

METHOD OF, APPARATUS FOR, ASSEMBLING ELECTRONIC
AND/OR ELECTRIC PARTS TO BASE MEMBER WITH
PREVENTION OF DAMAGING OF PARTS

The present invention relates generally to an apparatus ^{and method of} for assembling electronic and/or electric parts, such as an IC chips to a base member, such as a substrate of a circuit board. More specifically, the invention relates to an electronic and/or electric parts assembling apparatus ^{and method}, which is particularly adapted for assembling parts having connector pins or legs to be inserted into openings formed through a substrate.

Description of the Background Art

Japanese Patent First (unexamined) Publication (Tokkai) Showa 51-149562 and Japanese Patent Second (examined) Publication (Tokko) Showa 49-9824 discloses an electronic parts assembling apparatus for assembling electronic parts to a substrate. Such apparatus has a chucking mechanism chucking an electronic part to be assembled. The chucking mechanism is driven on a two-dimensional coordinate system formed on a plane substantially in parallel to a base member, such as a substrate of a circuit board, by means of a transverse driving mechanism. The chucking mechanism is also driven along an axis substantially perpendicular to the aforementioned two-dimensional coordinate system toward and away from the base member by means of a axial driving mechanism. The electronic parts as a work is carried by the chucking mechanism to a position in the aforementioned coordinate system, to assemble the part onto the base member, by the transverse driving mechanism. Subsequently, the chucking mechanism is driven toward the base member to assemble the electronic part to the base member with inserting pin or leg

1 thereof to an opening formed through the base member.

2 In such conventional apparatus, the chucking
3 mechanism maintains the part until the pin is fully
4 inserted. Faulty insertion of the pin is detected by
5 detecting stress strain generated at clinch edge of an
6 anvil mechanism by means of strain gauge or
7 piezoelectric element.

8 In the conventional apparatus set forth above,
9 because the chuck mechanism is driven toward the base
10 member by means of the axial driving mechanism carrying
11 the electronic part, the pin tends to be bent or, in the
12 worst case, damaged when the position of the pin offset
13 from the opening to insert. On the other, when the
14 electronic part has more than one pins are provided, it
15 is possible to detect faulty insertion after clamping
16 one or more pins by means of the clinch edge. Namely,
17 when one or some of the pins are accurately inserted and
18 clamped, faulty insertion of one of the pin cannot be
19 detected until the clinch edge reaches the pin inserted
20 in failure. In such case, the parts assembled in
21 failure has to be removed from the base with releasing
22 the clamped pin from the base. This operation has to be
23 done manually.

24 SUMMARY OF THE INVENTION

25 With the defect in the background art in mind,
26 it is an object of the present invention to provide an
27 apparatus for assembling electronic and/or electric
28 parts to a base member which can eliminate possibility
29 of damaging connector pins.

30 In order to accomplish the aforementioned and
31 other objects, an electronic and/or electric parts
32 assembling apparatus, according to the present
33 invention, inserts pin or pins of the electronic and/or
34 electric parts with a predetermined pressure in a chuck
35 released condition. Magnitude of motion of the electric
36 and/or electric parts is monitored for detecting

completion of insertion.

According to one aspect of the invention, there is provided an apparatus for assembling an electronic and/or electrical part on a substrate, which part has at least one
5 connector pin to be inserted through a corresponding opening formed in said substrate, comprising:

means for holding said part and carrying the latter to a predetermined orientation in relation to a substrate at which said at least one pin is aligned to said
10 corresponding opening;

means for shifting said part holding means toward said substrate for inserting said at least one pin into said corresponding opening;

means, cooperative with said shifting means, for
15 monitoring the magnitude of shifting of said part holding means to detect that said part holding means is at a predetermined position relative to said substrate, at which said at least one pin is inserted into said opening to a predetermined small depth;

20 means, responsive to said monitoring means detecting said part holding means at said predetermined position, for deactivating said shifting means and releasing said part holding means;

means responsive to said deactivating means
25 releasing the part, for exerting a controlled magnitude of depression force to further insert said at least one pin through said opening;

means for monitoring the position of said part to detect the position of the part where said at least one pin
30 is fully inserted through said opening; and

means, responsive to said part position monitoring means detecting said fully inserted position of said at least one pin, for clamping the end of said at least one pin for fixing said part on said substrate.

35 According to another aspect of the invention, there is provided an apparatus for automatically assembling

an electronic and/or electric part on a substrate, which part has at least one connector pin to be inserted in a corresponding opening in said substrate, comprising:

5 chucking means for chucking said part at a predetermined chucking station to which said part is supplied and carrying the latter to a predetermined orientation in relation to a substrate, at which said at least one pin of said part is aligned to said opening, from said chucking station;

10 shifting means for driving said chucking means to cause shifting said chucking means in a direction perpendicular to said substrate and towards said substrate for inserting said pin into said opening;

15 releasing means, cooperative with said chucking means, for monitoring the magnitude of shifting of said chucking means to detect that said part is at a predetermined position relative to said substrate, at which said pin is inserted into said ^{opening} to a predetermined depth which is small in relation to a full stroke of insertion, 20 and for then deactivating said shifting means and operating said chucking means to release said part from said chucking means;

25 depressing means, responsive to said releasing means, for exerting a controlled magnitude of depression force to further insert said at least one pin through said opening;

30 depression magnitude monitoring means for monitoring the position of said part to detect the position of the part where said at least one pin is fully inserted through said opening; and

clamping means, responsive to said part position monitoring means detecting said fully inserted position of said pin, for clamping end of said pin for fixing said part on said substrate.

35 In the preferred construction, the depressing means exerts the depression force, magnitude of which is determined in view of bending strength of the pin and is

1 set smaller than the bending strength. Practically, the
2 depressing means comprises a mechanical component which
3 resiliently generates the depression force and a
4 pneumatic component which pneumatically generates the
5 depression force. The mechanical component of the
6 depressing means is maintained at pre-loaded condition
7 while the chucking means holds the part and normally
8 exert the depression force to the part. The pneumatic
9 component which is cooperative with the mechanical
10 component and active after the mechanical component
11 completes depression for its own full stroke for
12 depression.

13 According to the preferred construction, the
14 clamping means is cooperative with the chucking means so
15 as to move in synchronism with movement of the chucking
16 means for being constantly positioned in alignment with
17 the chucking means across the substrate. The chucking
18 means comprises a chuck mechanism for chucking the part,
19 a chuck carrier mechanism carrying the chuck mechanism
20 over the substrate for shifting the chuck mechanism on a
21 plane substantially parallel to the substrate to
22 position the chuck mechanism at the predetermined
23 orientation, at which the pin of the part is aligned to
24 the opening. The chuck carrier mechanism comprises a
25 pivotal component mounting the chuck mechanism and
26 pivotally movable on the plane, and a linearly shifting
27 component associated with the pivotal component for
28 linearly shifting the chuck mechanism with the pivotal
29 component at least in a first direction.

30 Furthermore, the apparatus may further
31 comprise means for mounting the substrate, which
32 mounting means is movable in a second direction
33 perpendicular to the first direction for adjusting
34 relative position of the chuck mechanism and the
35 substrate in the second direction for aligning the pin
36 to the opening. The clamping means comprises a clamping

edge, a clamping edge carrier including a pivotal component which is pivotally moveable with carrying the clamping edge in synchronism with pivotal movement of the pivotal component of the chucking means, and a linearly shifting component associated with the pivotal component for linearly shifting the clamping edge with the pivotal component in the first direction in synchronism with linear movement of the linearly shifting component of the chucking means. The insertion monitoring means is operative to detect faulty insertion by detecting said part held at a position other than said position where said at least one pin is fully inserted through said opening, to actuate said holding means to remove the part from said substrate.

Also, the apparatus may further comprise a jig for straightening the pin removed from the substrate, and the chucking means carries the part, about which faulty insertion is detected, to the jig for repairing. Alternatively, the chucking means may be operative to re-align the part for re-alignment of the pin to the opening for re-insertion.

