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Soldering Systems and Methods

5 This invention relates to soldering systems and methods and more particularly to a system and method for the vapour-phase heating of a product and separate application of solder to the heated product.

10 Soldering is widely employed for the fabrication of many different products, especially products in the electronics field, notably printed circuit boards. For the production fabrication of printed circuit boards and similar products, wave solder systems have been widely employed. These systems include a reservoir of molten solder which is pumped in a wave, with the circuit board being transported in contact with the wave to cause wetting
15 of the intended areas of the board. The solder wave serves as a source of heat for heating of the circuit board and also as the solder source for application of solder to the board. The wave solder apparatus is relatively complex and must be carefully designed and constructed to provide a
20 solder wave of the appropriate dimensions and characteristics to provide the requisite heating and solder application to the particular product being processed. The length of the wave must be sufficient to provide sufficient time of contact to heat the surface to be soldered. The
25 wave design is critical in relation to the product and speed of the product through the wave. There is a maximum speed beyond which a product cannot be conveyed through a particular solder wave and still achieve sufficient heating. For greater speeds, the wave would have to be
30 reconfigured, which would necessitate a complete system redesign.

The height of the solder wave is also a critical factor and can be a limiting factor to the size of a product being processed. For example, in a printed circuit
35 board in which leaded components are inserted, the lead lengths cannot be longer than the depth of the solder wave

1 or else a board cannot be accommodated in the particular
wave solder apparatus because of interference with the long
component leads. Thus, care must be exercised in the
assembly of components on a circuit board to assure that
5 the lead lengths are less than the depth of the solder wave
for the particular solder apparatus to be employed. Since
the solder wave serves both as the source of solder and
source of heating, the dynamics of the system become
complex in designing a wave solder apparatus for particular
10 purposes. Also, these dynamics make it difficult to alter
the characteristics of the solder wave to accommodate
different types of products.

Another type of production solder system is the
drag solder system in which a reservoir of solder is
15 provided into which a product is dipped and immersed either
partially or completely to apply solder to the product.
Here again the molten solder serves both as the source of
heat for heating the product to a soldering temperature,
and as the solder applicator.

20 U. S. Reissue Patent No. Re. 30,399 shows a wave
flow soldering apparatus in which the solder wave is
provided at the bottom of a vessel containing a heated,
saturated vapour. The product is conveyed through the
vapour chamber and is heated by immersion in the vapour
25 phase and soldered by passage through the solder wave.
Solder is applied in an anaerobic atmosphere provided by
the vapour phase but there is little improvement in the
control or performance of the soldering operation by
location of the solder wave apparatus in the chamber. The
30 criticality and relative complexity of the solder wave
remains the same as described above, and the presence of
the solder wave within the heated vapour does not alter the
critical design considerations of the wave apparatus.

An article entitled "A New Soldering Process," by
35 W. R. George, Brazing & Soldering, No. 5, Autumn 1983,
shows a drag soldering system in which the product is

1 initially placed within a heated inert vapour phase prior
to immersion into the molten solder bath.

U. S. Patent No. 3,825,164 shows a soldering
system having a tank containing a pool of molten solder at
5 the bottom and covered by a liquid fluxing bath, with
solder spray apparatus within the fluxing bath. A printed
circuit card is inserted vertically into the fluxing bath
for fluxing and preheating, and solder is sprayed onto one
or both surfaces of the printed circuit card as the card is
10 withdrawn from the tank.

The present invention provides a system for the
soldering of circuit boards and other products in which the
product is heated by an independently controlled vapour
phase system, and solder applied by a separately controlled
15 nozzle applicator system operative to direct controlled and
defined streams of solder onto the product. A vessel is
provided for containing a heated saturated inert vapour
into which the product is introduced prior to solder
application and by which the product is heated to soldering
20 temperature. One or more nozzles are provided within the
vessel for directing one or more streams of molten solder
to the heated product, the impinging solder being retained
by the areas of the product surfaces to which the solder
will adhere. In the case of a circuit board the solder is
25 adherent to the conductive circuit paths, the
plated-through holes which may be present in the circuit
board, and to the leads or connection pads of components
assembled on or inserted on the board. After solder
application, the product is subject to a solder levelling
30 or debridging operation by passage passed one or more
nozzles which are operative to direct streams of the vapour
phase condensate onto one or more of the product surfaces
to drive off any excess solder and level the applied solder
to a uniform deposited layer, to remove icicles of solder,
35 or remove solder bridges between adjacent conductive areas
of a board, or clear solder in the through-holes. The

solder levelling or debridging operation is also accomplished within the heated vapour phase of the vessel.

