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METHOD FOR CHANGING A PRODUCTION SETUP

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Field of the Invention

The present invention generally relates to the field of automatic assembly machines, and more particularly, relates to a method for switching from the parts setup for a first product to a second product.

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Background of the Invention

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In the electronics industry, assembly machines or pick-and-place machines are used to produce printed circuit boards (PCB). The pick-and-place machine uses a variety of components to build a PCB. The machine's head selectively picks components, held in feeders, from predetermined locations on an assembly table and places them on a printed circuit board. When the printed circuit board is completely populated the assembly machine populates the next board. These machines save a great deal of time and labor in populating PCBs. However, because of their large cost, they usually require a large production run in order to justify their expense. Just in time, manufacturing has reduced production run length. These shorter production runs result in the operator having to change from one product's setup to a second product's setup more frequently. This can result in errors and down time.

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Verification systems for pick-and-place machines have been developed to increase the operator's accuracy in setting up the machines. These systems include using bar-codes on the component reels and reading these bar codes before placing the components onto the production table. They also use lights to direct the operator where to place the feeder onto the production table. In order to ensure the operator's accuracy in placing the feeders onto the assembly table, these systems require that the operator first remove all the existing feeders, then scan the feeders before placing them back on the table. Since some of the components used in producing the first product may be the same

components used in the second product. The process of taking all the component feeders off the table and the placing them back on the table wastes operator time. Other systems instruct the operator, with respect to each slot on the table, to remove, remove and add or just add-a
5 component. This process still does not use all the information available to the assembly machine. The assembly of the first product may use a component in one slot, and may use that same component in the second product but in a second slot. This information is not taken advantage of by either of the described systems.

10 Thus, there exists need for a process which takes advantage of the full information available to the assembly machine to minimize the number of operator steps to change the setup from a first to a second product.

15 **Brief Description of the Drawings**

FIG. 1 is a drawing of a pick-and-place assembly machine;

FIG. 2 is a component feeder;

FIG. 3 is a component reel;

20 FIG. 4 is a flow chart of a method used by the assembly machine of FIG. 1 in a changeover process;

FIG. 5 is a schematic diagram of the changeover process;

FIG. 6 is a flow chart of a remove and add operation; and

FIG. 7 is a flow chart of a move operation.

25 **Detailed Description of the Drawings**

FIG. 1 shows an assembly machine, or pick-and-place machine 10. The assembly machine 10 has an assembly table 12, a pick-and-place head
30 14, a CRT 16, a controller 18 and a scanner 20. The assembly table 10 has a plurality of slots 22 which hold a plurality of feeders 24 (shown in FIG. 2). Each slot 22 has a LED 26 and a proximity sensor 28 which can be a variety of devices, and in the preferred embodiment is a hall effect sensor. The proximity sensors 28 senses when the feeder 24 is placed in one of the slots
35 22. The pick-and-place head 14 retrieves components from the feeders 24 located in the slots 22 and populates a printed circuit board (PCB). The

location of the components is critical, since the assembly machine 10 populates the PCB based upon a component being located in a particular slot 22. Misplacing the feeder 24 can result in a component being misplaced which may cause the PCB to malfunction. The CRT 16 is used to give instructions and information to the operator. The controller 18 controls all aspects related to the assembly machine 10.

The scanner 20 is used to verify the type of components on a component reel 30 (shown in FIG. 3). The scanner 20 scans a component ID tag 32 on the reel 30. This information is then passed to the controller 18 which verifies the information. The operator is then instructed to place the component reel 30 onto the feeder 24, and the operator is then asked to scan the feeder ID tag 34. With this information, the controller 18 can verify the component and track the performance of the feeder 24.

When production switches from a first printed circuit board to a second printed circuit board, the first step that the controller 18 performs is shown in FIG. 4. This process starts at block 100, then it determines the differences between the first product setup and the second product setup at block 102. Next, it determines which parts from the first setup need to be removed, and which parts from the second setup need to be added at block 104. At block 106, the controller determines if any of the parts that needed to be removed from the first setup also needed to be added in the second setup. These parts, or components, are designated to be moved from their present slot to their destination slot.

