

APPARATUS AND METHOD FOR SOLDER FLUX TRANSFER

FIELD OF THE INVENTION

The present invention relates generally to an apparatus and method for solder flux transfer and in particular to an apparatus and method for the transfer of solder flux from a solder flux reservoir onto a printed circuit substrate in a solder ball mounting process.

BACKGROUND OF THE INVENTION

In a solder ball mounting process, solder balls are fed from a solder ball reservoir and are deposited onto a printed circuit substrate in a so-called ball grid array. Prior to the step of depositing the solder balls onto the printed circuit substrate, solder flux is first deposited onto the printed circuit substrate. The solder flux provides a fixturing capability to hold the solder balls in place on the printed circuit substrate. The solder balls are then melted and resolidified.

Various machines and methods have been commercially used to transfer solder flux from a solder flux reservoir onto a printed circuit substrate. A conventional method is the pin block method. The pin block method makes use of a block member with an array of pins extending downwardly from the bottom wall of the block member. The pins are mounted on the block member and are arranged in an array corresponding to a ball grid array disposed on the printed circuit substrate. The pins are adapted to transfer solder flux from a solder flux

9905070-0

08 OCT 1999

reservoir onto a printed circuit substrate. To commence the flux transfer process, the flux transfer pins are dipped into a layer of solder flux so that a certain amount of the solder flux is deposited on the tip of each pin. 5 The pins, being coated with solder flux, are then driven from the solder flux reservoir to a position above a printed circuit substrate where the array of pins is in alignment with the corresponding ball grid array on the printed circuit substrate. The block member with the pins 10 is then lowered until the pins make contact with the printed circuit substrate thereby transferring a portion of the solder flux from the tips of the pins onto the printed circuit substrate.

However, due to the contact of the flux transfer 15 pins with the printed circuit substrate as described above, the flux transfer pins as well as the printed circuit substrate may both be subjected to undesired pressure. This undesired pressure may cause damages to the flux transfer pins and the printed circuit substrate.

20 Some conventional pin block devices may involve the use of springs in an attempt to reduce the undesired pressure. As illustrated in Fig. 1, this pin block device comprises an array of pins 2 being slidably mounted in a block 4. A spring 6, mounted on one end of each pin 2, is 25 employed to absorb the undesired pressure on the printed circuit substrate 8 when the other ends of the pins extending out of the block 4 come into contact with the

printed circuit substrate 8. However, it is understood that it is difficult to achieve a desired minimum spring force (less than 10 gram) which acts on the printed circuit substrate to minimize any possible damages. Due to the
5 undesired spring force, the printed circuit substrate can be damaged. Further, it can be appreciated that it is difficult to replace the pins and the springs in the block if the pins are damaged. Hence, the conventional pin blocks tend to involve high maintenance cost.

10 BRIEF SUMMARY OF THE INVENTION

It is an object of the present invention to provide an apparatus and method for the transfer of solder flux from a solder flux reservoir, such as a solder flux plate onto a printed circuit substrate which can minimize
15 any damages that would have been caused to the flux transfer pins or the printed circuit substrate due to their contact during a solder flux transfer process.

It is another object of the present invention to provide a solder flux transfer method and apparatus which
20 is more reliable and efficient.

It is yet another object of the present invention to provide a solder flux transfer apparatus which is easy and simple to assemble and replace, and low in maintenance cost.

25 According to a first aspect of the invention there is provided an apparatus for the transfer of solder flux from a solder flux plate onto a printed circuit

substrate comprising a plurality of pins for transferring solder flux; housing means for supporting said plurality of flux transfer pins in a position where said flux transfer pins are depending and extending outwardly from a bottom wall of said housing means; means for supplying air pressure into said housing means thereby generating a predetermined force to hold said flux transfer pins in said position; and means for driving said housing means towards said solder flux plate so as to dip said flux transfer pins into the solder flux, and thereafter towards said circuit substrate so as to transfer a portion of the solder flux coated on said flux transfer pins onto said circuit substrate; said flux transfer pins being adapted to yield and retract into said housing means against said force when said flux transfer pins make contact with said solder flux plate and said circuit substrate.

According to a preferred embodiment of the invention the solder flux transfer apparatus further comprises means for regulating the air pressure generated from said air pressure supply means.