According to a further aspect of the invention, there is provided a method of assembling an electronic and/or electric part on a substrate, which part has at least one connector pin to be inserted in a corresponding opening in said substrate, comprising the steps of:

- holding said part;
- carrying said part to a predetermined orientation in relation to said substrate, at which said pin of said part is aligned to said opening;
- shifting said part toward said substrate for inserting said pin into said opening;
- monitoring the magnitude of shifting of said part to detect at a predetermined position relative to said substrate, at which said at least one pin is inserted into said corresponding opening in a predetermined small

magnitude;

detecting said part being at said predetermined position, for stopping shift of said part toward said substrate;

5 releasing said part;

exerting a controlled magnitude depression force to further insert said pin through said opening in response to releasing of holding;

10 monitoring the position of said part to detect the position of the part where said at least one pin is fully inserted through said opening; and

when the at least one pin is fully inserted clamping the end of said pin for fixing said part on said substrate.

15 The present invention will be understood more fully from the detailed description given herebelow and from the accompanying drawings of the preferred embodiment of the invention, which, however, should not be taken to limit the invention to the specific embodiment but are for explanation
20 and understanding only.

In the drawings:

Figure 1 is a front elevation of the preferred embodiment of an electronic parts assembling apparatus according to the invention;

25 Figure 2 is a side elevation of the preferred embodiment of the electronic parts assembling apparatus of figure 1;

Figure 3 is an enlarged section of a chuck mechanism incorporating an electronic parts insertion
30 magnitude monitoring arrangement, which chuck mechanism is employed in the preferred embodiment of the assembling apparatus of figures 1 and 2;

Figure 4 is an enlarged section of an electronic parts depressing arrangement employed in the preferred
35 embodiment of the assembling apparatus of figures 1 and 2

1 and cooperated with the check mechanism of Fig. 3;

2 Fig. 5 is a sectional view of a jig for
3 repairing bent pin of the electronic parts;

4 Fig. 6 is a section of an axial driving
5 mechanism employed in the preferred embodiment of the
6 assembling apparatus;

7 Fig. 7 is an enlarged side elevation of a
8 chuck housing in the chuck mechanism;

9 Fig. 8 is an enlarged section taken along line
10 VIII - VIII of Fig. 6;

11 Fig. 9 is a section of a rotatingly driving
12 mechanism employed in the assembling apparatus of the
13 invention;

14 Fig. 10 is a section taken along line X - X of
15 Fig. 9;

16 Fig. 11 is a section taken along line XI - XI
17 of Fig. 9;

18 Fig. 12 is a side elevation of a transversely
19 driving mechanism employed in the preferred embodiment
20 of the assembling apparatus of the invention;

21 Fig. 13 is a substrate base and driving
22 mechanism therefor, which is employed in the preferred
23 embodiment of the assembling apparatus;

24 Fig. 14 is a section of an anvil mechanism to
25 be employed in the preferred embodiment of the
26 assembling apparatus;

27 Fig. 15 is a side elevation of the anvil
28 mechanism;

29 Fig. 16 is a front elevation of a driving
30 mechanism for the anvil mechanism of Fig. 15 for driving
31 the anvil mechanism in a transverse direction; and

32 Fig. 17 is a side elevation of the
33 transversely driving mechanism of the anvil mechanism.

34 DESCRIPTION OF THE PREFERRED EMBODIMENT

35 Referring now to the drawings, particularly to
36 Figs. 1 and 2, the preferred embodiment of an assembling

1 apparatus for assembling electric or electronic part or
2 parts 12, such as an integrated circuit (IC) chip or
3 chips, to a substrate, according to the present
4 invention, is generally represented by the reference
5 numeral 11. As seen from Figs. 1 and 2, the electronic
6 part 12 is provided with one or more connector pins 12a
7 extending from part body and made of electrically
8 conductive material for establishing electrical
9 communication, which also serves as fixture of the
10 electronic part onto a base member 14, such as substrate
11 of a circuit board. Each pin 12a of the electronic part
12 is designed to be inserted through an opening 14a
13 (shown in Fig. 3) and extends therethrough to be clamped
14 at the side opposite to the side where the part body is
15 mounted for fixing the electronic part on the substrate.
16 The assembling apparatus 11 has a chuck mechanism 13
17 which chucks the electronic parts 12. The chuck
18 mechanism 13 is associated with a drive mechanism 15 to
19 be driven toward and away from a substrate 14 which
20 forms a base member for assembling the electronic parts
21 thereto. In the shown embodiment, the drive mechanism
22 15 drives the chuck mechanism 13 in vertical direction
23 along the axis of the chuck mechanism. Hereafter, this
24 drive mechanism 15 will be referred to as "axial driving
25 mechanism". The chuck mechanism 13 is also associated
26 with another drive mechanism 16. The driving mechanism
27 16 drives the chuck mechanism 13 transversely to the
28 axis of the chuck mechanism and thus will be hereafter
29 referred to as "transverse driving mechanism". The
30 transverse driving mechanism 16 drives the chuck
31 mechanism 13 substantially in parallel to the substrate
32 14 between a chucking position, at which the chuck
33 mechanism chucks the electronic parts 12 and
34 predetermined assembling position, at which the
35 electronic parts is assembled to the substrate 14.

36 In the practical assembling operation, the

1 chuck mechanism 13 is initially placed at the chucking
2 position. To the chucking position, the electronic part
3 12 is supplied. The chuck mechanism 13 chucks the
4 supplied electronic part 12. Then, the transverse
5 driving mechanism 16 drives the chuck mechanism 13 to
6 shift the latter above the substrate 14 to the
7 predetermined assembling position. When the chuck
8 mechanism 13 is positioned at the assembling position,
9 the axial driving mechanism 15 becomes active to drive
10 the chuck mechanism with the electronic part 12 toward
11 the substrate 14. By movement toward the substrate,
12 the pins 12a of the electronic part 12 is inserted into
13 the corresponding openings 14a of the substrate 14. At
14 the position, at which the pins 12a are inserted into
15 the opening 14a in a magnitude of 0.5 mm to 1 mm, the
16 axial driving mechanism 15 stops driving. Then, then
17 the chuck mechanism 13 releases the electronic part 12.
18 At this position, a depression mechanism 17 which is
19 shown in Figs. 3 and 4 becomes active to depress the
20 electronic part 12 toward the substrate with a
21 predetermined pressure. The pressure to be exerted on
22 the electronic part 12 by means of the depression
23 mechanism 17 is selected to be small enough so as not to
24 damage the pin or pins 12a. The magnitude of motion of
25 the electronic part 12 as depressed by the depression
26 mechanism 17 is monitored by means of an insertion
27 magnitude monitoring sensor 18. This sensor 18 is
28 designed to detect completion of insertion of the pins
29 12a through the openings 14a. When completion of
30 insertion is detected, the depression mechanism 17 stops
31 actuation.

32 Detailed construction of the preferred
33 embodiment of the assembling apparatus according to the
34 invention, will be discussed hereafter with reference to
35 Figs. 3 to 17. As shown in Fig. 3, the chuck mechanism
36 13 includes a pair of chucking arms 19 and 20 which have

1 chucking claws 19a and 20a at the free ends thereof.
2 The chucking arms 19 and 20 are associated with an air
3 cylinder assembly 21 which forms a part of the
4 depression mechanism 17 which will be discussed later.