Each of the operations is separately controllable and is substantially independent of the control of the other operations. Heating of the product is provided substantially by the heated vapour phase atmosphere within the vessel, and the establishment and control of this vapour atmosphere is separately provided by the vapour phase apparatus. Solder application is provided by the applicator nozzles which, with the associated solder source and pump, independently provide the intended solder streams for the particular product. Excess solder removal or solder levelling and/or debridging is separately accomplished by the solder removal nozzles which provide the intended vapour phase condensate streams for solder levelling or selected removal. The system can also provide reflow soldering by means of heat supplied by the vapour phase atmosphere.

The product can be introduced and removed from the processing vessel in any manner suitable for the particular application. Typically, for a continuous production process, the product is carried on a conveyor into the processing vessel for heating, solder application and solder levelling and/or debridging, and then carried by conveyor out of the vessel.

There now follows a detailed description, to be read with reference to the accompanying drawings of a solder system and method embodying the invention. It will be realised that this system and method have been selected for description to illustrate the invention by way of example.

In the accompanying drawings:-

Figure 1 is a diagrammatic elevation view of a solder system embodying the invention employing a pair of solder application nozzles, and a pair of solder levelling nozzles all within a vapour phase containing vessel;

1 Figure 2 is a diagrammatic elevation view of an alternative embodiment generally similar to the system of Figure 1 but having single nozzles disposed below the product;

5 Figure 3 is a diagrammatic elevation view of a further alternative embodiment generally similar to the system of Figure 1 but having single nozzles disposed above the product;

10 Figure 4 is a diagrammatic elevation view of the system in a preferred implementation;

 Figure 5 is a partially cutaway top view of the system of Figure 4; and

 Figure 6 is a partially cutaway pictorial view of a solder nozzle assembly.

15 A soldering system embodying the invention is shown in Figure 1, this embodiment being especially suited to the soldering of electronic circuit boards. A closed vessel 10 defines an interior vapour phase chamber in which a zone of inert saturated vapour is provided at a
20 predetermined elevated temperature for heating of a product to be soldered. Heaters 12 are disposed at the bottom of vessel 10 and are operative to heat a vapour phase liquid 14 to a temperature sufficient to provide a saturated vapour of that liquid within the chamber. Cooling coils 16
25 can be disposed around the vessel walls at a position to define the upper extent of the vapour zone within the chamber. Products such as circuit boards 27 are conveyed into the chamber by means of an entrance throat 18, and out of the chamber by means of an exit throat 20, each throat
30 outwardly extending from opposite side walls of the vessel 10. A conveyor 22 extends through the entrance throat 18, the interior chamber of vessel 10 and the exit throat 20, and is operative to convey or transport the circuit boards into and out of the vapour phase chamber. The conveyor can
35 be of any suitable form to accommodate the particular product being processed. For circuit boards, the conveyor

1 can include frames for holding the board edges, leaving the
board surfaces exposed for soldering. A pair of solder
nozzles 24 and 26 is disposed in the chamber, each in a
position to apply a stream of solder onto respective
5 opposite surfaces of the circuit boards which are conveyed
past the solder nozzles along the product travel path
within the chamber.