According to a preferred embodiment of the invention there is provided an flux transfer apparatus wherein said housing means defines a compartment in communication with said air pressure supply means.

According to a preferred embodiment of the invention there is provided an flux transfer apparatus wherein each of said flux transfer pins is provided with an

enlarged head portion being retained within said housing means and defining surfaces on which said force is uniformly exerted.

According to a preferred embodiment of the invention there is provided an flux transfer apparatus wherein said housing means is detachably mounted on an arm member which is engaged with said drive means.

According to a second aspect of the invention there is provided a method for the transfer of solder flux from a solder flux plate onto a printed circuit substrate comprising the steps of providing a plurality of pins for transferring solder flux; providing housing means for supporting said plurality of flux transfer pins in a position where said flux transfer pins are depending and extending outwardly from a bottom wall of said housing means; supplying air pressure into said housing means thereby generating a predetermined force to hold said flux transfer pins in said position; and driving said housing means towards said solder flux plate so as to dip said flux transfer pins into the solder flux; and driving said housing means towards said circuit substrate so as to transfer a portion of the solder flux coated on said flux transfer pins onto said circuit substrate; said flux transfer pins being adapted to yield and retract into said housing means against said force when said flux transfer pins make contact with said solder flux plate and said circuit substrate.

According to a preferred embodiment of the invention there is provided a method for the transfer of solder flux further comprising the step of regulating the air pressure generated from said air pressure supply means.

5 According to a preferred embodiment of the invention there is provided a method for the transfer of solder flux wherein said force is uniformly exerted on each pin.

 According to a preferred embodiment of the
10 invention there is provided a method for the transfer of solder flux further comprising the step of driving said housing means in a direction perpendicularly towards and away from said solder flux plate while said force is being exerted on said flux transfer pins; driving said housing
15 means reciprocally from a position above said solder flux plate to a position above said circuit substrate; and driving said housing means towards said circuit substrate comprising driving said housing means in a direction perpendicularly towards and away from said circuit
20 substrate while said force is being exerted on said flux transfer pins.

BRIEF DESCRIPTION OF THE DRAWINGS

A specific embodiment of the invention will now be described by way of example with reference to the
25 accompanying drawings wherein:

FIG. 1 is a cross-sectional view of a conventional solder flux transfer device;

FIG. 2 is a bottom perspective view of a solder flux transfer apparatus in accordance with a preferred embodiment of the present invention;

FIG. 3 is a cross-sectional view of the solder flux transfer apparatus of Fig. 2 showing the solder flux transfer apparatus in a position above a solder flux plate;

FIG. 4 is a similar cross-sectional view of the solder flux transfer apparatus of Fig. 3, showing the solder flux transfer apparatus in a lowered position where the solder flux transfer pins are immersed into a layer of solder flux material in the solder flux plate;

FIG. 5 is a cross-sectional view of the solder flux transfer apparatus of Fig. 4, showing the solder flux transfer apparatus in a position above a printed circuit substrate; and

FIG. 6 is a similar cross-sectional view of the solder flux transfer apparatus of Fig. 5, showing the solder flux transfer apparatus in a lowered position where the solder flux transfer pins are in contact with the printed circuit substrate.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now in more detail to the drawings in which like reference numerals represent like parts throughout the several views, FIG. 2 is a bottom perspective view of a solder flux transfer apparatus according to a preferred embodiment of the present invention.

The solder flux transfer apparatus, generally represented by reference numeral 10, comprises a hollow box member or housing 14 and a plurality of solder flux transfer pins 12 being slidably accommodated in the bottom wall of the housing 14 so as to protrude from the inside of the housing 14 through the bottom wall thereof in a direction perpendicular to the bottom wall 24 of the housing 14. The flux transfer pins 12 are arranged in an array corresponding to a ball grid array in which solder balls are to be disposed on a workpiece such as a printed circuit substrate.

The housing 14 is in turn mounted on an arm member 16 of the solder flux transfer apparatus 10. Preferably, the side of the housing 14 opposite to the bottom wall 24 thereof is open and the housing 14 is mounted on the arm member 16 such that its open side is covered by the same. Preferably, the arm member is generally L-shaped.