5 The air cylinder assembly 21 comprises a
6 cylinder body 23 to which the axial intermediate
7 sections of the chucking arms 19 and 20 are pivoted by
8 means of pivots 22. The air cylinder assembly 21
9 further comprises a piston 24 which is slidably
10 disposed within the hollow space defined within the
11 cylinder body 23. This piston 24 are provided with
12 sealing rings 25 and 26 which sealingly contact with the
13 inner periphery of the cylinder body 23 to establish
14 air-tight seal and whereby define upper and lower air
15 chambers 28 and 29. The upper and lower air chambers 28
16 and 29 are communicated with an air pressure source (not
17 shown) to introduce therefrom the pressurized air. The
18 upper and lower air chambers 28 and 29 are also
19 communicated with the ambient air via ventilation ports
20 (not shown) for ventilating the air pressure. When the
21 piston 24 is to be driven upwardly, the pressurized air
22 is introduced into the lower pressure chamber 29 and the
23 ventilation port of the upper air chamber 28 is open to
24 ventilate the air pressure in the upper air chamber. By
25 the pressure difference thus created, the piston 24 is
26 driven upwardly. On the other hand, when the piston 24
27 is to be driven downwardly, the pressurized air is
28 introduced into the upper pressure chamber 28 and the
29 ventilation port of the lower air chamber 29 is open to
30 ventilate the air pressure in the lower air chamber. By
31 the pressure difference thus created, the piston 24 is
32 driven downwardly.

33 As will be seen from Fig. 3, the piston 24 is
34 formed to have a smaller diameter section 30a connected
35 to the general section 30b having a diameter greater
36 than that of the smaller diameter section and

1 substantially corresponding to the internal diameter of
2 the cylinder body 23. The smaller diameter section 30a
3 and the general section 30b are connected by a tapered
4 section 31. The profile of the piston 24 configured
5 as set forth above serves as cam surface for actuating
6 the chucking arms 19 and 20 between chucking position
7 and chuck releasing position.

8 The chucking arms 19 and 20 are provided
9 rollers 32 and 33 at upper ends thereof. The chucking
10 arms 19 and 20 are formed with recesses 34a at the
11 position intermediate between the pivoted sections and
12 the upper ends where the rollers 32 and 33 are provided.
13 Coil springs 34 are seated on the recesses 34a at one
14 ends. The other ends of the coil springs 34 are seated
15 on the cylinder body 23. Therefore, the chucking arms
16 19 and 20 are constantly biased inwardly at the upper
17 portion above the pivoted portion. Consequently, the
18 chucking arms 19 and 20 are normally biased in chuck
19 releasing direction. With this biasing force of the
20 coil springs 34, the rollers 32 and 33 are forced toward
21 the cam surface of the piston 24.

22 With this construction, while the piston 24 is
23 held at the upwardly shifted position as shown in Fig.
24 3, the rollers 32 and 33 contact with the general
25 section 30b to maintain the chucking arms 19 and 20 at
26 the chucking position against the coil springs 34. When
27 the piston 24 shifts downwardly, the rollers 32 and 33
28 comes to contact with the smaller diameter section 30a
29 to allow the chucking arms 19 and 20 to chuck releasing
30 position. Therefore, as will be appreciated, as long as
31 the chuck mechanism 13 holds the electronic part 12, the
32 piston 24 is held upwardly shifted position.

33 The depression mechanism 18 is associated with
34 the chucking mechanism 13 for cooperation therewith.
35 The depression mechanism 18 has an actuation head 35
36 which is generally of crank shaped configuration having

1 a contact section 35a contacting with the top end of the
2 electronic part 12, as shown in Fig. 4. The actuation
3 head 35 also has an upwardly shifted section 35b
4 connected to an intermediate vertically extending
5 section 35c. This actuator head 35 is associated with
6 an air cylinder assembly 36 has a cylinder body 37
7 defining a hollow and downwardly open chamber 38. A
8 power piston 39 with a seal ring 39a is sealingly and
9 thrustingly disposed in the chamber 38 to define a
10 pressure chamber 41. The power piston 39 is
11 mechanically connected to the actuation head 35 via a
12 piston rod 40. The pressure chamber 41 is communicated
13 with a pressurized air source 44 via a pressure supply
14 line 44a via a pressure regulator valve 43. A coil
15 spring 42 is disposed within the pressure chamber 41 for
16 normally exerting a downward biasing force to the
17 actuation head 35.

18 While the chucking arms 19 and 20 of the chuck
19 mechanism 13 are held in chucking position, the
20 actuation head 35 is held at a position shifted upwardly
21 with exerting spring force of the coil spring 42. In
22 the practical operation, the electronic part 12 is
23 carried by the chucking mechanism 13 at this condition.
24 At the assembling position where the carried electronic
25 part 12 is to be assembled to the substrate 14 and after
26 inserting the lower end portion of the pins 12a into the
27 openings 14a of the substrate in a given length, e.g.
28 0.5 mm to 1 mm, the chucking arms 19 and 20 are operated
29 to the chuck releasing position, the actuation head 35
30 with the electronic part 12 is shifted downwardly by the
31 spring force of the coil spring 42. When further
32 depression is required for completely inserting the pins
33 12a through the openings 14a, the air pressure is
34 introduced into the pressure chamber 41.

35 It should be appreciated that the spring force
36 of the coil spring 42 and the air pressure to be

1 introduced into the pressure chamber 41 are adjusted so
2 as not to cause deformation of the pins 12a even when
3 the pins are not accurately inserted into the openings
4 14a or offset from the opening.

5 The insertion magnitude monitoring sensor 18
6 comprises a rod member 45 thrustingly received through
7 an axial opening 47 formed through the piston 24. The
8 lower end of the rod member 45 is positioned to contact
9 with the contact section 35a of the actuation head 35.
10 Adjacent the top of the rod member 45, a high resolution
11 type photo-microsensor 46 is provided for monitoring
12 magnitude of displacement of the top end of the rod
13 member and whereby monitors insertion magnitude of the
14 pins 12a. The photo-microsensor 46 defines a rod
15 receptacle recess 48 between a light emitting section
16 46a and a photo sensing section 46b, to receive the top
17 end of the rod member 45. The rod receptacle recess 48
18 is so designed as to receive the top end of the rod
19 member 45 in a magnitude that the received top end
20 interferes the light emitted from the light emitting
21 section 46a when the chucking mechanism 13 accurately
22 chucks the electronic part 12, and to allow the top end
23 moving away from the recess to fully irradiate the light
24 emitted from the light emitting section 46a on the photo
25 sensing section 46b when the rod member 45 is placed at
26 the lowermost position corresponding to the fully
27 inserted position of the pins 12a.

28 In the practical operation, the
29 photo-microsensor 46 generates a faulty insertion
30 indicative signal when the light emitted from the light
31 emitting section 46a cannot be received. In this case,
32 the chuck mechanism 13 is operated to chuck the
33 electronic part 12 which is installed in failure, to
34 carry the electronic part to a repairing section where a
35 pin repairing jig 49 shown in Fig. 5. The jig 49 has
36 openings 49a with a tapered upper guide sections 49b.

1 The pins 12a of the electronic part 12 which is carried
2 to the repairing section is inserted into the opening
3 49a through the guide section 49b. During this process,
4 the pin which is bent due to faulty insertion can be
5 repaired into straight. Thereafter, the electronic part
6 12 is again carried by the chucking mechanism 13 to the
7 assembling position. Then, assembling operation is
8 again performed. If faulty insertion is again detected
9 by the photo-micro sensor 46, the electronic part 12 is
10 again chucked and carried to be replaced by new one.

11 As shown in Fig. 6, the axially driving
12 mechanism 15 includes a chuck housing 50 receiving the
13 chuck mechanism 13. The chuck housing 50 is supported
14 on a chuck holder 53 via a rotary bearing 51. The chuck
15 housing 50 is pivotable about the axis of the rotary
16 bearing 51 in vertical direction in a range of 90° .

17 The chuck holder 53 is provided with an
18 upwardly extending cylindrical boss section 52. The
19 boss section 52 extends through an opening 54 formed
20 through a rotary plate 55. The rotary plate 55 is
21 pivotable about the axis of the boss section 52. The
22 boss section 52 receives the lower end of a spline shaft
23 56. A bearing sleeve 57 surrounds the spline shaft 56.
24 The bearing sleeve 57 allows thrusting motion of the
25 spline shaft 56 but prevent rotational movement thereof.
26 The bearing sleeve 57 is rotatably supported on a base
27 frame 60 through bearings 58 and 59.