The process of FIG. 4 is shown graphically in FIG. 5. The slots 22 are numbered one through twenty. Note that an actual machine would probably have considerably more than 20 slots. Each part or component is given an alpha label and not every slot has a component or a part. The top diagram 502 represents the setup of the assembly table for a first product. The second diagram 504 represents the setup necessary to produce a second product, and the third diagram 506 graphically represents the changeover process. In 506, those parts that need to be removed are shown overlapping the top line 508, those parts that need to be added are shown straddling the bottom line 510. While, those parts that need to be moved from one slot to another slot are shown by the lines and arrows 512. The first step in changing from the setup in 502 to the setup in 504 will be to remove all those components shown straddling the top line 508, and not

associated with the lines 512. The next step would be to move those parts that are shown associated with the lines 512. For instance, part C will be moved from slot 4 to slot 11. Finally, the last step in the process would be to add those products straddling line 510. For instance, part Q-will be added to slot 3.

FIG. 6 describes a combined remove and add step, which is represented by what occurs at slot 6 of FIG. 5. There component D is first removed and then component S is added. The first step 600 requires that a feeder be removed from a slot and that the feeder then be placed on a storage rack. The second step 602 requires the operator to find the part reel. In block 604, the operator scans the reel to verify that it is the correct part. Next, the operator in block 608 scans the feeder ID tag and mounts the part reel onto the feeder. In block 610 the operator places the feeder in the slot directed by the assembly machine. This direction is usually conveyed by both the CRT and by lighting one of the LEDs 22 where the feeder is to be placed. Step 620 requires the operator to scan the feeder after it has been placed on the assembly table 12. By asking the operator to scan the feeder both before he places the feeder onto the table and after he places the feeder on the table, the assembly machine can ensure that the operator placed the correct feeder in the correct slot. The location of the feeder is sensed by the proximity sensor 28.

FIG. 7 describes a move operation. The operator is first told to remove a feeder, at block 700, from a particular slot. Once the controller senses that this has been done, the operator is then told to place that feeder in a second slot, in block 702. The controller then determines the time between removing the feeder and placing the feeder in the second slot. If the time is less than a threshold time, then the process continues by either going on to the next move step or starting the add steps. If the time exceeds a certain threshold, then the operator is directed to scan the part on the reel, and things continue from block 604 through 612.

The process described herein, saves time during changeovers, because the operator does not have to unload all the feeders, find new parts, scan them and load them into the slots. Further time is saved by move steps, where a part used in both setups is moved from one slot to the next slot. Having move steps saves the operator from having to remove a feeder, locate the appropriate part reel, scan the part reel, mate the reel to the feeder, and scan the feeder ID tag. Using the method described herein, production changeover time is decreased, making it economical to produce the short production runs required by just in time manufacturing.

What is claimed is:



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Claims

1. A method for changing a parts table from a first product to a second product, the parts table having a plurality of slots each-capable of holding a feeder containing a part, said method comprising the steps of:
- 5 a) determining, from a first product setup and a second product setup, which feeders need to be removed from the parts table;
- b) determining, from the first product setup and the second product setup, which parts need to be added to the parts table;
- 10 c) determining if any of the parts can be moved from a first slot to a second slot on the parts table;
- d) removing the feeders located at a destination slot of a feeder to be moved;
- e) moving the feeders that need to be moved according to step c;
- 15 f) removing the feeders that need to be removed according to step a and have not been removed in step d or e; and
- g) placing the parts that need to be added in a feeder and adding the feeders holding the parts to be added on the parts table.
- 20 2. The method according to claim 1, wherein step c further includes the steps of determining if the part in any feeder to be removed according to step a needs to be added according to step b.
3. The method according to claim 1 wherein step g further
- 25 includes the steps of:
- finding a part reel holding an appropriate part;
- scanning a part reel's ID tag;
- placing the part reel in a feeder;
- scanning a feeder's ID tag;
- 30 placing the feeder in a designated slot; and
- scanning the feeder's ID tag.