A solder pump 28 is disposed within the vessel 10
in a sump 30 containing molten solder to provide solder to
10 nozzles 24 and 26. The sump 30 collects excess solder
which falls or drains from the boards after solder
application by the nozzles. The sump also serves as a
solder supply or source for the pump 28. A separate solder
source may alternatively be provided. The solder pump can
15 alternatively be disposed external to the vessel. A pair
of nozzles 32 and 34 is disposed downstream from the solder
application nozzles 24 and 26 and is operative to direct
vapour phase liquid streams onto the respective surfaces of
the circuit boards for purposes of solder levelling and/or
20 debridging; that is, for removing excess solder from the
boards and providing a uniform solder layer. For
convenience, these nozzles 32 and 34 are referred to as
solder removal nozzles, it being understood that they are
operative to provide levelling, debridging or excess solder
25 removal as required. The vapour phase liquid is supplied
to the nozzles 32 and 34 by a pump 36, located external to
the vessel 10, the pump drawing the condensate supply from
a sump 38 which receives condensed vapour phase liquid from
a gutter 40 below the coils 16 and pipe 41. Heaters 39 are
30 provided in the sump 38 to maintain the liquid therein at
the intended temperature. Alternatively the pump 36 can
draw condensate from the supply at the bottom of vessel 10,
or from a separate source. The pump 36 can also be
internal to the vessel. An overflow pipe 43 drains excess
35 condensate to the vessel 10.

1 The entrance and exit throats are preferably
configured in conjunction with the vessel to minimize the
outward flow of vapour from the vessel to the atmosphere.
Such configuration can be as shown in U. S. Patent
5 4,389,797. The present invention is not limited to use
with such entrance and exit throats, as many different
forms of product ingress and egress to and from the vessel
can be provided to suit the particular product
configurations and specific operational requirements.

10 It is preferable for continuous product
processing to provide a straight-through or substantially
straight-through system in which the product can be
conveyed continuously through the system for soldering
operations. The entrance and exit throats 18 and 20 can be
15 disposed in a substantially horizontal position or can be
inclined upward or downward to provide an intended
conveyance path and the requisite minimization of vapour
loss from the throats to the atmosphere.

 The solder removal techniques employed in the
20 present invention are the subject of, for example U. S.
Patent 4,315,042, to which attention is directed for
further information.

 The liquid streams of the vapour phase condensate
are projected onto the surfaces of the circuit board to
25 remove excess molten solder therefrom and provide a
levelling of the applied solder, typically to a thickness
of 0.0003 - 0.0006 inches (about 0.0076 to about 0.015 mm).
The nozzles 32 and 34 are each angularly adjustable and are
also adjustable in spacing from the confronting board
30 surface to provide the intended fluid streams. Typically,
the fluid streams are projected onto the product surfaces
at angles inclined to the surface of about 15 - 40° and at
a pressure of approximately 5 - 40 pounds per square inch
(about 34.5 - 275.8 KN/m²). The two nozzles 32 and 34 can
35 be at different orientations with respect to the circuit
board. The positioning of the nozzles and the fluid flow

conditions therefrom are determined to provide effective solder removal, including the clearance of unwanted solder from holes through the circuit board. Hole clearance can often be more readily accomplished when one of the two
5 nozzles projects a stream at or near normal to the board while the other nozzle projects a stream at an angle opposite to the removal direction of the board.

The soldering system employs three operations, heating of a product entering the vessel chamber, the
10 application of solder to the heated product, and the levelling or selected removal of applied solder, after which the product exits the chamber. Each of these operations is separately controllable and is substantially independent of the control of the other operations of the
15 overall system. The product entering the chamber is heated by the vapour phase atmosphere within the chamber. The establishment and control of the heated vapour atmosphere is provided by the vapour phase apparatus which includes the heaters 12 and vapour phase liquid 14 and the
20 associated heater control. The solder application is provided by the applicator nozzles, and associated solder supply and pump, which are constructed and adjusted to provide the intended solder streams for the product which has prior to solder application been heated to an intended
25 temperature by the vapour phase apparatus of the system. Excess solder removal or solder levelling and/or debridging is accomplished by the solder removal nozzles which are of construction and adjustment to separately provide the intended levelling or removal function.

30 If only one side of the circuit boards 27 is to be processed, the system can be implemented with only bottom nozzles 26 and 34, as shown in Figure 2, or with top nozzles 24 and 32 as shown in Figure 3.