28 An air cylinder assembly 61 is provided in the
29 base frame 60. The air cylinder assembly 61 comprises a
30 cylindrical opening 61a defined in the base frame 60.
31 The cylindrical opening 61a opens at the lower end
32 thereof. The lower end of the opening 61a is closed by a
33 seal block 61b. A piston 62 with a piston rod 62a is
34 disposed within the cylindrical opening 61a to define
35 upper and lower pressure chambers 65 and 66 which are
36 connected to an air pressure source (not shown). The

1 piston rod 62a has a threaded position 63 at the lower
2 end. To the threaded lower end 63 of the piston rod
3 62a, a nut 64 engages for fixing the lower end to the
4 rotary plate 55. With the construction set forth above,
5 the piston 62 with the rotary plate 55, the chuck holder
6 53 and the chuck housing 50 is shifted downwardly by
7 introducing the pressurized air into the upper pressure
8 chamber 65. On the other hand, the chuck housing 50 is
9 driven upwardly by introducing the pressurized air into
10 the lower pressure chamber 66 which drives the piston
11 upwardly to drive the chuck holder 53 through the rotary
12 plate 55.

13 As shown in Fig. 7, the chuck housing 50 is
14 configured in essentially L-shape. The chuck housing
15 50 has a downwardly extending extension 50a and a
16 laterally extending extension 50b. Pair of chucking
17 claws 19a and 19b of mutually different chuck mechanisms
18 13 extend from each of the extensions 50a and 50b.
19 These chuck mechanisms 13 are selected depending upon
20 the type or configuration of the electronic part 12 to
21 be assembled.

22 In order to rotatably drive the chuck housing
23 50, the rotary bearing 51 is constructed in a form shown
24 in Fig. 8. The rotary bearing 51 includes a rotary
25 shaft 67 rigidly fixed to the chuck housing 50. The
26 rotary shaft 67 is rotatably supported on the chuck
27 holder 53 by means of a axially arranged pair of
28 bearings 67a and 67b. A pinion 68 is also fixed to the
29 rotary shaft 67. The pinion 68 engages a pair of racks
30 69 and 70. These racks 69 and 70 are disposed within a
31 pair of cylinders 69a and 70a defined at both sides of
32 the pinion 68 in the chuck holder 53. Air chambers 72
33 and 73 are defined in the cylinders 69a and 70a, which
34 air chambers are communicated with pressurized air
35 source (not shown) via a pressure supply network (not
36 shown). Though it is not clearly shown, the pressure

1 supply network is designed for controlling the air
2 pressure in the air chambers 72 and 73 in such a manner
3 that when the air pressure in one of the air chambers 72
4 and 73 is increased, the air pressure in the other air
5 chamber is reduced. Namely, assuming the rack 69 is
6 initially placed at upwardly shifted position and the
7 air pressure in the air chamber 72 is increased. The
8 air pressure in the air chamber 73 is reduced by the
9 pressure supply network. As a result, the rack 69 is
10 driven downwardly by the increased air pressure in the
11 air chamber 72. By this, the pinion 68 is driven in
12 counterclockwise direction in Fig. 8. According to
13 counterclockwise rotation of the pinion 68, the rack 70
14 is driven upwardly with reducing the volume of the air
15 chamber 73. Simultaneously, by rotation of the pinion
16 68, the rotary shaft 67 is driven to cause pivotal
17 movement of the chuck housing 50. At the position of
18 the rotary bearing 51, the chuck mechanism 13 associated
19 with the extension 50a is active for chucking the
20 electronic part 12. On the other hand, when the chuck
21 mechanism 13 associated with the extension 50b is to be
22 used. The pressurized air is introduced into the air
23 chamber 73 to increase the air pressure therein to cause
24 downward movement of the rack 70 to cause clockwise
25 rotation of the pinion 68. According to clockwise
26 rotation of the pinion, the rotary shaft 67 is driven to
27 cause clockwise pivotal movement of the chuck housing 50
28 to direct the extension 50b downwardly as shown by
29 phantom line in Fig. 7.

30 Furthermore, the axial driving mechanism 18
31 includes a rotatingly driving mechanism 74 for causing
32 pivotal movement of the chuck holder 53 on the
33 horizontal plane. The driving mechanism 74 has an air
34 cylinder 75 which rotatingly drive an output shaft 76.
35 A driving pulley 77 rigidly fixed to the lower end of
36 the output shaft 76. The driving pulley 77 is connected

1 to a driven pulley 78 via a driving belt 79. By the
2 power train set forth above, the sleeve bearing 57 is
3 rotatingly driven by rotational torque output through
4 the output shaft 76. As shown in Fig. 9, the air
5 cylinder 75 comprises an essentially cylindrical
6 cylinder body 75a whose both ends are plugged by plugs
7 75b. A pair of pistons 80 and 81 are respectively
8 disposed within the cylinder body 75a to define air
9 chambers 75c and 75d which are connected to a
10 pressurized air source via a pressure supply network
11 which alternatively increase and decrease the air
12 pressure in the air chambers.

13 The pair of pistons 80 and 81 are connected by
14 a piston rod 82. A rack 82a is attached to the piston
15 rod 82 for thrusting motion with the piston rod 82
16 according to pressure difference between the air
17 chambers 75c and 75d. The rack 82a engages with a
18 pinion 83 which is rigidly fixed to the output shaft 76.

19 With this construction, the output shaft 76 is
20 driven in alternative directions according to the
21 direction of thrusting motion of the piston rod 82
22 carrying the rack 82a.

23 In the shown embodiment, the drive mechanism
24 74 drives the chuck holder 53 at angular positions
25 between an initial or reference position, 90° shifted
26 position, 180° shifted position and 270° shifted
27 position. In order to position the chuck holder 53 at
28 respective of aforementioned angular positions,
29 positioning mechanism 84 are provided on the air
30 cylinder 75. The positioning mechanism 84 are arranged
31 at four angular positions respectively corresponding to
32 the initial or reference position, 90° shifted position,
33 180° shifted position and 270° shifted position of the
34 chuck holder 53. Each positioning mechanism 84
35 comprises a stopper 85 including a stopper piston 88
36 which contacts to one longitudinal edge of an arc-shaped

1 projection 86 fixed on the driving pulley 77 for
2 rotation therewith. As seen from Fig. 11, the
3 projection 86 extends substantially along the peripheral
4 edge of the driving pulley 77 and in an angle of 90° so
5 that when one end contacts to one of the stopper piston
6 88, the other end contacts to another stopper pin
7 oriented at a position 90° offsetting. In order to
8 firmly receive the stopper pistons 88 at both ends,
9 stopper piston receptacle recess 86a are formed at both
10 ends of the projection 86.

11 As seen from Fig. 9, each stopper 85 comprises
12 an air cylinder 87 through which the stopper piston 88
13 is thrustingly disposed. A pressure chamber 90 is
14 defined above the top end of the stopper piston 88,
15 which pressure chamber is connected to a pressurized air
16 source (not shown) to introduce pressurized air
17 therefrom. On the other hand, a spring seat clip 88a is
18 fixed onto the intermediate portion of the stopper
19 piston 88. Upper end of a coil spring 89 is seated on
20 the spring seat clip 88a. The other end of the coil
21 spring 89 is seated on a flange 75a formed at the lower
22 end of a cylindrical boss section 75b of the cylinder
23 body 75, through which boss section, the output shaft 76
24 extends downwardly from the cylinder body. The coil
25 spring 89 thus constantly exerts upward spring force to
26 the stopper piston 88 so as to normally position the
27 stopper piston at an upwardly shifted position, at which
28 the lower end of the stopper piston is held away from
29 the projection 86. On the other hand, the spring seat
30 clip 88a also serves as a stopper for limiting upward
31 motion of the stopper piston 88.

