

COMBINED SEQUENCER AND
ELECTRICAL COMPONENT INSERTER MACHINE

Background of the Invention

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Field of the Invention

This invention relates to a combined machine that collects components from a variety of sources, positions the components in sequence on a conveyor which transfers the components to another conveyor for transport to a component placement or insertion head.

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Summary of the Prior Art

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It has been conventional in the process of automatically assembling axial lead electrical components to printed circuit boards to have a plurality of taped series of identical components aligned on a machine which removes the components from the tape and places them in a predesigned sequence on a conveyor. The conveyor then transports the components through a retaping station so that components are taped in the desired sequence for insertion into the board. A machine of this latter type is illustrated in commonly owned U.S. Patent No. 4,119,206. Thereafter, the taped roll of sequenced components is placed on an insertion machine which removes the components from the tape, bends the component leads and inserts the leads down through preselected openings in the printed circuit board. A

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cut-clinch unit located beneath the board cuts off excess lead wire and bends the wire over to physically fasten the component to the board. Machines of this latter type are illustrated in commonly owned U.S. Patent No's. 4,080,730 and 4,403,390.

5 It is desirable, however, to combine the functions of the sequencing and inserting machines into a single machine. U.S. Patent No. 3,455,493 illustrates a machine of this latter type.

10 Summary of the Invention

 It is an object of this invention to provide a combined sequencing and insertion machine in which a conveyor receives components from dispensers which
15 remove components from a taped series in a predetermined sequence, the conveyor delivers the sequenced components at a transfer station to another conveyor which transports the components to an insertion head which bends the component leads and
20 inserts the leads into preselected openings in a printed circuit board. A cut-clinch unit then attaches the component to the board.

 It is still a further object of this invention to provide two drive modes between a sequencing
25 conveyor and conveyor for transporting components to an insertion head, one drive mode permitting the conveyors to be operated in timed relation while a second drive mode permits the conveyors to be operated independently. In the first drive mode, the drive to
30 the sequencing conveyor drives the transport conveyor and in the second drive mode, the drive to the

insertion head drives the transport conveyor. The first drive mode is to recharge the transport conveyor and the second drive mode is the automatic indexing while inserting components into the printed circuit board.

5 It is another object of this invention to provide in a combined sequencing and inserting machine a component replacement and test station at the insertion head which permits the operator to insert into a sequence of components a missing component resulting from a component testing
10 inadequate at the sequencer or failing to be properly transferred between the sequencer and the inventor.

 It is a further object of this invention to provide a combined component sequencing and insertion machine wherein the components are body centered and lead trimmed at the
15 sequencing station and lead centered and lead trimmed at the insertion station.

 It is also an object of this invention to provide a combined component sequencing and insertion machine wherein the components are tested and faulty components removed at
20 the sequencing station, and faulty components replaced at the insertion station.

 It is another object of this invention to provide a component inspection station downstream from a transfer station positioned between a sequencing station and
25 insertion station of a combined axial lead component sequencing and insertion machine.

 The present invention provides a combination axial lead electrical component sequencing and inserting machine for placing the components on a printed circuit board
30 comprising: a sequencer conveyor for receiving components from a source; a verifier adjacent said sequencer conveyor for checking the acceptability of the component; means for removing unacceptable components from said sequencer conveyor; a component transfer station adjacent said
35 sequencer conveyor for receiving the components and including a transport conveyor to convey the components; a

component insertion means for receiving the components from said transport conveyor and positioning the components on the board; means for driving said sequencer conveyor; means for interconnecting said sequencer and transport conveyors and operating said driving means for conjointly displacing said sequencer and transport conveyors; means for driving said transport conveyor, and means for disconnecting said sequencer and transport conveyors and operating said transport conveyor driving means so that said transport conveyor is driven while said sequencer conveyor is idle.

Our co-pending UK Patent Application No. 8711989 of even date herewith, describes and claims a sequencing and inserting machine for placing electrical components on a printed circuit board. The machine comprises a conveyor for transporting the components, a rotatable disc means including a pair of axially spaced wheels each having a plurality of recessed shoulders for receiving the leads of the components, means for lifting the components off the conveyor onto the disc means, body centering means and lead trimming means.

Our co-pending UK Patent Application No. 8711990 of even date herewith, describes and claims a component insertion machine comprising a repair station located at the insertion head of an electrical component machine, the repair station permitting the testing and placement of components into the sequence of components to be inserted into printed circuit boards. The repair station includes a door which is movable to close the repair station or permit access thereto.