Driving mechanisms, in engagement with the arm member 16, are employed to drive the housing 14 together with the flux transfer pins 12 in different directions and positions throughout the solder flux transfer process.

For example, the solder flux transfer apparatus 10 can move in a vertically up or down direction, as indicated by the arrows in Fig. 2. Furthermore, the solder flux transfer apparatus 10 can be driven in a horizontal direction from one work station to another work station.

In this particular case, the solder flux transfer apparatus 10 can be driven reciprocally between a solder flux supply station and a solder flux deposition station.

Detailed features and operation of the solder
5 flux transfer apparatus in accordance with this preferred embodiment of the present invention are shown in Figs. 3 through 6.

Figs. 3 to 6 are cross-sectional views of the solder flux transfer apparatus in different stages of the
10 solder flux transfer process. According to the preferred embodiment of the present invention, each pin 12 of said plurality of flux transfer pins 12 has an enlarged pin head portion 18 and a tip end portion 20.

The flux transfer pins 12 are inserted through
15 corresponding openings or positioning through-holes 22 provided in the bottom wall 24 of the housing 14 such a way that the tip end portions 20 thereof extend outwardly from the housing 14. Preferably, the thickness of the bottom wall 24 of the housing 14 is dimensioned such that
20 substantially the entire shank portion of the pin 12 between its pin head portion 18 and its tip end portion 20 is received in the through-hole 22 in the bottom wall 14. The diameter of the through-holes 22 is preferably slightly larger than the diameter of the flux transfer pin 12 at its
25 tip end and shank portions. This ensures that the flux transfer pins 12 snugly fit into the respective through-holes 22 and can slide in the through-holes 22 in the

bottom wall 14 only in axial direction while guided smoothly and precisely by the same.

The enlarged pin head portions 18, having a diameter larger than the diameter of the through-hole 22, serve to stop the downward movement of the flux transfer pins 12 by abutting on the inner surface of the bottom wall 24 and to retain the flux transfer pins 12 in such a position that the tip end portions 20 of the flux transfer pins 12 are depending and projecting outwardly from the bottom wall 24 of the housing 14.

The through-holes 22 provided in the bottom wall 24 of the housing 14 are disposed in an array which corresponds to a ball grid array in which solder balls are to be deposited on a printed circuit substrate. The through-holes 22 serve to orientate the flux transfer pins 12 in such a corresponding array.

According to the present embodiment, as illustrated in Figs. 3 to 6, the housing 14 is detachably mounted on the arm member 16 of the solder flux transfer apparatus 10. To replace a flux transfer pin, for example, the operator can simply detach the housing 14 from the arm member 16 so that the transfer pin 12 can be removed from the housing 14 through its open side.

It is appreciated that the box member or housing 14 itself can be interchangeable. Housings with different patterns of through-holes and flux transfer pins can be used to produce different solder flux patterns as required

with different workpieces.

The solder flux transfer apparatus 10 of the present invention further comprises a tube or channel 26 which is connected to the hollow housing 14. The air passage defined by the channel 26 is in communication with an aperture 28 provided on the arm member 16 thereby allowing air to enter the compartment 30 in the housing 14. The aperture 28 serves as an air inlet of the housing 14.

A compressed air actuator (not shown) is used to supply compressed air into the compartment of the housing 14, as illustrated by the arrows in Figs 3-6. The air generated from the compressed air actuator passes through the channel 26 and enters the compartment 30 in the housing 14. As shown in the figures, the air enters the enclosed space in the compartment 30 which is directly above the space being occupied by the pin head portions 18 of the flux transfer pins 12. Thus it is ensured that a force is uniformly exerted on the surfaces of the enlarged pin head portions 18, primarily on the flat upper surfaces of the enlarged pin head portions 18 which are disposed generally on a horizontal plane.

The compressed air actuator can be of any conventional device used for the supply of air pressure. An air pressure regulator, coupling to the compressed air actuator, is used to regulate the air pressure generating from the compressed air actuator. This renders the supply of a desired minimum force sufficient enough to hold the

flux transfer pins 12 in place where their enlarged pin head portions abuts against the inner surface of the bottom wall 24, and yet allow the flux transfer pins 12 to yield and retract into the hollow housing 14 if counter-force is exerted on the flux transfer pins 12. The pressure being applied to the flux transfer pins 12 is preferably constant throughout the entire solder flux transfer process. However, it is understood that the pressure can be adjustable, if necessary.