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4. A method of verifying the location or slot of a plurality of components on an assembly table of an assembly machine when changing from producing a first product on the assembly machine to a second product, the method comprising the steps of:

- 5 a) removing a plurality of feeders holding a component used to produce the first product and not used to produce the second product;
- b) moving a feeder, from a first slot to a second slot, having a component that is used in producing the first and the second product;
- c) finding a component used in producing the second product;
- 10 d) scanning an ID tag on the component used in producing the second product;
- e) inserting the component used in producing the second product into a feeder;
- f) scanning an ID tag of the feeder holding the component used in
- 15 producing the second product; and
- g) placing the feeder holding the component used in producing the second product in a slot designated by the assembly machine.

5. The method of claim 4, further including the step of

20 determining which components need to be removed, which components need to be moved, and which components need to be added.

6. The method of claim 5, wherein step (a) further includes the steps of:

- 25 i) alerting an operator to remove a feeder holding a component used to produce the first product and not used to produce the second product;
- ii) sensing when the feeder has been removed; and
- iii) repeating step (i) and (ii) until all the feeders holding
- 30 components which need to be removed have been removed.

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7. The method of claim 5, wherein step (b) further includes the steps of:

- i) alerting an operator to move a feeder holding a component used in producing the first and the second product;
- 5 ii) sensing when the feeder has been removed from a source slot;
- iii) sensing when the feeder has been place in a destination slot; and
- iv) repeating steps (i) to (iii) until all the feeder holding components which needed to moved have been moved..

10 8. The method of claim 7, further including the steps of:
 determining a time between steps (ii) and (iii);
 if the time is less than a threshold proceeding to step (iv); and
 if the time is greater than a threshold alerting the operator to
15 remove the feeder and proceed from step (d).

9. The method of claim 5, wherein steps (c) to (g) are repeated until all the components which need to be added have been added.

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METHOD FOR CHANGING A PRODUCTION SETUP