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Brief Description of the Drawings

Figure 1 is an illustration of the combined sequence and inserting machine of this invention;

Figure 2 is an exploded perspective view of the drive between the sequencer conveyor and the transport conveyor;

Figures 3a and 3b are views illustrating the body centering and lead trimming mechanism;

Figures 4a to 4c are views illustrating the various positions of the component while passing through the body centering and lead trimming mechanism;

Figure 5 is a perspective view of the transport conveyor;

Figure 6 is a side elevational view of the details of the insertion head drive for the transport conveyor and

Figures 7 to 9 are views of the repair station.

Description of the Preferred Embodiment

Attention is directed to Figure 1 which illustrates side by side free standing sequencing machine 10 and inserting machine 12. The sequencing machine is of the type illustrated in U.S. Patent No. 4,119,206 and includes a base 14 supporting a driven conveyor 16 which receives components from dispensers 18 which remove components from taped reels (not shown) in a predetermined sequence and place the components on the conveyor. The components are passed through a verifier 20 to determine the acceptability of the component. Unacceptable components are blown off the conveyor by blower 25 leaving a blank space in the sequence. Also, if there is a component missing in the sequence at the verifier, the machine will stop so the operator can inspect for faults in the sequencer.

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Thereafter, the components pass through the transfer station 22 onto the transport belt 24 which conveys the components to the insertion machine. The insertion machine is of the type illustrated in U.S. Patent No's. 4,080,730 and 4,403,390 and has a base 26 supporting an insertion head 28 which receives the components, forms the leads into a staple shape and inserts the leads into preselected openings of a printed circuit board which is carried on the assembly table 30 of the insertion machine. Located downstream from the transfer station 22 is an inspection station 32 which will tell the machine control the location of missing components in the sequence occurring from components not being properly transported through the transfer station 22. If an inadequate component was removed at the verifier, the machine control will tell the inspection station that a blank space in the sequence is coming and should be ignored. If, however, a component does not properly pass through the transfer station, the inspection station will notice the absence of the component and stop the machine so the operator can check for a jammed area, for example, in the transfer station. The machine control will automatically stop the entire combined machine when the missing component sequence reaches the repair station 34 located at the operator's station 36 at the insertion head 28. Further, the machine control will designate to the operator the particular component that must be replaced and the operator can then test and replace the missing component into the sequence of components to be inserted into the board.

In the operation of the combined machines, there are two drive modes, one in which the sequencer 10 and the transport belt 24 are driven by the sequencer drive mechanism and the other drive mode in which the transport belt 24 is driven by the insertion head independently of the sequencer drive mechanism. The purposes of the first drive mode is to recharge the transport belt 24 with components during machine set up. The second drive mode is the normal automatic drive of the transport belt 24 as the insertion head removes components from the transport belt and automatically inserts the components into the printed circuit board.

Attention is now directed to Figure 2 which illustrates the common drive mechanism 38 for the sequencer 10 and the transfer station 22 which is used to load up an empty transport belt. A motor 40 drives a gear box 42 which has an output drive 44 to the verifier of the sequencing machine and an output drive 46 to drive both the sequencer 10 and the belt 24. The belt 24 comprises a pair of timing belts retained in tracks 98 and each timing belt has clips 48 for receiving the component leads. A drive belt 50 drives a shaft 52 which drives the chain 54 of the conveyor 16. The components (C) are deposited on the conveyor chain 54 by the dispensers 18. The conveyor chain 54 passes the components through the verifier 20 which has a blow-out station 25 which removes inadequate components from the chain 54. The chain 54 is illustrated in figure 2 in a raised position to better illustrate the pivotal body centering fingers 56 which hold the body for the lead cutting discs to be described in greater detail hereinafter.

Figures 3a and 3b illustrate the sequence of the component being passed through the body centering fingers 56, the leads being trimmed and the component being deposited in the clips 48.

5 As components (c) are carried along in the cavity 55 of the sequencer conveyor chain 54, they approach the driving cutter wheels 57 which have shoulders 58 which contact the component leads (L) and raise the leads out of the cavity 55 so that the component is supported on the shoulders 58 of
10 the wheels 57. Thereafter the component body (b) passes through the centering fingers 56 which centers the component body (b) between the wheel 57. The downward load of the fingers 56 is resisted by the undersurface of body (b) of the component being supported by the arcuate uprights 59' of
15 the support surface 59 carried on the machine frame (not shown). As the component passes through the ends 60 of the fingers 56, the leads are trimmed between the shoulders 58 of wheels 57 and the outboard small cutter wheels 61. The shoulders 58 and arcuate uprights 59' are taken from
20 different center lines and after the leads are trimmed, the shoulders 58 drop away from the surface 59 and the component body (b) is dragged along surface 59 by the uprights 62 of the chain 54. Pivottally supported on the cutter wheel shaft 63 is a door 64 which contacts the upper surface on the
25 component leads so that the leads are retained between the door 64 and surface 59' as it is pushed along by the uprights 62. Thereafter, the component leads are positioned down into the clips 48 and the door 64 closes above the component leads to prevent the components from falling out
30 of the clips. At this time the uprights 62 which are pivoted at 61 fall off cam 66' and pass by the component leads so that the leads are securely positioned in the clips 48 without being bent during the transfer from the sequencer to the transport belt 24.

