

SPECIFICATION

Apparatus for soldering printed circuit boards carrying components

5 The present invention relates to a new and improved apparatus for soldering printed circuit or wiring boards carrying circuit components.

Generally speaking, the soldering apparatus for
10 printed circuit boards of the present invention is of the type comprising a solder bath and a number of transport frames moved by a conveyor device. Each of the transport frames is structured for receiving a circuit board upon which there have been placed the
15 circuit components. The transport frames are guided at their leading corners and at their trailing corners by related guide tracks. These guide tracks, at the region of the solder bath and, viewed in the direction of the conveying of the transport frames, possess
20 respective descending ramps and following these respective ascending ramps.

In the context of this disclosure there is to be understood by the expression "soldering printed circuit boards carrying circuit components" that
25 there are soldered the connection leads or wires of active circuit components which are mounted at one side or face of a prepared printed circuit board. Soldering is accomplished at that location where the connection leads or wires protrude out of the other
30 side or face of such circuit board. These connection leads or wires, also referred to in the art sometimes as "legs", have different lengths, so that at the side of the printed circuit board facing away from the circuit components or elements, there is formed a
35 so-to-speak "lead tuft", where the individual connection leads or wires are arranged more compactly next to one another the smaller the circuit components are, on the one hand, and the more compact the circuit components are arranged upon the
40 printed circuit board, on the other hand.

As will be readily appreciated it is not simple to solder such a "lead or wire tuft" in one working operation such that each of the protruding connection leads or wires has been positively soldered only
45 at its location it piercingly extends through the printed circuit board and only at such location.

If the immersion of the printed circuit board into the solder bath is accomplished parallel to itself and to the surface of the solder bath, for instance by
50 lowering the printed circuit board or by raising the solder bath, then the danger exists that air bubbles will be caught in the "lead tuft", and therefore, hinder soldering of one or the other connection lead or wire. This defect, as mentioned, can be somewhat
55 counteracted if the immersion of the printed circuit board into the solder bath is accomplished with a forward tilting movement of the printed circuit board, so that initially the leading region of the underside or face of the printed circuit board is
60 immersed into the solder bath and only thereafter the trailing region. In this way it is possible to afford sufficient time for air entrapped in the "lead tufts" to possibly escape.

On the other hand, particularly in the case of long,
65 protruding and/or densely arranged connection

leads or wires it is important to prevent that, upon lifting the printed circuit board out of the solder bath, solder tabs or bridges will not remain hanging at such connection leads or wires. Should such occur,
70 then it is possible that there are formed undesired electrical connections between connection leads or wires which otherwise should remain insulated from one another.

Therefore, with the foregoing in mind, it is an
75 object of the present invention to provide a new and improved construction of apparatus for soldering printed circuit or wiring boards carrying circuit components in such a manner than the aforementioned drawbacks and limitations of the prior art are
80 substantially reduced or avoided.

The present invention consists in apparatus for soldering printed circuit boards carrying circuit components, said apparatus comprising a solder bath, a plurality of transport frames, each adapted to
85 receive a printed circuit board, a conveying device for sequentially feeding to and removing from the solder bath the transport frames, each of said frames comprising two leading and two trailing corners as seen in the generally horizontal conveying direction,
90 the conveying device comprising guide means for guiding each transport frame at its leading and trailing corners, characterized in that the guide means comprise an individual guide track for each of the leading and for each of the trailing corners, each
95 of said guide tracks having in the region of the solder bath descending ramps followed in conveying direction by ascending ramps, the descending ramps being parallel to each other and the ascending ramps being parallel to each other, the spacing in
100 conveying direction between the descending ramps of the guide tracks associated respectively with the leading and the trailing corners being less than the distance between the leading and the trailing corners of a transport frame, and the spacing in
105 conveying direction between the ascending ramps associated respectively with the leading and the trailing corners corresponding to the distance between the leading and the trailing corners of a transport frame.

110 The arrangement of the descending ramps ensures for the desired tilting movement of the transport frames and the thereby carried printed circuit boards during immersion of the printed circuit boards into the solder bath. On the other hand, the
115 arrangement of the ascending ramps ensures that the printed circuit boards essentially will be raised out of the solder bath parallel to themselves, so that there cannot be formed any solder bridges or the like, since excess solder drips off the ends of the connection leads or wires in the direction thereof.
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The invention will now be further described, by way of example, with reference to the accompanying drawings, in which:

125 *Figure 1* is a simplified schematic top plan view of part of one embodiment of an apparatus according to the invention for soldering printed circuit or wiring boards carrying circuit components;

Figure 1A is a perspective view of part of the apparatus shown in *Figure 1*;

130 *Figure 2* is a simplified illustration in side view

transverse to the conveying direction, partially in section taken substantially along the line II-II of Figure 1, of the soldering apparatus depicted in such Figure 1;

5 *Figure 3* is a sectional view through a transport frame, the section being taken transversely with respect to the conveying direction of the transport frame;

10 *Figures 4, 5 and 6* respectively show in side views, similar to the illustration of Figure 2, the soldering apparatus thereof illustrating the transport frames at different phases of their movement path; and

15 *Figures 7, 8, 9 and 10* are respective sectional views of the soldering apparatus of Figure 6 through the guide rails closer to the viewer of the illustration of Figure 6, the sectional views being taken along the respective section lines AA, BB, CC and DD in Figure 6.