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Abstract of the Disclosure

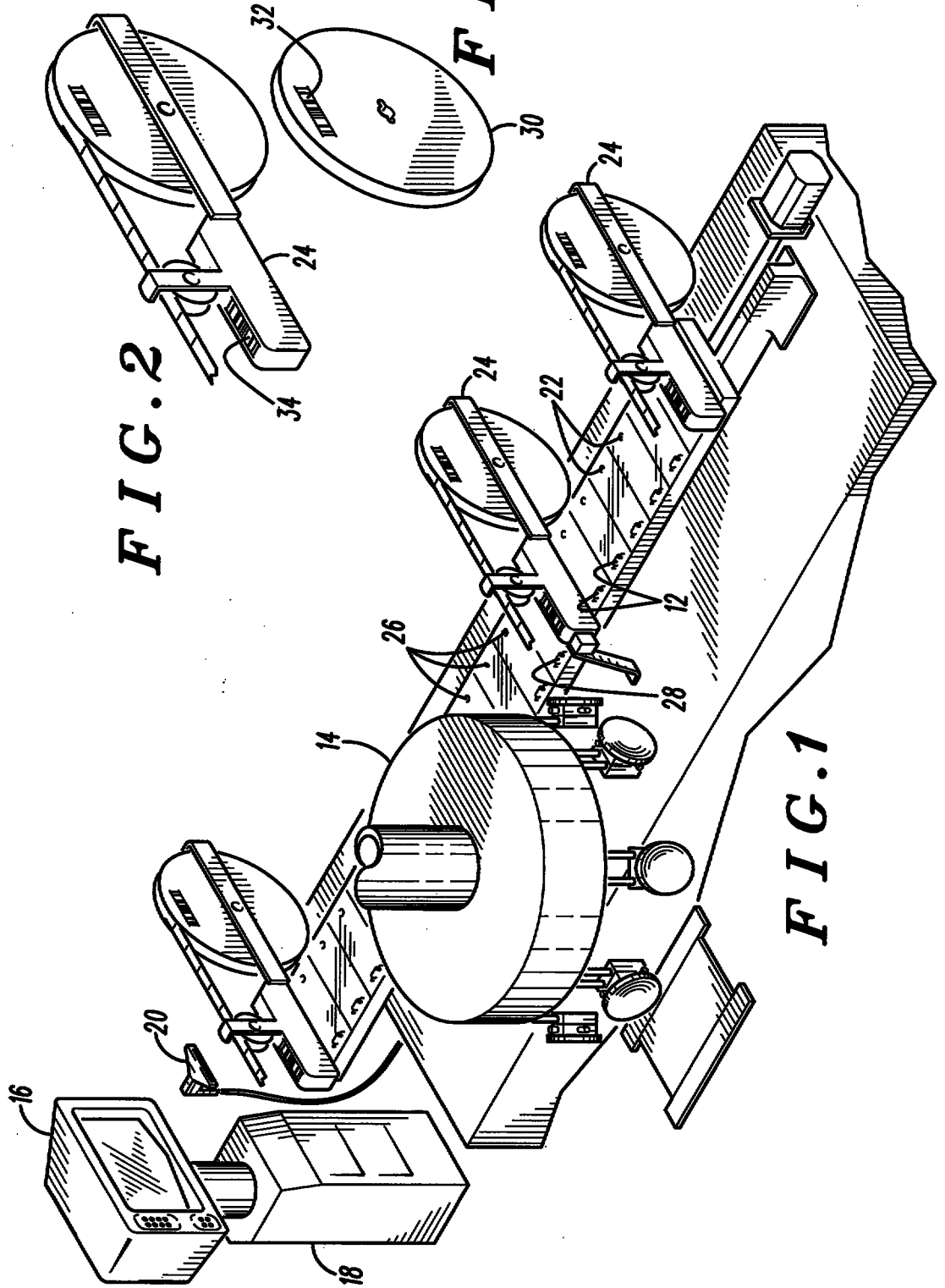
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A method of changing the setup of an assembly machine (10) from a first product to a second product. The assembly machine (10) has a plurality of slots (22) each of which hold a feeder (24) containing a component reel (30). The assembly machine (10) automatically assembles a printed circuit board from these components. When a changeover occurs the assembly machine (10) determines which components need to be added (104), which need to be removed and which can be moved (106). The assembly machine (10) then instructs an operator to first perform all the remove operations, then to perform all the move operations and last to perform all the add operations.

