

The present invention has as its object a tin-soldering machine with an automatic wave guard, for printed circuit boards.

In the electronic industries which mass-produce printed circuit boards the soldering of the components is effected in accordance with the so-called "wave" process, in which a turbine maintains a constant rate of flow of molten lead/tin alloy, flowing over a weir of a specific shape.

The shape of the surface of the molten alloy, its speed of flow, and its cleanliness are important factors which influence the quality of the soldered joints.

The geometry of the electronic board is also a determining factor: ideally, the board is plane, and in its movement of translation it collides with a rectilinear generatrix of the volume of molten alloy.

In practice, the boards are not plane, and have the shape of a tile which is all the more accentuated the wider they are. The generatrix of the molten metal is not rectilinear any longer, and slags may in addition distort the surface thereof.

It is understood that if the board to be soldered possesses the shape of a tile with a convexity turned downwards, there is a very great risk of the molten metal, at the instant of collision, inundating the components side of the board, which is irreparably lost. If, in order to avoid this, an attempt is made at a compromise adjustment, components run the risk of not being soldered.

These reasons cause costly stop-gap measures to be taken, amongst them:

- the addition of stiffeners to the electronic board itself; if it is a board which contain power elements, advantage will

be able to be taken of the rigidity of the metallic radiators;

- or more generally the use of a soldering frame in which the circuit has been confined, and which unites the functions which the electronic board cannot fulfil by itself, and in particular the wave guard function.

According to the document US-A-3 379 356 a nozzle soldering machine is known which necessitates, in order to avoid the flooding of the upper face of the boards to be soldered, the fixing of a deflector (12) on these boards.

The invention has as its object a soldering machine realised so as to avoid any additional expense at the board, or supplementary manufacturing operations such as placing the board into a frame, then withdrawing it after soldering.

The soldering machine in accordance with the invention is provided with a wave guard device integral with the machine, which comprises a device which causes a local lowering of the level of the ridge of tin solder just prior to the arrival of the leading edge of the board to be soldered.

In accordance with an advantageous feature of the invention, the wave guard device comprises a sheet of a material which does not fuse at the temperature of the molten tin solder and which dips into the surface of the solder bath in front of the leading edge of the circuit to be soldered.

The present invention will be better understood on reading the detailed description of an embodiment, taken by way of a non-restrictive example and illustrated by the accompanying drawings, in which:

- Figure 1 is a simplified and partial side view of a soldering machine in accordance with the invention, and
- Figures 2 and 3 are enlarged detail views of the soldering

machine of Figure 1 at two different instants of the passage of a printed circuit board.

That part of a tin-soldering machine which is situated at the wave 1 of tin has been shown diagrammatically in Figure 1. Understood by tin is any suitable fusible soldering product or alloy which contains tin, but not exclusively this metal only. The wave 1 of tin is produced in the conventional manner with the aid of a nozzle 2. This wave 1 can flow symmetrically upstream and downstream of the nozzle, as shown in the drawing, or else asymmetrically. The direction of displacement of the conveyor of the machine has been represented by an arrow 3. This conveyor transports printed circuit boards provided with their components, such as the board 4 shown in the drawing. The relative positions of the conveyor and of the nozzle 2 are such that the upper face 5 of the wave 1 of tin is at a higher level than that of the upper face of the board 4, which necessitates, with the machines of the prior art, wave guards arranged in front of the boards (or support frames provided with front walls acting as a wave guard) to avoid the flooding of the upper face of the board by the molten bath.

In accordance with the invention, a moving wave guard is arranged on the machine. In the embodiment shown in the drawings this wave guard comprises a flap 6 movable in rotation about an axis 7 parallel to the planes of the main faces of this flap, from which axis it is suspended, this axis 7 being perpendicular to the direction of displacement of the conveyor. The flap 6 has a substantially rectangular shape, and its width is substantially equal to the width of the board 4. In its rest position (in an unbroken line in Figure 1), the flap 6 is arranged in such a way that its lower lateral face 8 is at a distance $D = 2$ to 3 mm approximately below the level of the lower face of the board 4, this face therefore being below the level 5. The axis 7 of the flap 6 is arranged approximately vertical to a line A (only the trace thereof has been shown in Figure 2) which

can be defined as the position which the leading ridge B of the board 4 (lower ridge of the front face 9 of the board 4) would occupy at the instant when it would enter into contact with the wave 1 if the flap 6 did not exist.