10 This adjustable minimum force is an important feature of the solder flux transfer apparatus of the present invention. This minimum force can substantially reduce the chance of damaging the flux transfer pins and the printed circuit substrate during the flux transfer process. Conventional solder flux transfer devices, including the pin block devices with springs, are unable to achieve such a small minimum force as produced by the solder flux transfer apparatus of the present invention.

20 The method for transferring solder flux using the above-mentioned solder flux transfer apparatus will now be described in detail.

 According to the present embodiment, a reservoir or plate 32 is employed to contain a thin layer of solder flux material 34. A fresh layer of solder flux material is prepared each time before the solder flux material is transferred from the solder flux plate 32. The fresh layer of solder flux material can be prepared by using a

conventional device such as a squeegee or the like.

At the beginning of the solder flux transfer process, the solder flux transfer apparatus 10 is positioned above the solder flux plate 32, as illustrated in Fig. 3. The compressed air actuator is activated so that compressed air is fed into the compartment 30 through the channel 26. The air pressure in the housing 14 produces a minimum force being exerted uniformly on the flux transfer pins 12. This minimum force is enough to hold the flux transfer pins 12 in place within the through-holes 22 of the housing 14, so that the enlarged pin head portions 18 of the pins 12 abut on the inner surface of the bottom wall 24 of the housing 14.

The solder flux transfer apparatus 10 is then driven vertically downwards to a position where the tips 20 of the flux transfer pins 12 are simultaneously immersed into the layer of solder flux material 34, as shown in Fig. 4. The solder flux transfer apparatus 10 is then driven vertically upwards thereby removing the flux transfer pins 12 from the layer of solder flux material 34. A predetermined amount of solder flux is now being coated on the tip 20 of each flux transfer pin 12.

The solder flux transfer apparatus 10 is then driven horizontally to an adjacent work station where a workpiece such as a printed circuit substrate 36 is positioned, as illustrated in Fig. 5. With the compressed air actuator still being activated, the solder flux

transfer apparatus 10 is then driven vertically downwards to a position where the tips 20 of the flux transfer pins 12, being coated with solder flux, slightly touch the circuit substrate 36 simultaneously, as shown in Fig. 6, thereby transferring a portion of the solder flux from the tips 20 of the flux transfer pins 12 onto the circuit substrate 36.

At the moment the tips 20 of the flux transfer pins 12 touch the printed circuit substrate 36, the flux transfer pins 12 can yield and retract upwards against the force being exerted on the flux transfer pins 12. It minimizes the damages that would have caused to the circuit substrate 36 and/or to the flux transfer pins 12 by the impact of the flux transfer pins 12 on the circuit substrate 36 during the solder flux transfer.

Although it has been described that the pressure being applied to the flux transfer pins 12 is preferably constant throughout the entire solder flux transfer process, it is understood that the pressure can be changed, if necessary, even during the solder flux transfer process. For example, the pressure being applied to the flux transfer pins 12 during the transfer of solder flux from the flux transfer pins 12 to the circuit substrate 36 can be greater than the pressure being applied to the flux transfer pins 12 during the transfer of solder flux from the solder flux plate 32 to the flux transfer pins 12.

With the use of the solder flux transfer

apparatus of the present invention, the solder flux transfer process becomes more efficient and productive. Furthermore, as disclosed and illustrated in the drawings in the present application, the solder flux transfer
5 apparatus is simple in construction, easy to assemble and replace resulting in low manufacturing and maintenance costs.

While the present invention has been shown and described with particular reference to a preferred
10 embodiment thereof, it should be noted that various other changes or modifications may be made without departing from the scope of the present invention.