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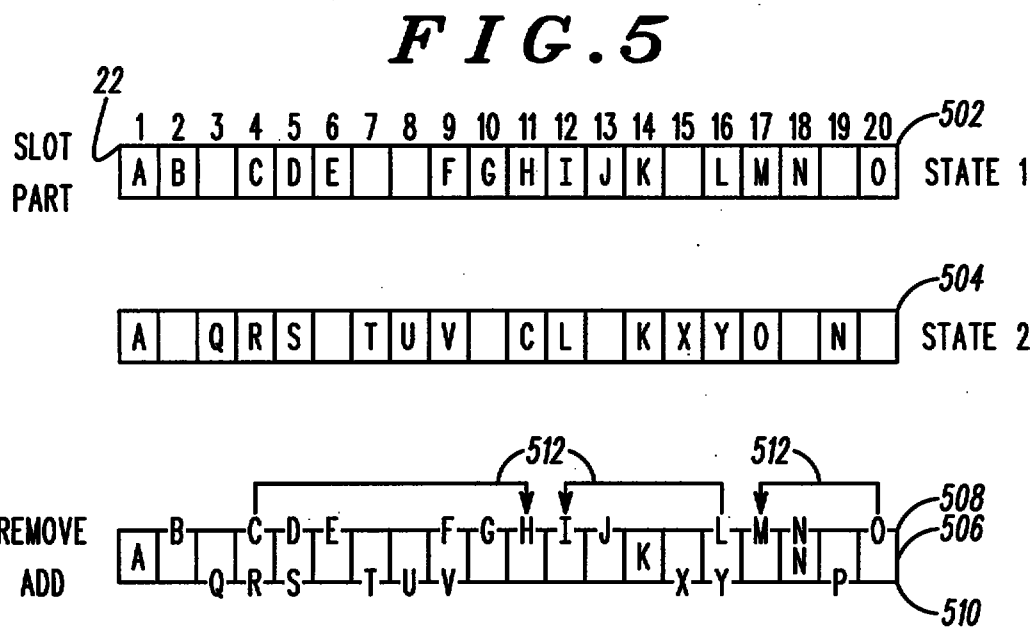
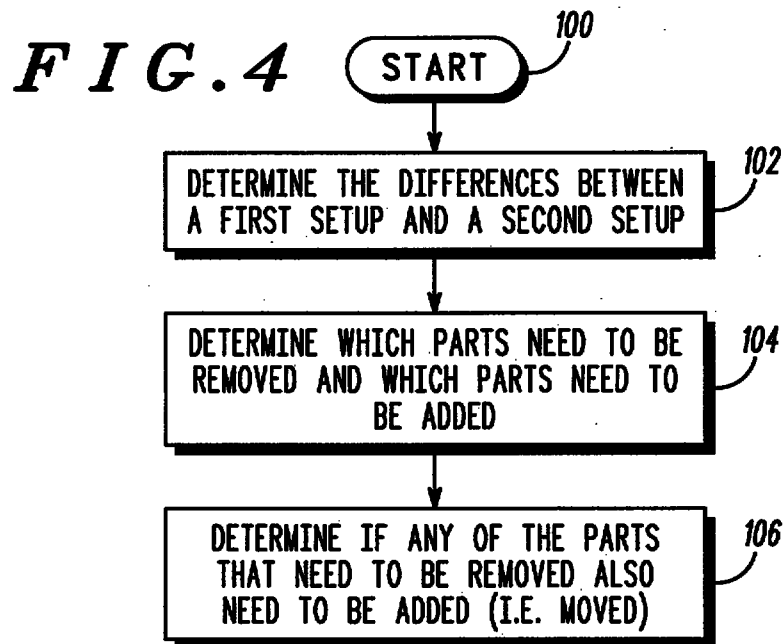
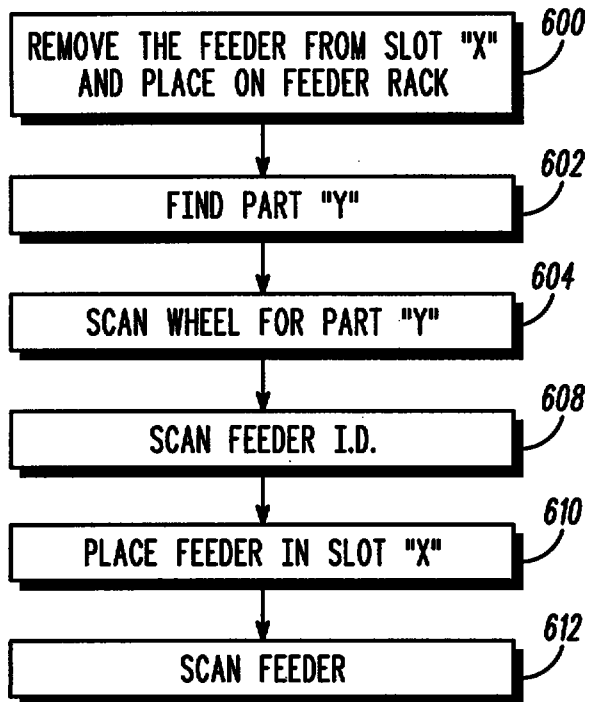
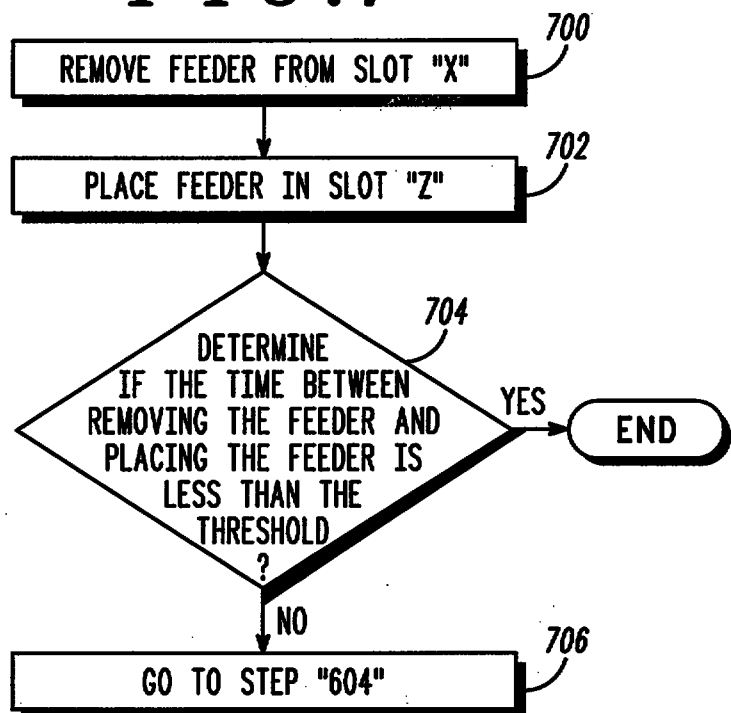