A location device 10 cooperating with a position pick-up 11 is fixed to the upper portion of the flap 6. This pick-up 11 can just as well be of optical type as electromagnetic or otherwise. The pick-up 11 is connected to a device 12 for processing the items of information of the pick-up and for controlling a jack 13 arranged downstream of the flap 6. The realisation of the device 12 is evident for an expert on reading the present description, and it depends on the type of pick-up 11 and jack 13 which are used. The rod 14 of the jack 13 is connected to the flap 6 through the medium of a flexible connection 15 such as a chain or a cable. When the jack 13 is activated by the device 12, it pulls the flap downstream (that is to say towards the right in the drawing).

The operation of the machine described above is as follows. At rest, the flap 6 being in the position shown in an unbroken line in Figures 1 and 2, the conveyor moves the board 4 as far as into contact with the flap 6. The conveyor continuing to advance, the board 4 pushes the flap 6 over a length of approximately $L = 1$ to 2 cm without anything happening.

As soon as the board 4 has travelled the length L , the flap 6 arrives in the position designated by the reference 6A in Figures 1 and 3, and the location device 10 arrives in the position bearing the reference 10A. At this instant, the signal supplied by the pick-up device 11 reaches a predetermined threshold adjusted in the device 12, which causes this latter to excite the jack 13 which retracts its rod 14 and thus pulls through the medium of the connection 15 on the flap 6. The characteristics of the jack 13 and of its control are such that it moves the flap away downstream at a

speed greater than that of the displacement of the board 4. The jack 13 moves the flap away as far as a position 6B (Figure 1) such that this flap can allow the board 4 to pass without the components running the risk of touching the flap.

The flap 6, at the start of its movement from the rest position towards the final position 6B (while it is in contact with the tin wave) pushes the tin away practically in the same way as a conventional wave guard would do. When the flap 6 draws away rapidly from the position 6A towards the position 6B, it pushes the tin away while creating there a moving "hollow" which precedes the board 4 and prevents it from being submerged. The wave crest which follows this hollow "wets" only the lower face of the board 4 while depositing solder at the desired locations.

The distances D and L', as well as the level 5 in relation to the level of the board 4, and the speed of retraction of the jack 13 are adjusted experimentally so as to ensure an optimum soldering of the tails or feet of the components of the board 4.

The movement of the flap 6 also has the effect of keeping away from the board 4 any slags 16 which might possibly be found at the surface of the wave of tin. A device (not shown), which may either detect the end of the passage of the board 4, or be activated at the end of a calculated delay, controls the exit of the rod 14 of the jack 13.

According to a modification of the embodiment described above, not shown, the flap is moved in a straight line whilst being maintained substantially perpendicular to the direction 3, then, when the board 4 is sufficiently engaged on the wave 11, the flap is raised perpendicularly to the direction 3, in order to be brought back to its "rest" position (the same as the one of Figure 1, but one can then have $D = 0$) after the passage of the board.

According to another embodiment of the invention, the flap is replaced by a moving nozzle for blowing hot inert gas. This nozzle creates a "curtain" of gas just in front of the board 4 which it precedes, this curtain of gas producing a hollow at the surface of the wave of tin which prevents the tin from submerging the board.



CLAIMS

1. A tin-soldering machine with an automatic wave guard for printed circuit boards (4), characterised in that the wave guard device (6) is integral with the machine and comprises a device (6) which causes a local lowering of the level of the ridge of tin solder just prior to the arrival of the leading edge of the board (4).
2. A soldering machine according to Claim 1, characterised in that the wave guard device comprises a sheet (6) of a material which does not fuse at the temperature of the molten tin solder and which dips into the surface of the solder bath (1) in front of the leading edge of the circuit to be soldered.
3. A soldering machine according to Claim 2, characterised in that the sheet is movable in rotation about an axis (7) perpendicular to the direction of displacement (3) of the board.
4. A soldering machine according to Claim 3, characterised in that during a first period of its rotation the sheet is pushed forward by the board (4) and is then rapidly removed in the same direction in order to allow the passage of the board.
5. A soldering machine according to Claim 2, characterised in that the sheet is moved in a straight line while being maintained substantially perpendicular to the direction of displacement of the board, and is then raised perpendicularly to this direction.
6. A soldering machine according to Claim 1, characterised in that the wave guard device comprises a moving nozzle for blowing hot inert gas.