32 At a desired angular position of the driving
33 pulley 77, which angular position corresponds to the
34 desired angular position of the chuck holder 53, air
35 cylinders 87 associated with the stopper pistons 88
36 opposing both ends of the projection 86 are actuated by

1 the pressurized air introduced into the pressure
2 chambers 90 for depressing the corresponding stopper
3 pistons 88 downwardly to establish engagement between
4 the stopper pistons and the stopper piston receptacle
5 recesses 86a. By this, the driving pulleys 77 are
6 locked at the desired angular position to lock the chuck
7 holder 53.

8 Through the operation for pivotally driving
9 the chuck holder 53 as set forth above, angular position
10 of the chucking claws 19a and 20a of the chucking arms
11 19 and 20 can be adjusted so as to chuck the desired
12 portion of the electronic part 12.

13 The transversely driving mechanism 16 has a
14 movable bracket 91 carrying the base frame 60 of the
15 axially driving mechanism 15, as shown in Figs. 1 and
16 12. The movable bracket 91 is configured in to
17 essentially L-shaped configuration to have a vertically
18 extending section 91a and a horizontally extending
19 section 91b. The base frame 60 of the axially driving
20 mechanism 15 is rigidly secured on the lower surface of
21 the horizontally extending section 91b. A pair of
22 linear bearings 92 are mounted on the upper surface of
23 the horizontally extending section 91b. The linear
24 bearings 92 are slidably engaged with lower ends of
25 vertically extending sections 93a of an essentially
26 channel shaped guide rail 93. The guide rail 93 extends
27 transversely across the assembling apparatus. Both ends
28 of the guide rail 93 are supported by vertically
29 extending support frames 100 and 101.

30 As will be seen from Fig. 1, the support
31 frames 100 and 101 extends from a main table 102. In
32 front of the main table, an auxiliary table 103 is
33 provided. The auxiliary table 103 is designed to mount
34 thereon a mounting base 104, on which the substrate 14
35 is to be mounted.

36 The guide rail 93 has a horizontally extending

1 section 93b extending between the vertically extending
2 sections 93a. A pair of bearings 94 and 95 are mounted
3 on the lower surface of the horizontally extending
4 section 93b of the guide rail 93 and rotatably support a
5 ball screw rod 97. As will be seen from Fig. 1, the
6 ball screw rod 97 extends substantially in parallel to
7 the guide rail. A cylindrical movement 96 engages with
8 the screw rod 97 to be thrustingly driven there along by
9 rotation of the screw rod. In order to rotatably drive
10 the screw rod 97, an electric servo motor 99 is provided
11 in the vicinity of one end of the screw rod. The output
12 shaft 99a of the servo motor 99 is drivingly coupled
13 with the screw rod 97 via an alignment jig 98. The
14 cylindrical movement 96 is rigidly connected to the
15 vertically extending section 91a of the movable bracket
16 91. Therefore, the movable bracket 91 can be driven in
17 a direction parallel to the axis of the screw rod 97 by
18 the servo motor 99.

19 In the shown embodiment, coordinate system is
20 established to control the position of the electronic
21 part 12 as carried by the chuck mechanism 13 with
22 respect to the substrate 14 mounted on the mounting base
23 104. As will be seen, the transversely driving
24 mechanism 15 set forth above, is designed to shift the
25 chuck holder 53 carrying the chuck mechanism 13 along
26 the axis of the screw rod 97. The direction of movement
27 of the chuck mechanism 13 as driven by the transversely
28 driving mechanism 15 in parallel to the axis of the
29 screw rod 97 and in parallel to the plane of the
30 substrate 14 on the mounting base 104 will be hereafter
31 referred to as "x-axis direction" in the established
32 coordinate system. As will be appreciated from the
33 discussion given hereabove, the transversely driving
34 mechanism 15 drives the chuck mechanism 13 only in the
35 x-axis direction.

36 In order to adjust the relative position of

1 the electronic part 12 and the substrate 14 is y-axis
2 direction which extends in a direction perpendicular to
3 the x-axis direction and in parallel to the plane of the
4 substrate; the mounting base 104 is designed to be
5 driven in y-axis direction for shifting the substrate 14
6 relative to the electronic part 12 in y-axis direction.
7 So as to move in the y-axis direction, the mounting base
8 104 is mounted on a pair of guide shafts 108 and 109
9 which respective extend through through openings 110 and
10 111 formed through the mounting base. The guide shafts
11 108 and 109 extend in direction parallel to the y-axis
12 and in parallel relationship to each other. The
13 mounting base 104 is fixed to a pair of screw nuts 113
14 which are aligned to each other along the one lateral
15 edge. The screw nuts 113 engage with ball screw rod 114
16 which is drivingly coupled with an electric servo motor
17 116 via an alignment jig 115. The screw rod 114 extends
18 in y-axis direction for driving the mounting base 104 in
19 y-axis direction by rotatingly driving the screw rod 11.

20 Though it is not clearly shown in Fig. 1, an
21 anvil mechanism is provided beneath the mounting base
22 104 for clamping the lower end of the pins 12a extending
23 downwardly from the substrate 14 for fixing the
24 electronic part 12 on the substrate, which anvil
25 mechanism is generally represented by the reference
26 numeral 117. The anvil mechanism 117 employed in the
27 shown embodiment of the assembling apparatus is shown in
28 Fig. 14. As shown in Fig. 14, the anvil mechanism 117
29 comprises a pair of movable arms 118 and 119 which
30 respectively have anvil edges 118a and 119a. These
31 movable arms 118 and 119 are pivotable about a common
32 pivot 120. The pivot 120 extends from the inner
33 periphery of an anvil housing 121 which housing the
34 aforementioned assembly of movable arms. The movable
35 arms 118 and 119 are formed with recesses 118b and 119b
36 on the side edges at the sides remote from the other

1 movable arms. The recesses 118b and 119b receive one
2 end of coil springs 118c and 119c. The other end of the
3 coil springs 118c and 119c are seated on the inner
4 periphery of the side walls of the anvil housing 121.
5 The coil springs 118c and 119c are so oriented as to
6 bias respectively associated movable arms 118 and 119 in
7 a direction to normally maintain the anvil edges 118a
8 and 119a in a positioned shifted away from each other,
9 as shown in Fig. 14. The aforementioned assembly of the
10 movable arms will be hereafter referred to as "anvil
11 edge assembly 117a".

12 The anvil edge assembly 117a is associated
13 with an actuating air cylinder 122. The air cylinder
14 122 comprises a cylindrical cylinder body 123, a piston
15 124 is disposed within the internal space of the
16 cylinder body in thrusting fashion. The piston 124
17 carries a piston rod 124a which extends upwardly from
18 the piston. The piston rod 124a has a conical head 125
19 at the top thereof. The conical head 125 opposes the
20 anvil edge assembly 117a. Opposing the conical head 125
21 of the piston rod 124a, rollers 126 and 127 are mounted
22 on the lower end portion of the movable arms 118 and 119
23 in mutually opposing relationship to each other. The
24 movable arms 118 and 119 are normally biased to be
25 maintained at the position of Fig. 14.

26 Pressure chambers 123a and 123b are defined in
27 the cylinder body 123, which pressure chambers are
28 communicated with pressurized air source (not shown) to
29 introduce therefrom the pressurized air. The piston 124
30 with the piston rod 124a are normally maintained at the
31 lowered position, at which the conical head 125 is held
32 away from the rollers 126 and 127. When the pressure in
33 the pressure chamber 123a is increased, the piston 124
34 with the piston rod 124a is lifted upwardly. Then, the
35 conical head 125 enters into a gap between the rollers
36 126 and 127 against the spring force of the coil springs

1 118c and 119c. By this, the rollers 126 and 127 are
2 shifted way from each other to approach the anvil edges
3 118a and 119a. At this position, the anvil edge 118a
4 and 119a can grip the pin 12a of the electronic part 12
5 for clamping the lower end thereof.