FIG. 6**FIG. 7**

METHOD FOR CHANGING A PRODUCTION SETUP

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Field of the Invention

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15 place machine uses a variety of components to build a PCB. The machine's head selectively picks components, held in feeders, from predetermined locations on an assembly table and places them on a printed circuit board. When the printed circuit board is completely populated the assembly machine populates the next board. These
20 machines save a great deal of time and labor in populating PCBs. However, because of their large cost, they usually require a large production run in order to justify their expense. Just in time, manufacturing has reduced production run length. These shorter production runs result in the operator having to change from one
25 product's setup to a second product's setup more frequently. This can result in errors and down time.

Verification systems for pick-and-place machines have been developed to increase the operator's accuracy in setting up the machines. These systems include using bar-codes on the component reels and
30 reading these bar codes before placing the components onto the production table. They also use lights to direct the operator where to place the feeder onto the production table. In order to ensure the operator's accuracy in placing the feeders onto the assembly table, these systems require that the operator first remove all the existing feeders, then scan the
35 feeders before placing them back on the table. Since some of the components used in producing the first product may be the same

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METHOD FOR CHANGING A PRODUCTION SETUP

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Abstract of the Disclosure

10 A method of changing the setup of an assembly machine (10) from a first product to a second product. The assembly machine (10) has a plurality of slots (22) each of which hold a feeder (24) containing a component reel (30). The assembly machine (10) automatically assembles a printed circuit board from these components. When a changeover occurs the assembly machine (10) determines which components need to be added (104), which need to be removed and which can be moved (106). The assembly machine (10) then instructs an operator to first perform all the remove operations, then to perform all the move operations and last to perform all the add operations.

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Fig. 5

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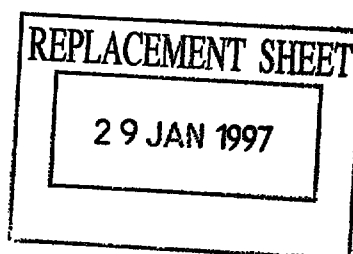


TEXT OF THE ABSTRACT

METHOD FOR CHANGING A PRODUCTION SETUP

A method of changing the setup of an assembly machine (10) from a first product to a second product. The assembly machine (10) has a plurality of slots (22) each of which hold a feeder (24) containing a component reel (30). The assembly machine (10) automatically assembles a printed circuit board from these components. When a changeover occurs the assembly machine (10) determines which components need to be added (104), which need to be removed and which can be moved (106). The assembly machine (10) then instructs an operator to first perform all the remove operations, then to perform all the move operations and last to perform all the add operations.