The system of Figure 1 is shown in typical
35 implementation in Figures 4 and 5. A pair of conveyor chains 42 and 45 are coupled to frames 44, which are

operative to retain printed circuit boards for transport through vessel 10. The frames 44 are each coupled at their forward end to the driving chains by a coupling 46, and include side members or skids 48 which slide along guide surfaces 50 within the vessel 10 and normally within the entrance and exit throats. The guide surfaces 50 within the vessel follow a downward path 52 at the entrance portion of the vessel and then follows a linear upward path through the vessel which is substantially colinear with the exit throat 20. An idler wheel 54 is provided within the vessel for each chain to change the direction of chain motion as illustrated. After entrance of a frame and the circuit board carried thereby into the vessel, the frame and circuit board follows the path of the guide surfaces and assumes an upwardly inclined orientation as shown in Fig. 4 for linear upward travel through the processing chamber. The circuit board, by this means, is conveyed into an intended orientation for uniform travel past the solder nozzles so that an intended relative position between the board surfaces and the confronting nozzles can be maintained within the shortest convenient vessel length in order to minimize the length of time that the circuit board is subject to the high temperatures of the processing zone within the vessel.

A pair of hold-down plates 74 is disposed above the conveyor to resiliently urge the side skids 48 of the conveyor frame into engagement with guide surfaces 50 and hold the frame and circuit board contained by the frame down against the guide surfaces. The circuit board is thus maintained in an accurate guided position and orientation along its path past the solder nozzles.

The solder nozzles 24 and 26 are provided on respective sides of the board transported therebetween astride the travel path and each nozzle is adjustable in the angular orientation of the nozzle orifice with respect to the circuit board and in the offset or spacing of the

1 nozzle from the confronting board surfaces. Typically, the
nozzles are angularly adjustable over a range of 45 degrees
to either side of an axis normal to the board surface, and
are adjustable in offset in the range of 1/4 - 1 inch
5 (0.64 - 2.54 cm). The lower nozzle 26 is further
illustrated in Fig. 6 and comprises an elongated generally
cylindrical tubular member 60 having an elongated linear
orifice 62 along the length thereof and a length to provide
a solder stream to the entire board width. A lip member 64
10 is adjustable with respect to a lip member 66 to provide an
adjustable orifice gap. The orifice has a gap typically in
the range of 10 - 30 mils (about 0.254 - 0.762 mm). The
cylindrical member is rotatable about a pivot axis to
provide for angular adjustment of the orifice to select the
15 intended angle of incidence of the solder stream applied to
the confronting board surface. A linkage 68 is coupled to
the cylindrical member 60 for upward and downward
adjustment of the cylindrical member to select the intended
spacing between the nozzle and the confronting board
20 surface. The upper nozzle 24 is similarly adjustable in
offset from the confronting board surface and angular
orientation. Molten solder is supplied to the nozzles via
piping 70 which is coupled to a supply manifold 72 which in
turn is coupled to the molten solder source or sump within
25 the vessel 10.

Each of the solder nozzles 24 and 26 is
adjustable to provide a selectable angular orientation of
the nozzle with respect to the confronting board surface,
and to select the gap or distance between the nozzle and
30 the confronting board surface. The angular adjustability
of each solder nozzle provides an angle of incidence for
the impinging solder stream which can be normal to the
board surface or at an angle with or against the travel
direction of the board. The angular orientation of each
35 nozzle and the distance between the nozzle and board
surface is determined to provide the intended quantity of

1 solder and definition of the solder stream for the
particular product being processed. The solder streams are
separately controlled to provide the intended application
of solder to the circuit board. The product has been
5 heated by the vapour phase within the vessel and is thus at
soldering temperature upon introduction to the solder
application nozzles.

The solder removal nozzles 32 and 34 are also
adjustable in angular orientation and offset in similar
10 manner to the solder nozzles to provide the desired
incident streams of levelling liquid onto the board
surface.

The system is useful in soldering a variety of
circuit board types. The system can be employed for
15 so-called bare boards which are printed circuit boards
having circuit patterns on the board surfaces but without
any components thereon, and which may include through-holes
interconnecting the circuit patterns. The system can also
be employed for circuit boards containing surface mounted
20 components on one or both surfaces thereof, leaded
components having leads which extend through the board, or
a mixture of leaded and surface mounted components. The
apparatus of the illustrative embodiment can be employed
with either or both solder nozzles operative for a
25 particular processing run. In some cases, solder need only
be applied to one board surface, in which case the other
solder nozzle can be deactivated by appropriate valving of
the solder supply to that nozzle.