6 The anvil edge assembly 117a also associated
7 with a rotatingly driving mechanism 129. The rotatingly
8 driving mechanism 129 is provided with the cylinder body
9 123 which has upward extension 123a with a through
10 opening 123b, in which the rotatingly driving mechanism
11 is received. The rotatingly driving mechanism 129 has
12 generally the identical construction to the rotatingly
13 driving mechanism 74 shown in Fig. 10. Namely, the
14 rotatingly driving mechanism 129 includes a rotary shaft
15 129a rigidly connected to the anvil housing 121 for
16 rotation therewith and rotatably supported in the
17 through opening 123b of the extension 123 via bearings
18 129c. A pinion 129d is rigidly secured on the rotary
19 shaft 129a. The pinion 129d engages with a rack (not
20 shown) firmly attached to a piston rod of an air
21 cylinder 129e, which is shown by broken line in Fig. 15.
22 The construction of the air cylinder 129e is not clearly
23 shown in Fig. 15. However, it should be appreciated
24 that the air cylinder is of identical construction to
25 that illustrated in Fig. 10.

26 The rotatingly driving mechanism 129 is thus
27 pivotally drive the anvil edge assembly 117a by
28 rotatingly driving the rotary shaft 129a. By pivotal
29 movement of the anvil edge assembly 117a, two anvil
30 mechanisms 117 which are mounted on the anvil housing
31 121 in a positions mutually offset 90° in angle, as
32 shown in Fig. 15, can be selectively used.

33 The anvil edge assembly 117a is further
34 associated with a vertically driving mechanism 128 which
35 has substantially the same construction as that
36 discussed with respect to the axially driving mechanism

1 15 of the chuck mechanism 13. Namely, the vertically
2 driving mechanism 128 comprises a vertical extending
3 guide shaft 128a which thrustingly extends through a
4 rotary sleeve 128b which is rotatably supported in a
5 through opening 128c formed through a base frame 139 via
6 bearings 128d. A plate member 128e rotatably engaged to
7 the lower portion of the cylinder body 123. The plate
8 member has an upper surface 128f mating with the lower
9 surface of the extension 123a. The plate member 128e is
10 associated with an air cylinder 128g having a piston
11 128h with a piston rod 128i. The piston rod 128i has a
12 threaded top fixed with the plate member 128e by means
13 of fastening nut 128j. With this construction, by
14 adjusting the pressure in the upper and lower pressure
15 chambers 128k and 128m, the anvil edge assembly 117a is
16 lifted up and down to move toward and away from the
17 mounting base 104 on which the substrate 14 is mounted.

18 Similarly to that illustrated in Fig. 6, a
19 driven pulley 130a is fixed to the rotary sleeve 128b.
20 The driven pulley 130a is connected to a driving pulley
21 130b via a driving belt 130c. The driving pulley 130b
22 is drivingly connected to the output shaft 130d of a
23 servo motor 130 which has identical construction to that
24 illustrated in Fig. 8. With this construction, the
25 cylinder body 123 is rotatably driven by the driving
26 force of the servo motor 130 in horizontal direction.
27 This rotatably driving mechanism is associated with a
28 positioning mechanism 131 which has identical
29 construction as illustrated in Figs. 9 and 11. By this
30 rotatably driving mechanism in cooperation with the
31 positioning mechanism 131, the anvil edge assembly 117a
32 can be pivotally displaced and positioned at positions
33 at initial position and 90° , 180° and 270° shifted
34 position from the initial position.

35 In the shown embodiment, the anvil mechanism
36 117 has to be positioned in vertical alignment with the

1 chuck mechanism 13. Therefore, the anvil mechanism 117
2 has to be driven to the orientation in the x-y
3 coordinate system in synchronism with movement of the
4 chuck mechanism 13. For this purpose, a transversely
5 driving mechanism 132 for the anvil mechanism 117 in
6 cooperation with the transversely driving mechanism 16
7 of the chucking mechanism 13 is provided. As set forth,
8 the transversely driving mechanism 132 is designed to
9 horizontally drive the anvil mechanism 117 in x-axis
10 direction in synchronism with the x-axis direction
11 movement of the chuck mechanism 13.

12 As shown in Fig. 16, a channel shaped retainer
13 133 is mounted on the horizontally extending section 91b
14 of the L-shaped mounting bracket 91. The retainer 133
15 has a horizontally extending section 133a secured on the
16 horizontally extending section 91b of the mounting
17 bracket 91 and a pair of vertically extending sections
18 133b. To the vertically extending sections 133b, a
19 tension adjuster bolts 134 are engaged. To the tension
20 adjuster bolts 134, both ends of a steel belt 135 is
21 secured. The steel belt 135 extends along a path
22 defined by means of guide pulleys 142, 143, 144 and 145.
23 The steel belt 135 is coupled with an endless steel belt
24 137 by means of a coupling device 136. The base frame
25 139 of the anvil mechanism 117 is rigidly fixed to the
26 steel belt 137 by means of fastening means, such as
27 fastener bolts. The steel belt 137 extends in a path
28 defined by the guide pulleys 146 and 147 which are
29 mounted on common brackets 148 to the guide pulleys 144
30 and 145.

31 As seen from Fig. 17, the base frame 139 is
32 rigidly secured to essentially L-shaped support 140.
33 The support 140 has a vertically extending section 140a,
34 on which the base frame 139 is secured, and a
35 horizontally extending section 140b. A recess 140c is
36 formed on the lower section of the horizontally

1 extending section 140b for engaging with guide rails 141
2 which are mounted on the main table 102 and extend
3 essentially parallel to each other and in a direction
4 parallel to the x-axis of the coordinate system.

5 With the construction set forth above, the
6 steel belt 137 is driven with the belt 135 according to
7 movement of the mounting frame 91 which carries the
8 chuck mechanism 13. Therefore, synchronous movement of
9 the chuck mechanism 13 and the anvil mechanism 117 can
10 be established.

11 In the practical operation of the assembling
12 apparatus, the chuck mechanism 13 is selected in
13 relation to the electronic part 12 to be assembled to
14 the substrate 14. Simultaneously, one of two anvil
15 mechanism 117 is selected according to the type of the
16 electronic part 12. Therefore, the rotatingly driving
17 mechanisms 51 and 129 are driven to drive the chuck
18 housing 50 and the anvil housing 121 according to the
19 selection of the chuck mechanism 13 and the anvil
20 mechanism, 117 to be used.

21 It may be possible to facilitate automatic
22 selection of the chuck mechanisms 13 and the anvil
23 mechanisms 117 according to a preliminary set program
24 which may include information of the type of the
25 electronic parts 12 and orientation of the parts to be
26 assembled in the coordinate system. The program may
27 also include information to set the angular positions of
28 the chuck holder 53 and the anvil mechanism 117. For
29 adjustment of the angular positions of the chuck holder
30 53 and the anvil mechanism 117, the servo motors 75 and
31 130 are driven to cause pivotal movements of the chuck
32 holder 53 and the anvil mechanism 117 in horizontal
33 direction. The angular positions of the pivoting chuck
34 holder 53 and the anvil mechanism 117 may be monitored.
35 In order to monitor the angular positions of the chuck
36 holder 53 and the anvil mechanism 117, position sensors

1 which monitor position of the piston or piston rod of
2 the air cylinder or monitor magnitude of angular
3 displacement of pinion may be provided. When the chuck
4 holder 53 and the anvil mechanism 117 at the
5 predetermined angular positions are detected, the
6 stoppers 85 of the positioning mechanisms 84 and 131 are
7 driven by introducing pressurized air into the pressure
8 chamber 90, which stoppers are respectively oriented at
9 the angular position to set the chuck holder 53 and the
10 anvil mechanism 117.

11 When both of the chuck holder 53 and the anvil
12 mechanism 117 are positioned through the foregoing
13 process to determine the angular positions, the chuck
14 mechanism 13 and the anvil mechanism 117 are oriented in
15 vertical alignment to each other.