WHAT IS CLAIMED IS:

1. An apparatus for the transfer of solder flux from a solder flux plate onto a printed circuit substrate comprising:

- 5 a plurality of pins for transferring solder flux;
housing means for supporting said plurality of flux transfer pins in a position where said flux transfer pins are depending and extending outwardly from a bottom wall of said housing means;
- 10 means for supplying air pressure into said housing means thereby generating a predetermined force to hold said flux transfer pins in said position; and
means for driving said housing means towards said solder flux plate so as to dip said flux transfer pins into
15 the solder flux, and thereafter towards said circuit substrate so as to transfer a portion of the solder flux coated on said flux transfer pins onto said circuit substrate;
- 20 said flux transfer pins being adapted to yield and retract into said housing means against said force when said flux transfer pins make contact with said solder flux plate and said circuit substrate.

2. An apparatus as claimed in claim 1 further
25 comprising means for regulating the air pressure generated from said air pressure supply means.



3. An apparatus as claimed in claim 1 wherein said housing means defines a compartment in communication with said air pressure supply means.

5 4. An apparatus as claimed in claim 1 wherein each of said flux transfer pins is provided with an enlarged head portion being retained within said housing means and defining surfaces on which said force is exerted.

10 5. An apparatus as claimed in claim 1 wherein said force is uniformly exerted on each pin.

6. An apparatus as claimed in claim 1 wherein said housing means is provided with a plurality of elongated
15 through-holes for receiving said plurality of pins.

7. An apparatus as claimed in claim 1 wherein said plurality of pins are arranged in an array corresponding to a ball grid array on said circuit substrate.

20

8. An apparatus as claimed in claim 1 wherein said drive means is adapted to drive said housing means in a direction perpendicularly towards and away from said solder flux plate while said force is being exerted on said flux
25 transfer pins.

9. An apparatus as claimed in claim 1 wherein said



drive means is adapted to drive said housing means reciprocally from a position above said solder flux plate to a position above said circuit substrate.

5 10. An apparatus as claimed in claim 1 wherein said drive means is adapted to drive said housing means in a direction perpendicularly towards and away from said circuit substrate while said force is being exerted on said flux transfer pins.

10

11. An apparatus as claimed in claim 1 wherein said housing means is detachably mounted on an arm member which is engaged with said drive means.

15 12. A method for the transfer of solder flux from a solder flux plate onto a printed circuit substrate comprising the steps of:

providing a plurality of pins for transferring solder flux;

20 providing housing means for supporting said plurality of flux transfer pins in a position where said flux transfer pins are depending and extending outwardly from a bottom wall of said housing means;

supplying air pressure into said housing means
25 thereby generating a predetermined force to hold said flux transfer pins in said position; and

driving said housing means towards said solder



flux plate so as to dip said flux transfer pins into the solder flux; and

driving said housing means towards said circuit substrate so as to transfer a portion of the solder flux
5 coated on said flux transfer pins onto said circuit substrate;

said flux transfer pins being adapted to yield and retract into said housing means against said force when said flux transfer pins make contact with said solder flux
10 plate and said circuit substrate.

13. A method as claimed in claim 12 further comprising the step of regulating the air pressure generated from said air pressure supply means.

15

14. A method as claimed in claim 12 wherein said housing means defines a compartment in communication with said air pressure supply means.

20 15. A method as claimed in claim 12 wherein each of said flux transfer pins is provided with an enlarged head portion being retained within said housing means and defining surfaces on which said force is exerted.

25 16. A method as claimed in claim 12 wherein said force is uniformly exerted on each pin.



17. A method as claimed in claim 12 wherein said housing means is provided with a plurality of elongated through-holes for receiving said plurality of pins.

5 18. A method as claimed in claim 12 wherein said plurality of pins are arranged in an array corresponding to a ball grid array on said circuit substrate.

19. A method as claimed in claim 12 further
10 comprising the step of driving said housing means in a direction perpendicularly towards and away from said solder flux plate while said force is being exerted on said flux transfer pins.

15 20. A method as claimed in claim 12 further comprising the step of driving said housing means reciprocally from a position above said solder flux plate to a position above said circuit substrate.

20 21. A method as claimed in claim 12 wherein the step of driving said housing means towards said circuit substrate comprising driving said housing means in a direction perpendicularly towards and away from said circuit substrate while said force is being exerted on said
25 flux transfer pins.



22. A method as claimed in claim 12 wherein said

- 21 -

housing means is detachably mounted on an arm member which is engaged with said drive means.