The shaft 52 drives a belt 68 coupled to the free wheeling disc 70 of the clutch 72. The opposite side 74 of clutch 72 is keyed to the shaft 76 which drives the belt 24. Mounted on a bracket 78 is a cylinder 80 secured to the yoke 82 controlling the position of clutch member 74. The clutch member 74 has slots 86 and cylinder 80 will slide clutch member 74 on shaft to 76 to engage the pins 84 in slots 86 to drivingly couple shaft 52 to shaft 76 to drive the belt 24. In the movement of the cylinder 80, the cylinder bottoms out in both directions which determines the stroke of clutch member 74. In the above described recharged mode where it is desirable to get components to the head quickly, the clutch 72 is engaged to couple the drive to the sequencer chain and the drive to the transfer belt together.

Attention is now directed to Figure 5 which illustrates details of the transport belt 24. The tracks 98 comprise a pair of opposed guides 95 mounted to the machine frame. The guides 95 comprises upper and lower elongated housings 97, 97' having spaced opposed openings 99 for receipt of the component leads. Carried in the guides 95 are timing belts 101 on which clips 48 are mounted. As the belts 101 are driven, the clips 48 retain the leads (L) and the leads are received in the openings 99 with their ends adjacent the shoulders 103 of housings 97 so the leads are laterally retained while being transported normal to their longitudinal axis.

Attention is now directed to Figures 1, 6 and 8 which illustrate the operation of the insertion head 28 and the drive for the belts 101 during the automatic insertion operation. The components (c) are carried by belt 101 to a position above the insertion head. The belts then travel downwardly and under the insertion head around sprockets 107 carried on shafts 121. The components pass through a guide chute 100 which has lead centering surfaces 116 which center the components and positions the components for lead

trimming, forming and inserting mechanism 102. The components pass through a guide chute 100 which has lead centering surfaces 116 which center the components and positions the components for lead trimming, forming and inserting mechanism 102. The components are taken off the end 114 of the chute 100 by clips 48 and positioned on the shear block 109. Thereafter, the upper shear block 111 trims the leads and the scrap is carried by clips 48 off the shear block 109 and falls from the ramp 113 into a collection bin 115.

The insertion head 28 is operated by the cylinder 104 which pivots the arm 106 of linkage 108 attached to the insertion head. The arm 110 of link 108 drives indexing mechanism 117 which indexes the gear to drive the timing belts 101. As the insertion head moves down, the arm 110 is pivoted upward causing pin 91 to move in slot 93 of housing 119 against the bias of spring 127. The bottom 123 of arm 117 carries link 125 connected to shaft 133 through a one way clutch (not shown). As the insertion head is lowered, the arm 117 is moved upward and the link 125 strikes stop 129. At this time, the clutch 72 is disengaged and the solenoids 135 and 90 (Fig. 2) are engaged to lock the drive gears and the shaft 76. Also, in the sequence of operation, the sequence at this time is depositing a component. The solenoids 135 and 90 each have rollers 92 which engage star wheels 96 on the shafts 121 and 76 to lock the shafts in fixed positions with a pair of clips 48 positioning a component directing under the head.

As the insertion head is raised, the arm 110 will be lowered until the pin 107 bottoms out in slot 93 which will move arm 117 downward rotating link 125 clockwise (Fig. 6). At this time, the solenoids 90 and 135 are disengaged removing rollers from star wheels 96 leaving the shaft 74 and shafts 121, free to rotate. The link 125 drives gear 131 through a one way clutch (not shown) on shaft 133 and

indexes gears 139 counter clockwise one incremental spacing of clips 48 to place another component under the insertion head. The shaft 133 is carried on a link 141 pivoted at 142 on the head casing 143. A tension spring 145 is secured
5 between the link 141 and the head casing to bias gear 131 toward gear 139 to obtain zero backlash between the gears 131 and 139. An adjustable stop 151 limits the pivotal movement of the link 141 and permits accurate adjustment of the meshing of gears 131 and 139.