Fig. 1.





Claims

1. A method for changing a parts table of an assembly machine from a first product to a second product, the assembly machine including a controller, the parts table having a plurality of slots each capable of holding a feeder containing a part, said method comprising the steps of:
 - a) determining, in the controller, from a first product setup and a second product setup, which feeders need to be removed from the parts table;
 - 10 b) determining, in the controller, from the first product setup and the second product setup, which parts need to be added to the parts table;
 - c) determining, in the controller, if any of the parts can be moved from a first slot to a second slot on the parts table;
 - d) removing the feeders located at a destination slot of a feeder to be
15 moved;
 - e) moving the feeders that need to moved according to step (c);
 - f) removing the feeders that need to be removed according to step a and have not be removed in step (d) or (e); and
 - g) placing the parts that need to be added in a feeder and adding the
20 feeders holding the parts to be added on the parts table.
2. The method according to claim 1, wherein step (c) further includes the steps of determining if the part in any feeder to be removed according to step (a) needs to be added according to step (b).
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3. The method of according to either claim 1 or claim 2, wherein step (g) further includes the steps of:
 - finding a part reel holding an appropriate part;
 - scanning a part reel's ID tag;
 - 30 placing the part reel in a feeder;
 - scanning a feeder's ID tag;
 - placing the feeder in a designated slot; and
 - scanning the feeder's ID tag.
- 35 4. A method of verifying the location or slot of a plurality of components on an assembly table of an assembly machine when changing from producing a first product on the assembly machine to a second



product, the assembly machine including a controller, the method comprising the steps of:

- a) removing a plurality of feeders holding a component used to produce the first product and not used to produce the second product;
- 5 b) moving a feeder, from a first slot to a second slot, having a component is used in producing the first and the second product;
- c) finding a component used in producing the second product;
- d) scanning an ID tag on the component used in producing the second product;
- 10 e) inserting the component used in producing the second product into a feeder;
- f) scanning an ID tag of the feeder holding the component used in producing the second product; and
- g) placing the feeder holding the component used in producing the
- 15 second product in a slot designated by the controller of the assembly machine.

5. The method of claim 4, further including the step of determining, in the controller of the assembly machine, which components need to be removed, which components need to be moved, and which components

20 need to be added.

6. The method of claim 5, wherein step (a) further includes the steps of:

- 25 i) alerting an operator to remove a feeder holding a component used to produce the first product and not used to produce the second product;
- ii) sensing when the feeder has been removed; and
- iii) repeating step (i) and (ii) until all the feeders holding
- 30 components which need to be removed have been removed.

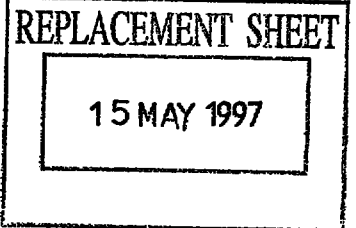
7. The method of either claim 5 or claim 6, wherein step (b) further includes the steps of:

- 35 i) alerting an operator to move a feeder holding a component used in producing the first and the second product;
- ii) sensing when the feeder has been removed from a source slot;
- iii) sensing when the feeder has been place in a destination slot; and



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iv) repeating steps (i) to (iii) until all the feeder holding components which needed to moved have been moved.

8. The method of claim 7, further including the steps of:
- 5 determining a time between steps (ii) and (iii);
if the time is less than a threshold proceeding to step (iv); and
if the time is greater than a threshold alerting the operator to
remove the feeder and proceed from step (d).
- 10 9. The method of any one of claims 5 to 8, wherein steps (c) to (g) are
repeated until all the components which need to be added have been
added.





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- iv) repeating steps (i) to (iii) until all the feeder holding components which needed to moved have been moved.
8. The method of claim 7, further including the steps of:
- 5 determining a time between steps (ii) and (iii);
if the time is less than a threshold proceeding to step (iv); and
if the time is greater than a threshold alerting the operator to
remove the feeder and proceed from step (d).

