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SOLDER DROSS REMOVAL APPARATUS AND METHOD

BACKGROUND OF THE INVENTION

The present invention relates to an improved apparatus and method for recovering solder from dross present on the surface of molten solder where it is exposed to atmospheric air.

In the manufacture of a printed circuit board assembly, there are two commercially important methods of soldering, namely, reflow soldering and wave soldering. The reflow soldering is costly as it employs a solder paste composed of solder particles mixed with flux. In the wave soldering, a wave of solder is caused to well upwardly and contact various portions of a printed circuit board at once. As such, the wave soldering is more economical and provides a higher degree of productivity than the reflow and other processes.

A usual wave soldering machine includes a pair of endless chain conveyors which are driven to advance a printed circuit board at a constant speed from the entrance to exit ends of the machine. While the printed circuit board is held by gripping fingers, the board is first carried to a fluxer where a foam or spray of flux is applied to the underside of the board. The printed circuit board is then carried over preheaters where the temperature of each board is elevated to approximately 110°C to 130°C so as to evaporate excess flux solvent, activate the flux and minimize thermal shock to the printed circuit board. After the printed circuit board is brought to such a preheat

temperature, the board passes over a solder reservoir to receive solder. The board is finally transported to a cool down zone where the solder is cooled to solidify. The solder reservoir is equipped with heating elements so as to maintain the molten solder at a preset suitable temperature. A relatively narrow solder nozzle is placed in the solder reservoir to produce a turbulent wave. A relatively wide solder nozzle is provided downstream of the narrow solder nozzle to produce a non-turbulent smooth solder wave. A duct extends within the solder reservoir and has one end connected to each of the nozzles. A pump is disposed in the other end of the duct and connected to a motor through a belt-and-pulley assembly. The pump is activated to transmit pressure energy to the molten solder to cause the solder within the duct to lift and form the solder wave. A flow control panel is mounted within each of the nozzles and has a plurality of apertures. The molten solder is caused to flow in a turbulent fashion in the duct due to the pumping action of the solder pump. The apertures of the flow control panel allows uniform flow of the molten solder above the panel within the nozzle.

A problem with such a conventional wave soldering machine is that a quantity of dross forms on the surface of the molten solder where it is exposed to and contacted with atmospheric air. The formation of such dross brings about a change in the height of the solder wave flowing up through the nozzles. When the dross blocks the apertures of the flow control panel, the height of the solder wave becomes

low, with the result that at least some of the electronic components in the printed circuit board are left unsoldered. The wave height suddenly becomes higher when the dross is forced away from the apertures due to the continued pumping
5 action of the solder pump. If the wave height is too high, the solder will flow on the top surface of the printed circuit board and ruin the board. Attachment of the dross itself to the printed circuit board causes a short circuit or deteriorates aesthetic appearance of the finished board.

10 Dross generation also adds considerably to the cost of the wave soldering process due to the lost value of the solder and the maintenance it imposes. It is necessary from time to time to remove dross from the solder reservoir and repair mechanical parts of the machine as damaged by
15 its abrasive action.

Accordingly, it is an object of the present invention to provide an improved apparatus and method for effectively and economically recovering solder from dross formed in a solder reservoir.

20 SUMMARY OF THE INVENTION

According to one aspect of the present invention, there is provided an apparatus for recovering solder from dross, which comprises a solder reservoir for holding a pool of molten solder, at least one solder nozzle disposed
25 in the solder reservoir and adapted to form and direct a solder wave against a substrate to be soldered, the solder nozzle including opposite side troughs inclined downwardly toward one side of the solder reservoir to direct dross

toward a dross zone formed in the one side of the solder reservoir, a hood mounted to the solder reservoir and located above the dross zone, and an agitator extending across the one side of the solder reservoir and activated
5 to agitate the dross so as to remove oxides and recover solder from the dross.

The temperature within the dross is much lower than that of the molten solder since the dross present on the surface of the molten solder is exposed to atmospheric air.
10 As such, any solder contained in the dross has a relatively low flowability. To this end, a heating element may be mounted within or outside the hood to heat the interior of the hood to at least 100°C at which the flowability of the solder becomes higher. This promotes removal of the solder
15 from the dross. Preferably, a source of non-oxidizing gas such as nitrogen may be introduced into the interior of the hood through a gas injector so as to provide a substantially oxygen-free atmosphere. Such an atmosphere not only promotes removal of the oxides from the dross, but also
20 inhibits reoxidization of the solder as reclaimed from the dross. Preferably, a heater may be connected between the source of non-oxidizing gas and the gas injector.

According to another aspect of the present invention, there is provided a method for recovering solder from dross
25 present in a solder reservoir within which a pool of molten solder is held. Dross is directed toward a dross zone defined in one side of the solder reservoir and covered by a hood. The dross is agitated to thereby remove oxides and

recover solder from the dross. The solder as reclaimed from the dross is returned to the pool of molten solder. The oxides are delivering out of the solder reservoir.