Referring now to the drawings, the exemplary illustrated embodiment of apparatus according to the invention for soldering printed circuit or wiring boards carrying circuit components has been generally designated by reference character 10 and will be seen to comprise a trough or container 11 within which there is arranged a vat or receptacle 12 into which, for instance, liquid tin solder is continuously pumped by a suitable pump unit 13. To preserve clarity in illustration and since the structure of the heating elements used for retaining the tin in a liquid state is unimportant for understanding the basic concepts of the invention, such heating elements, which are standard, have been conveniently omitted from the drawings. The vat or receptacle 12 contains therein a solder bath 14, the level or meniscus 15 of which is located practically at a constant height, since any excess of the tin solder which is supplied by the pump 13 is continuously permitted to flow off over the upper edges 12a of the vat 12, together with the oxide layer which is formed thereat, into the trough or container 11 from where it is again recycled by the pump unit or pump 13 back into the vat 12. Two guide rails 16 and 17 are arranged to extend along both of the lengthwise or longitudinal sides 12b of the vat or receptacle 12. The profile or cross section of these guide rails 16 and 17, as best seen by referring to Figure 1A and Figures 7 to 10, has the shape of the letter "H" containing two transverse webs 80. In the hollow spaces or regions 18 and 19 (Figures 7 to 9) formed by such sectional configuration or shape of the guide rails 16 and 17 there are guided both runs 20 and 21 (Figures 1, 1A, 2) of a conveyor chain 22 or equivalent structure, this chain 22 being driven by any suitable drive in the direction of the arrows 23.

55 The upper edges 82 of the lateral side plates or checks 84 of the guide rails 16 and 17 are inwardly bent, so that there are formed two guide tracks 24 and 25 located in spaced relationship from one another and containing therebetween a slot 26. This slot 26 extends over the entire length of the related guide rail 16 and 17. The upper run 20 of the conveyor chain 22 is accessible through the corresponding slot 26. The guide track 24 which extends closer past the solder vat 12 has been referred to hereinafter as a matter of convenience as the "inner"

guide track, while the more remote guide track 25 which extends past the solder vat 12 has been conveniently referred to hereinafter as the "outer" guide track.

70 Now for the purpose of receiving the printed circuit or wiring boards 27 which are to be soldered there are advantageously provided a number of essentially rectangular transport frames 28. These transport frames 28 are provided at their leading corners 86 with laterally protruding slide runners or shoes 29 or wheels 29' (Figure 1A) which are supported on the inner guide tracks 24. Attached to the slide runners 29 or the shafts of the wheels 29' is an entrainment element, here shown as an entrainment tooth or dog 30, which extends into the related slot 26 and at that location between two neighboring chain links of the upper run 20 of the chain 22. The trailing corners 88 of the transport frames 28 are likewise provided with laterally protruding slide runners or shoes 31 or with wheels 31' (Figure 1A), which however in this case bear upon the related outer guide track 25. From the foregoing it will be apparent that the transport frames 28 are directly dragged by the conveyor chain 22 in the guide rails 16 and 17, and that the leading corners 86 of the transport frames 28 are correlated or operatively associated with the inner guide tracks 24, while the trailing corners 86 of these transport frames 28 are correlated or operatively associated with the outer guide tracks 25.

85 Both the inner guide tracks 24 and also the outer guide tracks 25 each possess a respective descending ramp 32 and 33, and following the same an ascending ramp 34 and 35, respectively. The descending ramp 33 and the ascending ramp 35 of each of the outer guide tracks 25 are formed by a respective bracket element or block 36 and 37, for instance formed of sheet metal, but another material can be used, each of which bracket elements 36 and 37 can be secured by means of the bolts 39, extending through elongated holes or slots 38 thereof, to the outer guide track of the related guide rails 16 and 17, respectively. Hence, it is possible to selectively adjust the position of the descending ramps 33 with respect to the descending ramps 32 and the ascending ramps 35 with respect to the ascending ramps 34 along the guide rails 16 and 17.