The system can also be employed for solder
30 application by a solder nozzle to one board surface, with
reflow soldering provided on the opposite board surface.
In some types of circuit boards, it is preferable to attach
components on a board surface by reflow solder techniques
in which, for example, a solder paste applied to the board
35 prior to its entrance into the solder system, is heated to
cause the solder paste to reflow and form a bond between

1 the associated component and conductive areas of the board
surface. Reflow soldering is accomplished in known manner
by the present system by introduction of the circuit board
into the heated saturated vapour within the vessel. The
5 opposite board surface can be soldered by the solder stream
from the associated nozzle. The present system is
therefore very versatile in providing both solder stream
and reflow solder capability within a single apparatus, all
within the environment of the heated vapour phase.

10 The vapour phase atmosphere within vessel 10 is
heated to a temperature typically in the range of
415 - 450°F. (213 - 232°C.). The solder source is
maintained typically in the same range. The solder within
15 sump 30 is maintained in molten state by the heated
environment within the vessel. Alternatively, separate
heaters can be provided in or around the sump to maintain
the solder at the intended temperature. The vapour phase
atmosphere is therefore at a temperature sufficient for
20 heating the circuit boards to soldering temperature so
that, prior to solder stream application by the solder
nozzles, the product is already at the soldering
temperature. The solder stream of each solder nozzle is
determined in relation to the viscosity of the molten
solder, the pressure provided by the pump 28 and the
25 orifice dimensions of the nozzle to produce the intended
stream configuration for the proper impingement of solder
upon the board. The product is conveyed through the system
at a speed sufficient to provide heating of the board by
the vapour phase atmosphere within vessel 10 and proper
30 application of solder to the heated product. In typical
implementation, the circuit boards are conveyed through the
vessel at a speed of 4 - 10 feet per minute (1.20 - 3.05
metres per minute).



Claims:-

1. A continuous soldering system comprising:
 - a vapour phase chamber within a vessel;
 - 5 means for generating a heated saturated inert vapour within said chamber at a temperature for heating a product prior to solder application; and
 - means for transporting the product into and out of the vapour phase chamber;
 - 10 at least one solder nozzle disposed in said chamber and confronting the path of the product through the chamber;
 - a solder source coupled to the at least one solder nozzle, the solder nozzle being operative to direct
 - 15 a stream of solder against the heated product as the product is transported through the vapour phase chamber; and
 - at least one solder removal nozzle disposed in said vapour phase chamber and confronting the path of
 - 20 the product through the chamber and operative to direct a liquid stream of vapour phase liquid against the product after the product has been conveyed past the solder stream.
2. A system for soldering circuit boards
 - 25 comprising:
 - a vessel defining a vapour phase chamber;
 - means for providing a heated saturated inert vapour within the chamber at a temperature for heating the
 - circuit boards to soldering temperature prior to solder
 - 30 application;
 - means for conveying the circuit boards through the vapour phase chamber;
 - at least one solder application nozzle coupled to a solder source and disposed within the vapour
 - 35 phase chamber for directing a stream of molten solder onto the heated circuit boards; and



at least one solder removal nozzle disposed in said vapour phase chamber and confronting the path of the circuit boards through the chamber and operative to direct a liquid stream of vapour phase liquid against the circuit boards after the circuit boards have been conveyed past the solder stream.

3. A system for the soldering of a product comprising:

10 a vessel defining a vapour phase chamber;
means for providing a heated saturated inert vapour in the chamber at a controlled temperature for heating the product prior to solder application; and
means for conveying the product through the

15 vapour phase chamber;
a source of molten solder;
one or more solder nozzles coupled to the solder source and disposed within the vapour phase chamber and to direct one or more streams of molten solder to the

20 heated product; and
at least one solder removal nozzle disposed in said vapour phase chamber and confronting the path of the product through the chamber and operative to direct a liquid stream of vapour phase liquid against the product

25 after the product has been conveyed past said one or more solder nozzles.