Preferably, the interior of the hood may be heated to
5 a temperature of at least 100°C. A non-oxidizing gas may preferably be introduced into the interior of the hood to generate a substantially oxygen-free atmosphere within the hood. The none-oxidizing gas may be selected from nitrogen, carbon dioxide, argon and other inert gases, and hydrogen
10 gas and other reactive gases.

The above and other objects, features and advantages of the present invention will be apparent from the following detailed description of the preferred embodiments of the invention, as illustrated in the accompanying
15 drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a top plan view of a solder dross removal apparatus according to one embodiment of the present invention;

20 Fig. 2 is a sectional view taken along the line II-II of Fig. 1; and

Fig. 3 is a sectional view taken along the line III-III of Fig. 1.

DETAILED DESCRIPTION OF THE INVENTION

25 Referring now to Figs. 1 to 3, there is shown a solder dross removal apparatus assembled according to one embodiment of the present invention and generally indicated by reference numeral 10. The apparatus 10 includes a

solder reservoir 12 within which a pool of molten solder is held at a preset suitable temperature by heaters (not shown). A relatively narrow solder nozzle 14 is vertically disposed in the solder reservoir 12 to produce a turbulent
5 wave 16. The turbulent wave enables the molten solder to fill the gap between leads of electronic components (not shown) and through holes (not shown) in a printed circuit board (not shown). A relatively wide solder nozzle 18 is vertically disposed downstream of the narrow solder nozzle
10 14 to produce a smooth laminar flow solder wave 20. The smooth solder wave serves to remove bridges, icicles and other solder deposits which may be formed while the printed circuit board (not shown) passes through the turbulent wave in a direction such as shown in the arrow in Fig. 1. As
15 best shown in Fig. 2, a horizontal duct 22 has one end connected to the lower end of the wide solder nozzle 18. A solder pump 24 is disposed within the other end of the duct 22. An inlet opening 26 is defined in a portion of the duct 22 below the pump 24. A vertical shaft 28 has one end
20 connected to the pump 24. The other end of the shaft 28 extends above the solder reservoir 12. A pulley (not shown) is secured to the other, free end of the shaft 28. A belt (not shown) extends between the pulley and the output shaft of a motor (not shown). The motor is
25 energized to activate the pump 24 through the belt-and-pulley assembly. This activation allows the molten solder within the solder reservoir 12 to flow into the duct 22 through the inlet opening 26. The molten solder is caused

to flow in a turbulent fashion as a result of the continued pumping action of the pump 24. To provide for uniform flow of the molten solder within the nozzle 18, a flow control plate or panel 30 is mounted within the nozzle 18 adjacent
5 to the juncture between the nozzle 18 and the duct 22. The flow control plate 30 is formed with a number of apertures 32. The apertures 32 are so arranged that the molten solder has a substantially straight vertical path above the flow control panel 30 to provide a substantially parallel
10 solder wave.

A pair of elongated side troughs 34 are formed in the longitudinal sides of the wide solder nozzle 18. As best shown in Fig. 2, the side troughs 34 are inclined at an acute angle to the horizontal. A guide plate 36 is
15 attached to each of the downwardly sloping troughs 34. The guide plate 36 has a bent first section 38 extending forwardly and downwardly from the lower end of the trough 34, and a vertical second section 40 connected to the lower end of the first section 38 and terminating a short
20 distance above the bottom of the solder reservoir 12. The guide plates 36 serve to direct the solder and dross 41 toward a dross zone 42 which is located in one side of the solder reservoir 12 opposite the pumps 24. The guide
25 plates 36 also act as barriers to prevent the dross 41 from flowing below or toward the duct 22.

A hood 44 is mounted to and extends across one side of the solder reservoir 12. As shown in Fig. 2, the hood 44 has a substantially semicircular section. The hood 44

has an opening 46 which is open to the nozzle 18 to receive the dross 41. A screw 48 extends across the solder reservoir 12 and is partly submerged in the pool of molten solder. The hood 44 is positioned to surround a part of
5 the screw 48 above the level of the molten solder. As best shown in Fig. 3, the screw 48 has a shaft 50, and a pulley 52 is mounted to one end of the screw shaft 50. A belt 54 extends between the pulley 52 and a motor 56 which is mounted to the solder reservoir 12 adjacent to the pulley
10 52. A non-oxidizing gas injector 58 in the form of a pipe is communicated with the interior of the hood 44. The gas injector 58 is connected through a heater 60 to a source of non-oxidizing gas 62. Illustratively, but not limited to, the non-oxidizing gas is nitrogen. Alternatively, the non-
15 oxidizing gas may be selected from carbon dioxide, argon and other inert gases, and hydrogen gas, ammonolysis gas and other reactive gases. Illustratively, but not limited to, the heater 60 is in the form of a tube containing a conventional heating coil (not shown).

20 Preferably, a heating element 62 is mounted within the hood 44 to raise the temperature within the hood 44. Alternatively, the heating element 62 may be mounted outside of the hood 44. A rectangular dross collection tray 64 is mounted to one side of the solder reservoir 12
25 opposite the pulley 52 so as to collect oxides 66 as removed from the dross 41. Preferably, the hood 44 extends over the dross collection tray 64. This arrangement prevents the oxides in powder form from being scattered

over the solder reservoir 12.