The linear section of the inner guide track 24 following the descending ramp 32, is maintained somewhat higher in elevational position, by means of a ledge 40 or equivalent structure, equally shiftable in lengthwise direction, than the linear section following the descending ramp 33 of the outer guide track 25. The length of the ledge 40 or the like is chosen such that its end 41, confronting the ascending ramp 34, viewed in the direction of conveying, is spaced somewhat from the lower end 33a of the descending ramps 33 of the outer guide track 25 by an amount which corresponds to the length of the transport frame 28. Viewed in the direction of conveying the spacing of the descending ramps 32 and 33 from one another, in any event, is less than the length of the transport frame 28. The adjustability of the bracket elements 36 containing the descending ramps 33, viewed in the conveying direc-

tion, serves for setting the immersion position of the transport frames 28, and thus, that of the printed circuit boards 27 which are retained by such transport frames. This immersion position is to be
 5 differently selected, depending upon the dimensions of the printed circuit boards 27. The spacing of the ascending ramps 34 and 35 from one another, in any event, corresponds essentially to the length of each of the transport frames 28. The adjustability of the
 10 bracket element 37 with the ramp 35, in relation to the ramp 34, in the first instance serves for adjusting the soldering apparatus 10 to transport frames 28 of different length.

The ledge or strip 40 serves the purpose of first
 15 placing the leading region of that side of the printed circuit board 27, from which there protrude the connection leads or wires 42 (Figure 2), into contact with the meniscus or surface 15 of the solder bath 14, also when the trailing region of this side of the
 20 printed circuit board contacts the bath meniscus, i.e. when the slide shoes or runners 31 or the wheels 31' of the transport frames 28 have reached the lowest location following the descending ramp 33 of the outer guide track 25.

Continuing, now in Figure 4 reference character
 25 28₁ designates a transport frame which has just begun to carry out its immersion movement by forwardly tilting. Reference character 28₂ illustrates a transport frame shortly before it has completed its
 30 immersion position. This has been attained in Figure 5 for the transport frame designated by reference character 28₃. In Figure 6 reference characters 28₄ and 28₅ designate two phases of lifting out of the transport frame, and in Figure 5 there is designated
 35 by reference character 28₆ a transport frame which has already been completely lifted out of the solder bath and fed by the conveyor chain 22 to a subsequent processing station, for instance a so-called cutter where the excess length of the now fixedly
 40 soldered connection leads or wires 42 are cut or trimmed.

It has been found that the above described soldering apparatus not only is quite practical in operation -- each transport frame 28 can be sus-
 45 pended at a random, free position of the conveyor chain 22 --, but also affords improved soldering in several respects, so that by virtue of the proposed soldering apparatus it is possible to beneficially still increase the arrangement density of the circuit
 50 components upon the printed circuit boards, i.e. there can be further extension of the miniaturization of printed circuit boards.

CLAIMS

1. Apparatus for soldering printed circuit boards carrying circuit components, said apparatus comprising a solder bath, a plurality of transport frames, each adapted to receive a printed circuit board, a
 60 conveying device for sequentially feeding to and removing from the solder bath the transport frames, each of said frames comprising two leading and two trailing corners as seen in the generally horizontal conveying direction, the conveying device comprising
 65 guide means for guiding each transport frame at

its leading and trailing corners, characterized in that the guide means comprise an individual guide track for each of the leading and for each of the trailing corners, each of said guide tracks having in the
 70 region of the solder baths descending ramps followed in conveying direction by ascending ramps, the descending ramps being parallel to each other and the ascending ramps being parallel to each other, the spacing in conveying direction between
 75 the descending ramps of the guide tracks corners being less than the distance between the leading and the trailing corners of a transport frame, and the spacing in conveying direction between the ascending ramps associated respectively with the leading
 80 and the trailing corners corresponding to the distance between the leading and the trailing corners of a transport frame.

2. Apparatus as claimed in claim 1, wherein the guide tracks comprise inwardly turned flanges of
 85 two lengthwise-slotted, hollow rails, said hollow rails extending substantially parallel to one another and to opposite sides of the solder bath, and wherein the conveyor device comprises a driven conveyor chain disposed in each hollow rail, and entrainment
 90 teeth attached to the leading corners of each transport frame are arranged to engage with the driven conveyor chains.

3. Apparatus as claimed in claim 2, wherein the flanges of the hollow rails extending adjacent the
 95 solder bath are associated with the leading corners of the transport frames and the flanges remote from the solder bath are associated with the trailing corners of the transport frames.

4. Apparatus as claimed in claim 2 or 3, wherein
 100 the descending ramps of the guide tracks associated with the trailing corners of the transport frames are formed by bracket members adjustable along the hollow rails in order to regulate the immersion position of the printed circuit boards carried by the
 105 transport frames into the solder bath.