16 After initial set through the process set
17 forth above, the transversely driving mechanism 16 is
18 driven to cause shifting of the chuck mechanism 13.
19 Initially, the chuck mechanism 13 is shifted to a
20 chucking station, to which electronic parts 12 are
21 supplied from a parts supply device (not shown). At the
22 chucking station, the axially driving mechanism 15 is
23 driven to shift the chuck mechanism downwardly to set
24 the chuck mechanism at the vertical orientation for
25 chucking the electronic part 12 to be assembled.

26 During the aforementioned initial operation,
27 the air pressure in the pressure chamber 28 is held
28 higher than that pressure chamber 29 for maintaining the
29 piston 30 at the downwardly shifted position. As a
30 result, the movable arms 19 and 20 are held away from
31 each other. When the chuck mechanism 13 is placed at a
32 position for chucking the electronic part 12, the
33 pressure in the pressure chamber 29 is increased and the
34 pressure in the pressure chamber 28 is decreased. This
35 causes upward movement of the piston 30. At the
36 upwardly shifted position of the piston 30, the general

1 section 30b comes to contact with the rollers 32 and 33
2 for pivotally shifting the movable arms 19 and 20 to
3 approach the chucking claws 19a and 20a. Thus, the
4 electronic part 12 is chucked at the chuck mechanism 13.

5 Then, the axially driving mechanism 15 is
6 again driven to shift the chuck mechanism 13 upwardly
7 with holding the electronic part 12. After the chuck
8 mechanism 13 reaching the predetermined vertical
9 position, the transversely driving mechanism 16 is
10 driven to shift the chuck mechanism 13 in x-axis
11 direction. The magnitude of transverse shift of the
12 chuck mechanism 13 may be controlled by continuously
13 monitoring the position of the chuck mechanism
14 transversely shifted or by monitoring magnitude of
15 revolution of the servo motor 99 so that the chuck
16 mechanism 13 can be transversely positioned at a
17 position, at which the electronic part 12 is to be
18 assembled to the substrate 14.

19 The servo motor 116 may also be driven to
20 drive the ball screw rod 114 for a controlled magnitude
21 to shift the mounting base 104 in y-axis direction to
22 position the openings 14 of the substrate in alignment
23 with the pins 12 of the electronic part 12.

24 During transverse movement of the chuck
25 mechanism 13, the anvil mechanism 117 is synchronously
26 shifted in transverse direction to maintain vertical
27 alignment with the chuck mechanism 13. Therefore, when
28 the electronic part 12 carried by the chuck mechanism 13
29 is placed to align the pins 12a to the openings 14a of
30 the substrate 14, the anvil mechanism 117 is placed
31 below the substrate in alignment with the electronic
32 part.

33 Then, the axially driving mechanism 15 is
34 again driven to drive the chuck mechanism 13 downwardly.
35 Downward movement of the chuck mechanism 13 is monitored
36 by monitoring the vertical position of the chuck

1 mechanism or the spline shaft 56. When the chuck
2 mechanism 13 at a position where the pins 12a of the
3 electronic part 12 is inserted into the openings 14a of
4 substrate 14 in a magnitude of 0.5 mm to 1 mm, the
5 axially driving mechanism terminates operation.

6 At this position, the pressurized air is again
7 introduced into the air chamber 28 to increase the
8 pressure therein and the air in the air chamber 29 is
9 ventilated to reduce the pressure therein. As a result,
10 the piston 30 is driven downwardly to oppose the smaller
11 diameter section 30a to the rollers 32 and 33.
12 Therefore, the chucking arms 19 and 20 are pivotally
13 shifted by the spring force of the springs 34 to release
14 the chucking claws 19a and 20a from engagement with the
15 electronic part 12.

16 By releasing the chucking arms 19 and 20, the
17 electronic part 12 becomes free from restriction. At
18 this position, the biasing force of the spring 42 which
19 is exerted through the actuator head 35, becomes active
20 to depress the electronic part 12 in order to further
21 insert the pins 12a into the openings 14a of the
22 substrate 14. Magnitude of insertion of the pins 12a is
23 then monitored by means of the photo-microsensor 46
24 which monitors the position of the top of the rod member
25 45. In case the stroke of the spring 42 is not enough
26 to fully insert the pins 12a through the openings 14a of
27 the substrate 14, the controlled pressure of pressurized
28 air is introduced into the pressure chamber 41 for
29 further depressing the actuator head 35 until the
30 photo-microsensor 46 detects the fully inserted position
31 of the rod member 45.

32 It should be again noted that the spring force
33 of the spring 42 is adjusted so as not to be strong to
34 damage or bent the pins 12a even when the pins are
35 offset from the corresponding openings 14a. Likewise,
36 the pressure to be introduced into the pressure chamber

1 41 is adjusted so as not to be too great to cause
2 damaging or bending of the pins by means of the pressure
3 regulator valve 43.

4 The anvil mechanism 117 is cooperatively and
5 synmetrically operated with the aforementioned pin
6 inserting operation to clamp the lower end of the pins
7 12a. In the practical operation, the anvil mechanism
8 117 may be triggered the operation in response to the
9 signal from the photo-microsensor 46 so that it may
10 clamp the lower end of the pins after completion of the
11 insertion of the pins.

12 As will be appreciated herefrom, since the
13 assembling apparatus according to the invention,
14 performs assembling operation for inserting the pins of
15 the electronic parts into the openings formed through
16 the substrate with relatively light force which may not
17 cause damaging or bending of the pins, yield in
18 assembling operation can be significantly improved.
19 Furthermore, since the clamping operation for clamping
20 the pins is performed after completion of insertion of
21 the pins, unnecessary step to be manually performed for
22 removing the electronic parts which is assembled and
23 clamped in inaccurate attitude, can be successfully
24 avoided. This may improve efficiency of assembling
25 operation.

26 While the present invention has been disclosed
27 in terms of the preferred embodiment in order to
28 facilitate better understanding of the invention, it
29 should be appreciated that the invention can be embodied
30 in various ways without departing from the principle of
31 the invention. Therefore, the invention should be
32 understood to include all possible embodiments and
33 modifications to the shown embodiments which can be
34 embodied without departing from the principle of the
35 invention set out in the appended claims.

CLAIMS

1. An apparatus for assembling an electronic and/or electrical part on a substrate, which part has at least one connector pin to be inserted through a corresponding opening formed in said substrate, comprising:
- means for holding said part and carrying the latter to a predetermined orientation in relation to a substrate at which said at least one pin is aligned to said corresponding opening;
- means for shifting said part holding means toward said substrate for inserting said at least one pin into said corresponding opening;
- means, cooperative with said shifting means, for monitoring the magnitude of shifting of said part holding means to detect that said part holding means is at a predetermined position relative to said substrate, at which said at least one pin is inserted into said opening to a predetermined small depth;
- means, responsive to said monitoring means detecting said part holding means at said predetermined position, for deactivating said shifting means and releasing said part holding means;
- means responsive to said deactivating means releasing the part, for exerting a controlled magnitude of depression force to further insert said at least one pin through said opening;
- means for monitoring the position of said part to detect the position of the part where said at least one pin is fully inserted through said opening; and
- means, responsive to said part position monitoring means detecting said fully inserted position of said at least one pin, for clamping the end of said at least one pin for fixing said part on said substrate.



2. An apparatus as set forth in claim 1, wherein said depression force exerting means is arranged to exert depression force whose magnitude is determined in regard of the force required to bend said at least one pin and is set
5 smaller than that force.

3. An apparatus as set forth in claim 1, 2 or 3, wherein said depression force exerting means comprises a mechanical component which resiliently generates said depression force
10 and a pneumatic component which pneumatically generates said depression force.

4. An apparatus as set forth in claim 3, wherein said mechanical component of said depression force exerting means
15 is maintained in a pre-loaded condition while said holding means holds said part and normally exerts said depression force to said part.