It should be understood that the narrow solder nozzle 14 is substantially similar in structure to the wide solder nozzle 18 except that the nozzle opening of the narrow
5 solder nozzle 14 is smaller than that of the wide solder nozzle 18 and will not be described herein.

In use, the pump 24 is activated to draw the liquid solder into the duct 22 through the inlet opening 26. The solder then flows toward the nozzle 18 as shown in Fig. 2.
10 When the solder passes through the apertures 32 in the flow control panel 30, the solder has a substantially straight vertical path. A series of printed circuit boards (not shown) pass over the solder waves 16, 20 established in the nozzles 16, 18, respectively. At this time, the underside
15 of the boards makes contact with the solder waves whereby solder bumps and connections are formed on the printed circuit boards.

When the solder is pumped up through the nozzle 18, the solder falls into the sloping side troughs 34. At
20 this time, the solder is exposed to and contacted with atmospheric air. As a result, dross forms on the top of the molten solder. The dross 41 is directed toward the dross zone 42. The dross 41 is then agitated by the screw 48. As the interior of the hood 44 is heated to a high
25 temperature, the flowability of the solder becomes higher. This promotes removal of oxides and other contaminants from the dross 41. The oxides 66 are delivered to the dross collection tray 64. Any free or reclaimed solder is

returned to the solder bath 12. The nitrogen, as heated to a temperature of approximately 150°C , is introduced into the the hood 44 through the gas injector 58 so as to maintain the interior of the hood 44 under a substantially
5 oxygen-free atmosphere. This not only promotes removal of the oxides from the dross, but also inhibits reoxidization of the reclaimed solder.

The present invention has been described with respect to its preferred embodiments, it is to be understood that
10 various modifications and changes may be made without departing from the scope of the invention as defined by the appended claims.

WHAT IS CLAIMED IS:

1. An apparatus for recovering solder from dross, comprising:

a solder reservoir for holding a pool of molten solder, said solder reservoir having a dross zone at one side thereof;

at least one solder nozzle for forming and directing a solder wave against a substrate to be soldered, said at least one solder nozzle being disposed in said solder reservoir, said at least one solder nozzle including opposite side troughs inclined downwardly toward said one side of said solder reservoir to direct dross toward said dross zone;

a hood mounted to said solder reservoir and located above said dross zone, said hood having an interior; and

an agitator mounted to and extending across said one side of said solder reservoir, said agitator being activated to agitate the dross so as to remove oxides and recover solder from the dross.

2. The apparatus of claim 1, wherein said hood has a substantially semicircular section.

3. The apparatus of claim 1, wherein said solder reservoir has a bottom, and said at least one solder nozzle includes guide plates, each of said guide plates including a downwardly sloping first section connected to a corresponding one of said side troughs and a vertical second section connected to said first section and terminating a short distance above the bottom of said

solder reservoir.

4. The apparatus of claim 1, further comprising a heating element associated with said hood and adapted to heat the interior of said hood to a predetermined temperature.

5. The apparatus of claim 1, further comprising a flow control plate mounted within said at least one solder nozzle and including a plurality of apertures whereby the molten solder has a substantially straight vertical path above said flow control plate.

6. The apparatus of claim 1, further comprising a source of non-oxidizing gas, and a gas injector connected to said source of non-oxidizing gas and communicated with the interior of said hood.

7. The apparatus of claim 6, further comprising a heater connected between said source of non-oxidizing gas and said gas injector.

8. The apparatus of claim 1, further comprising a dross collection tray mounted to said solder reservoir adjacent to one end of said agitator and associated with said agitator.

9. The apparatus of claim 8, wherein said hood extends over said dross collection tray.

10. The apparatus of claim 1, wherein said hood includes an opening open to said at least one solder nozzle.

11. A method for recovering solder from dross present in a solder reservoir within which a pool of molten solder is held, said solder reservoir including a hood below which a

dross zone is defined,

directing dross toward said dross zone;

agitating the dross to remove oxides and recover solder from the dross; and

returning the recovered solder to the pool of molten solder and delivering the oxides out of the solder reservoir.

12. The method of claim 11, wherein the hood has an interior, said interior of said hood being heated to a temperature of at least 100°C.

13. The method of claim 11, wherein a non-oxidizing gas is introduced into said hood to generate a substantially oxygen-free atmosphere within said hood.

14. The method of claim 13, wherein the non-oxidizing gas is an inert gas.

15. The method of claim 14, wherein said inert gas is nitrogen.

16. The method of claim 14, wherein said inert gas is carbon dioxide.

17. The method of claim 14, wherein said inert gas is argon.

18. The method of claim 13, wherein the non-oxidizing gas is a reactive gas.

19. The method of claim 18, wherein said reactive gas is hydrogen gas.

20. The method of claim 18, wherein said reactive gas is ammonolysis gas.