10 Reference is now made to Figures 5 to 7 which illustrate the chute 100 and the repair station 34. The components are moved through the chute 100 by the clips 48 (see Figure 5) until they are carried off the end 114 of the chute by the clips and onto the shear block 109 of the
15 insertion head tooling 102.

Located in the chute 100 is the repair station 34 which comprises a door 118 slidably disposed on the sides 120 of the housing 122 attached to the chute 100 by bolts 124. When a blank occurs in the sequence, the machine will stop
20 with the empty clips 48 in front of the slots 126 (see Figure 7) in the repair station. The machine control will tell the operator the component to select and the operator will place the component on the shelves 120 and in the relieved areas 128 of the drive wheel 130. As the door is
25 withdrawn from the closed position, the racks 132 engage the teeth 134 on wheels 130 rotating the wheels 130 with the component leads through the contacts 136, 138 to test the component. If the component test is adequate, then the door can be further withdrawn and the wheels 130 rotated to dump
30 the component leads into the slots 126. If the replacement component does not test adequate the shelf is returned to the closed position and by removing the component another replacement component can be tested.

In the above manner, a separate sequencing and
35 inserting machine can be used together to verify components,

inspect for missing components and repair the sequence of components at the operator's station at the insertion head.

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Claims:

1. A combination axial leaded electrical component sequencing and inserting machine for placing the components on a printed circuit board comprising:
- 5 a. a sequencer conveyor for receiving components from a source;
- b. a verifier adjacent said sequencer conveyor for checking the acceptability of the component;
- 10 c. means for removing unacceptable components from said sequencer conveyor;
- d. a component transfer station adjacent said sequencer conveyor for receiving the components and including a transport conveyor to convey the components;
- 15 e. a component insertion means for receiving the components from said transport conveyor and positioning the components on the board;
- f. means for driving said sequencer conveyor;
- g. means for interconnecting said sequencer and
- 20 transport conveyors and operating said driving means for conjointly displacing said sequencer and transport conveyors;
- h. means for driving said transport conveyor, and
- i. means for disconnecting said sequencer and
- 25 transport conveyors and operating said transport conveyor driving means so that said transport conveyor is driven while said sequencer conveyor is idle.
2. The machine of claim 1 further characterised by an
- 30 inspection station adjacent said transport conveyor functioning to determine the absence of the components in the sequence.
3. The machine of claim 1 further characterised by a
- 35 repair station at the insertion means.



4. The machine of claim 3 wherein said drive means is characterised by means to disconnect the drive to the transport conveyor.
- 5 5. The machine of claim 1 wherein said transport conveyor is characterised by clips to hold the component leads and said transfer station is characterised by upper and lower supports for the component, said upper support being pivotal to a position to securely place the component
10 leads into said clips.
6. A combination axial leaded electrical component sequencing and inserting machine for placing the components on a printed circuit board characterised by:
- 15 a. a sequencer for receiving components from a source;
- b. a component transfer station adjacent said sequencer including transport means for conveying the components;
- 20 c. a component insertion means for receiving the components from said transport means and positioning the components on the board; and
- d. drive means for driving said sequencer and said transport means in unison.
- 25 7. The machine of claim 6 including indexing means further characterised by having means to drive only said transport means, in an alternative mode of operation.
- 30 8. The machine of claim 1 wherein said sequencer conveyor is characterised by means to center the component body and trim the leads.
9. The machine of claim 1 wherein said insertion
35 means is characterised by means (116,109,111) to lead center the component and trim the leads.



10. A combination axial leaded electrical component sequencing and inserting machine characterised by:

a. a sequencer for receiving components from a source in a predetermined sequence;

5 b. a component transfer station adjacent the sequencer for receiving the components and including component transport means;

c. a component insertion means including means for receiving the components from said transport means.

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11. The machine of claim 8 further characterised by a repair station adjacent said insertion means functional to replace missing components in the sequence.

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12. The machine of claim 8 further characterised by inspection means adjacent the transport conveyor functional to determine the absence of components in the sequence.

13. The machine of claim 8 further characterised by a
20 common drive means for said sequencer conveyor and said transfer conveyor.

14. The machine of claim 11 wherein said drive means is characterised by means to disconnect the drive between
25 said sequencer conveyor and said transport conveyor.

15. A combination axial leaded electrical component sequencing and inserting machine substantially as hereinbefore described with reference to and as shown in the
30 accompanying drawings.