5. Apparatus as claimed in claim 2, 3 or 4, wherein the ascending ramps of the guide tracks associated with the trailing corners of the transport frames
 110 are formed by bracket members adjustable along the hollow rails in order to accommodate the ramps for transport frames of different lengths.

6. Apparatus for soldering printed circuit boards, constructed and adapted to operate substantially as hereinbefore described with reference to the accompanying drawings.

tion, serves for setting the immersion position of the transport frames 28, and thus, that of the printed circuit boards 27 which are retained by such transport frames. This immersion position is to be differently selected, depending upon the dimensions of the printed circuit boards 27. The spacing of the ascending ramps 34 and 35 from one another, in any event, corresponds essentially to the length of each of the transport frames 28. The adjustability of the bracket element 37 with the ramp 35, in relation to the ramp 34, in the first instance serves for adjusting the soldering apparatus 10 to transport frames 28 of different length.

The ledge or strip 40 serves the purpose of first placing the leading region of that side of the printed circuit board 27, from which there protrude the connection leads or wires 42 (Figure 2), into contact with the meniscus or surface 15 of the solder bath 14, also when the trailing region of this side of the printed circuit board contacts the bath meniscus, i.e. when the slide shoes or runners 31 or the wheels 31' of the transport frames 28 have reached the lowest location following the descending ramp 33 of the outer guide track 25.

Continuing, now in Figure 4 reference character 28₁ designates a transport frame which has just begun to carry out its immersion movement by forwardly tilting. Reference character 28₂ illustrates a transport frame shortly before it has completed its immersion position. This has been attained in Figure 5 for the transport frame designated by reference character 28₃. In Figure 6 reference characters 28₄ and 28₅ designate two phases of lifting out of the transport frame, and in Figure 5 there is designated by reference character 28₆ a transport frame which has already been completely lifted out of the solder bath and fed by the conveyor chain 22 to a subsequent processing station, for instance a so-called cutter where the excess length of the now fixedly soldered connection leads or wires 42 are cut or trimmed.

It has been found that the above described soldering apparatus not only is quite practical in operation ...each transport frame 28 can be suspended at a random, free position of the conveyor chain 22..., but also affords improved soldering in several respects, so that by virtue of the proposed soldering apparatus it is possible to beneficially still increase the arrangement density of the circuit components upon the printed circuit boards, i.e. there can be further extension of the miniaturization of printed circuit boards.

CLAIMS

1. Apparatus for soldering printed circuit boards carrying circuit components, said apparatus comprising a solder bath, a plurality of transport frames, each adapted to receive a printed circuit board, a conveying device for sequentially feeding to and removing from the solder bath the transport frames, each of said frames comprising two leading and two trailing corners as seen in the generally horizontal conveying direction, the conveying device comprising guide means for guiding each transport frame at

its leading and trailing corners, characterized in that the guide means comprise an individual guide track for each of the leading and for each of the trailing corners, each of said guide tracks having in the region of the solder baths descending ramps followed in conveying direction by ascending ramps, the descending ramps being parallel to each other and the ascending ramps being parallel to each other, the spacing in conveying direction between the descending ramps of the guide tracks corners being less than the distance between the leading and the trailing corners of a transport frame, and the spacing in conveying direction between the ascending ramps associated respectively with the leading and the trailing corners corresponding to the distance between the leading and the trailing corners of a transport frame.

2. Apparatus as claimed in claim 1, wherein the guide tracks comprise inwardly turned flanges of two lengthwise-slotted, hollow rails, said hollow rails extending substantially parallel to one another and to opposite sides of the solder bath, and wherein the conveyor device comprises a driven conveyor chain disposed in each hollow rail, and entrainment teeth attached to the leading corners of each transport frame are arranged to engage with the driven conveyor chains.

3. Apparatus as claimed in claim 2, wherein the flanges of the hollow rails extending adjacent the solder bath are associated with the leading corners of the transport frames and the flanges remote from the solder bath are associated with the trailing corners of the transport frames.

4. Apparatus as claimed in claim 2 or 3, wherein the descending ramps of the guide tracks associated with the trailing corners of the transport frames are formed by bracket members adjustable along the hollow rails in order to regulate the immersion position of the printed circuit boards carried by the transport frames into the solder bath.

5. Apparatus as claimed in claim 2, 3 or 4, wherein the ascending ramps of the guide tracks associated with the trailing corners of the transport frames are formed by bracket members adjustable along the hollow rails in order to accommodate the ramps for transport frames of different lengths.

6. Apparatus for soldering printed circuit boards, constructed and adapted to operate substantially as hereinbefore described with reference to the accompanying drawings.