5. An apparatus as set forth in claim 4, wherein said
20 pneumatic component which is cooperative with said mechanical component and active after said mechanical component completes depression for its own full stroke for depression.

25 6. An apparatus as set forth in any one of the preceding claims, wherein said clamping means is cooperative with said holding means so as to move in synchronism with movement of said holding means so as to be constantly positioned in alignment with said holding means across said substrate.

30 7. An apparatus as set forth in any one of the preceding claims wherein said holding means comprises a chuck mechanism for chucking said part, a chuck carrier mechanism for carrying said chuck mechanism over said substrate for
35 shifting said chuck mechanism on a plane substantially



parallel to said substrate to position said chuck mechanism at said predetermined orientation, at which said at least one pin of said part is aligned with said opening.

- 5 8. An apparatus as set forth in claim 7, wherein said chuck carrier mechanism comprises a pivotal component mounting said chuck mechanism and pivotally movable on said plane, and a linearly shifting component associated with said pivotal component for linearly shifting said chuck
- 10 mechanism with said pivotal component at least in a first direction.
9. An apparatus as set forth in claim 8, which further comprises means for mounting said substrate, which mounting
- 15 means is movable in a second direction perpendicular to said first direction for adjusting relative position of said chuck mechanism and said substrate in said second direction for aligning said at least one pin to said opening.
- 20 10. An apparatus as set forth in claim 8, wherein said clamping means comprises a clamping edge, a clamping edge carrier including a pivotal component which is pivotally movable with carrying said clamping edge in synchronism with pivotal movement of said pivotal component of said holding
- 25 means, and a linearly shifting component associated with said pivotal component for linearly shifting said clamping edge with said pivotal component in said first direction in synchronism with linear movement of said linearly shifting component of the said holding means.
- 30 11. An apparatus as set forth in any one of the preceding claims, wherein said insertion monitoring means is operative to detect faulty insertion by detecting said part held at a position other than said position where said at least one
- 35 pin is fully inserted through said opening, to actuate said



holding means to remove the part from said substrate.

12. An apparatus as set forth in claim 11, which further comprises a jig for straightening said at least one pin removed from said substrate, and said holding means carries said part, about which faulty insertion is detected, to said jig for repair.

13. An apparatus as set forth in claim 11, wherein said holding means operates to re-align said part for re-alignment of said pin to said opening for re-insertion.

14. An apparatus for automatically assembling an electronic and/or electric part on a substrate, which part has at least one connector pin to be inserted in a corresponding opening in said substrate, comprising:
chucking means for chucking said part at a predetermined chucking station to which said part is supplied and carrying the latter to a predetermined orientation in relation to a substrate, at which said at least one pin of said part is aligned to said opening, from said chucking station;

shifting means for driving said chucking means to cause shifting said chucking means in a direction perpendicular to said substrate and towards said substrate for inserting said pin into said opening;

releasing means, cooperative with said chucking means, for monitoring the magnitude of shifting of said chucking means to detect that said part is at a predetermined position relative to said substrate, at which said pin is inserted into said ^{opening} to a predetermined depth which is small in relation to a full stroke of insertion, and for then deactivating said shifting means and operating said chucking means to release said

part from said chucking means;
depressing means, responsive to said releasing means,



for exerting a controlled magnitude of depression force to further insert said at least one pin through said opening;

depression magnitude monitoring means for monitoring the position of said part to detect the position of the part
5 where said at least one pin is fully inserted through said opening; and

clamping means, responsive to said part position monitoring means detecting said fully inserted position of said pin, for clamping end of said pin for fixing said part
10 on said substrate.

15 15. An apparatus as set forth in claim 14, wherein said depressing means is arranged to exert a depression force less than that which would cause bending of the at least one pin.

16. An apparatus as set forth in claim 15, wherein said depressing means comprises a mechanical component which resiliently generates said depression force and a pneumatic
20 component which pneumatically generates said depression force.

17. An apparatus as set forth in claim 16, wherein said mechanical component of said depressing means is maintained
25 at pre-loaded condition while said chucking means holds said part and normally exert said depression force to said part.

18. An apparatus as set forth in claim 17, wherein said pneumatic component which is cooperative with said
30 mechanical component and active after said mechanical component completes depression for its own full stroke for depression.

19. An apparatus as set forth in any one of claim 14 to 18,
35 wherein said clamping means is cooperative with said



chucking means so as to move in synchronism with movement of said chucking means for being constantly positioned in alignment with said chucking means across said substrate.

5 20. An apparatus as set forth in any one of claims 14 to 19, wherein said chucking means comprises a chuck mechanism for chucking said part, a chuck carrier mechanism carrying said chuck mechanism over said substrate for shifting said chuck mechanism on a plane substantially parallel to said
10 substrate to position said chuck mechanism at said predetermined orientation, at which said pin of said part is aligned to said opening.

21. An apparatus as set forth in claim 20, wherein said
15 chuck carrier mechanism comprises a pivotal component mounting said chuck mechanism and pivotally movable on said plane, and a linearly shifting component associated with said pivotal component for linearly shifting said chuck mechanism with said pivotal component at least in a first
20 direction.

22. An apparatus as set forth in claim 21, which further comprises means for mounting said substrate, which mounting means is movable in a second direction perpendicular to said
25 first direction for adjusting relative position to said chuck mechanism and said substrate in said second direction for aligning said pin to said opening.

23. An apparatus as set forth in claim 21, wherein said
30 clamping means comprises a clamping edge, a clamping edge carrier including a pivotal component which is pivotally movable with carrying said clamping edge in synchronism with pivotal movement of said pivotal component of said chucking means, and a linearly shifting component associated with
35 said pivotal component for linearly shifting said clamping



edge with said pivotal component in said first direction in synchronism with linear movement of said linearly shifting component of the said chucking means.

5 24. An apparatus as set forth in any one of claims 14 to 23, wherein said insertion monitoring means is operative to detect faulty insertion by detecting said part being held at a position other than said position where said at least one pin is fully inserted through said opening, to actuate
10 said chucking means to remove^{same} from said substrate.

25. An apparatus as set forth in claim 24, which further comprises a jig for straightening said pin removed
15 from said substrate, and said chucking means carries said part, about which faulty insertion is detected, to said jig for repairing.

26. An apparatus as set forth in claim 14, wherein
20 said chucking means operates to re-align said part for re-alignment of said pin to said opening for re-insertion.

27. A method of assembling an electronic and/or electric part on a substrate, which part has at least one
25 connector pin to be inserted in a corresponding opening in said substrate, comprising the steps of:

holding said part;
carrying said part to a predetermined orientation in relation to said substrate, at which said pin of said
30 part is aligned to said opening;
shifting said part toward said substrate for inserting said pin into said opening;
monitoring the magnitude of shifting of said part to detect at a predetermined position relative to said
35 substrate, at which said at least one pin is inserted into



said corresponding opening in a predetermined small magnitude;

detecting said part being at said predetermined position, for stopping shift of said part toward said
5 substrate;

releasing said part;

exerting a controlled magnitude depression force to further insert said pin through said opening in response to releasing of holding;

10 monitoring the position of said part to detect the position of the part where said at least one pin is fully inserted through said opening; and

when the at least one pin is fully inserted clamping the end of said pin for fixing said part on said substrate.

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28. A method as set forth in claim 27, wherein said depression force is set at a magnitude less than that required to bend the at least one pin.

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29. A method as set forth in claim 28, wherein said depression force comprises a mechanical component mechanically and resiliently generated and a pneumatic component pneumatically generated.

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30. A method as set forth in claim 29, wherein said mechanical component of said depression force is maintained in a pre-loaded condition while said parts is held and normally exerts said depression force to said part.

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31. A method as set forth in claim 30, wherein said pneumatic component which is cooperative with said mechanical component and active after said mechanical component completes depression for its own full stroke for depression.

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32. Apparatus for assembling parts constructed and arranged to operate substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

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33. A method of assembling parts substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