4. A system according to claim 3, wherein the solder source is disposed within the vapour phase chamber.

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5. A system according to either one of claims 3 and 4, wherein the vessel includes an entrance throat and an exit throat each outwardly extending from opposite side walls of the vessel, the product being conveyed into the vapour phase chamber through the entrance throat for

35 heating and solder application and out of the vapour phase chamber through the exit throat after said heating and solder application.



1 6. A system according to claim 1, wherein said
at least one solder nozzle is adjustable in distance from
the confronting surface of the product conveyed through the
vapour phase chamber and in the angle of the solder stream
5 projected onto the product surface.

 7. A solder system according to any one of
claims 3 to 5, wherein said means for providing the vapour
includes means for controlling the temperature of the
10 vapour to provide heating of the product to a temperature
at least at the soldering temperature of the product prior
to solder application.

 8. A system according to any one of claims 3 to
15 5 and 7, comprising means for maintaining the product in a
predetermined orientation during its travel past the one or
more solder nozzles.

 9. A system according to claim 8, wherein the
20 maintaining means includes guide means disposed in the
vessel and means for urging the product into engagement
with the guide means during product conveyance through the
vessel.

25 10. A system according to claim 8, wherein said
maintaining means includes guide means disposed in the
vessel having a downwardly inclined path at the entrance
portion of the vessel and a linear upward path through the
remaining portion of the vessel, said one or more solder
30 nozzles and at least one solder removal nozzle being
disposed along the linear upward path.

 11. A system according to any one of claims 3 to
5 and 7 to 10 wherein, the conveying means includes a pair
35 of conveyor chains disposed along a conveyor path through
the vessel; and



- 1 a plurality of frames each linked to the
conveyor chains in spaced apart relation to adjacent
frames, each of the frames operative to retain a product
therein.
- 5
12. A system according to any one of claims 3 to
5 and 7 to 11 wherein, said solder nozzles are each
adjustable in distance from the confronting surface of the
product conveyed through the vapour phase chamber and in
10 the angle of the solder stream projected onto the product
surface.
13. A system according to any one of claims 3 to
5 and 7 to 11, wherein said solder nozzles are each
15 adjustable in distance from the confronting surface of the
product conveyed through the vapour phase chamber.
14. A system according to any one of claims 3 to
5 and 7 to 11 wherein, said solder nozzles are each
20 adjustable in the angle of the solder stream projected onto
the product surface.
15. A system for soldering circuit boards
comprising:
- 25 a vessel defining a vapour phase chamber;
means for providing a heated saturated inert
vapour within the chamber at a temperature for heating the
circuit boards to soldering temperature prior to solder
application;
- 30 an entrance throat and an exit throat each
outwardly extending from opposite side walls of the vessel;
means for conveying circuit boards through
the entrance throat, vapour phase chamber of vessel and
exit throat;
- 35 a source of molten solder;



17.

one or more solder nozzles coupled to the solder source and disposed within the vapour phase chamber and operative to direct one or more streams of molten solder to the heated circuit boards; and

5 one or more solder removal nozzles disposed in said vapour phase chamber and confronting the path of the circuit boards through the chamber and operative to direct a liquid stream of vapour phase liquid against the circuit boards after the circuit boards have been conveyed
10 past the solder stream; and wherein

the entrance and exit throats provide a substantially straight-through conveyance path through the vessel and entrance and exit throats for heating of the circuit boards and solder application within the vapour
15 phase chamber.

16. A system according to claim 15, wherein the vapour providing means includes heaters at the bottom of the vessel operative to heat a vapour phase liquid to
20 provide said saturated inert vapour within the vapour phase chamber.

17. A system according to claim 16, wherein said vessel includes cooling coils around the vessel walls at a
25 position to define the upper extent of the vapour within the vapour phase chamber.

18. A system according to any one of claims 15 to 17, wherein each of the solder nozzles includes:

30 an elongated tubular member having an elongated linear orifice of a length sufficient to provide a solder stream across the entire width of the circuit board; and

35 piping means coupling said tubular member to the solder source for supplying molten solder to the tubular member and orifice.



1 19. A system according to claim 18, wherein each
elongated linear orifice is adjustable in a direction
normal to its length to provide further control of the
solder stream.

