provided with magnets for attracting said magnetically attractable portion
20 of a said workpiece.

15. Apparatus according to claim 1, 8 or 9, comprising a plurality of drive means for moving said workpiece conveyance means by different feed pitches, and further comprising buffer means between adjoining
25 ones of said drive means having different feed pitches, said buffer means, in use, absorbing a



difference in feed pitch between said adjoining drive means and maintaining a tension of said workpiece conveyance means.

16. Apparatus according to claims 10 to 15, wherein:

5 at least one of said drive means has an adjustable feed pitch;

 said buffer means is provided succeeding said drive means adjustable; and

10 a shifting mechanism is provided for shifting said drive adjustable means and said buffer means integrally in a feed direction of said timing belt.

17. Apparatus according to any preceding claim, further comprising a rotatable lift support means for supporting an inner surface of said workpiece conveyance means, a lift drive mechanism for raising or lowering said lift support means in a substantially vertical direction, and buffer means for absorbing an excessive or insufficient feed pitch of said workpiece conveyance means caused by vertical movement of said lift support means.

18. A method for conveying a workpiece having a magnetically attractable portion, the method wherein the workpiece is received by retaining means provided at a uniform spacing on a workpiece conveyance means, the conveyance means being moved intermittently by a prescribed feed pitch, the workpiece being held.



relative to the workpiece retaining means by magnetic attraction of the magnetically attractable portion, and the workpiece retaining means holding the workpiece positively in position in the feed direction of the workpiece conveyance means.

19. A method or apparatus substantially as hereinbefore described with reference to the accompanying drawings.



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