5 20. A system according to either one of claims 1
and 6, wherein said at least one solder removal nozzle is
adjustable in distance from the confronting surface of the
product conveyed through the vapour phase chamber and in
10 the angle of the liquid stream projected onto the product
surface.

21. A system according to any one of claims 3 to
5 and 7 to 14, wherein said at least one solder removal
15 nozzle is adjustable in distance from the confronting
surface of the product conveyed through the vapour phase
chamber and in the angle of the liquid stream projected
onto the product surface.

20 22. A system according to any one of claims 3 to
5 and 7 to 14, wherein said at least one solder removal
nozzle is adjustable in distance from the confronting
surface of the product conveyed through the vapour phase
chamber.

25 23. A system according to any one of claims 3 to
5 and 7 to 14, wherein said at least one solder removal
nozzle is adjustable in the angle of the liquid stream
projected onto the product surface.

30 24. A system for the soldering of a product
comprising:

a vessel defining a vapour phase chamber;
means for providing a zone of saturated
35 inert vapour within the chamber at a selected elevated



1 temperature to heat the product to a predetermined
temperature prior to solder application; and
means for conveying the product into and out
of the vapour zone along a travel path;
5 a source of molten solder;
one or more solder nozzles coupled to the
solder source and disposed within the vapour zone and each
operative to direct a stream of molten solder to the heated
product to apply solder to the product; and
10 at least one solder removal nozzle disposed
within the vapour zone and operative to direct a liquid
stream of vapour phase liquid to the soldered product to
remove excess solder from the product.

15 25. A system according to claim 24, wherein at
least one pair of the solder removal nozzles is disposed
astride the product travel path to direct the liquid
streams onto opposite surfaces of the soldered product.

20 26. A system according to either one of claims
24 and 25, wherein at least one pair of the solder nozzles
is disposed astride the product travel path to direct the
streams of molten solder onto opposite surfaces of the
heated product.

25 27. A system according to any one of claims 24
to 26, wherein the heating of the product prior to solder
application, the application of the solder and the solder
removal are separately controllable and are each
30 substantially independent of the control of the other.

28. A system according to any one of claims 24
to 27, wherein each solder nozzle is separately
controllable to provide the desired application of the
35 solder.



- 1 29. A system according to any one of claims 24
to 28, wherein each solder removal nozzle is separately
controllable to provide the desired removal of the solder.
- 5 30. A system according to any one of claims 24
to 29, comprising means to return excess solder not
adhering to the product to the solder source.
- 10 31. A system according to any one of claims 24
to 30, wherein the solder source is disposed within the
vapour zone.
- 15 32. A system according to any one of claims 24
to 31, wherein the travel path of the product is a
continuous, substantially straight-through path.
33. A method for soldering of a product
comprising:
- 20 establishing a zone of saturated inert
vapour at a selected elevated temperature;
 conveying the product along a travel path
into and out of the vapour zone;
 heating the product to a predetermined
temperature by exposing it to the vapour in the vapour
25 zone;
- subsequently to heating the product to the
predetermined temperature and prior to conveying the
product out of the vapour zone, applying solder to the
product by directing one or more streams of molten solder
30 to the heated product; and
- subsequently to applying solder to the
product and prior to conveying the product out of the
vapour zone, removing excess solder from the product by
directing one or more liquid streams of vapour phase liquid
35 to the soldered product.



1 34. A method according to claim 33, wherein the travel path is a continuous, substantially straight-through path.

5 35. A method according to either one of claims 33 and 34, wherein the predetermined temperature to which the product is heated is at or above the reflow temperature of solder applied to the product prior to conveying the product into the vapour zone and further comprising the
10 step of reflowing the preapplied solder by exposing it to the vapour in the vapour zone.

 36. A method according to any one of claims 33 to 35, comprising the step of separately controlling each
15 solder stream to provide the desired application of the solder.

 37. A method according to any one of claims 33 to 36, comprising the step of separately controlling each
20 liquid stream to provide the desired solder removal.

 38. A soldering system constructed arranged and adapted to operate substantially as hereinbefore described with reference to the accompanying drawings.

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 39. A method for soldering a product substantially as hereinbefore described with reference to the accompanying drawings.

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