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(54) Solder delivery means

(57) A solder delivery means comprises a strip of solder material (32) disposed between two polymeric layers (30) and (36), one of the layers (36) being provided with windows (38) to control the flow of solder. The layers may be separate pieces, or may be parts of a folded sheet or a tube of polymeric material. In use, conductors to be soldered are placed on corresponding terminals of a connector body and the solder delivery means placed in contact with and perpendicular to the conductors, with the side containing the windows (38) positioned towards the conductors. On the application of heat the solder melts and flows through the windows (38) towards the terminals, and solder bridges are prevented by the "window frames" (40) which lie between the terminals.

Fig.1.

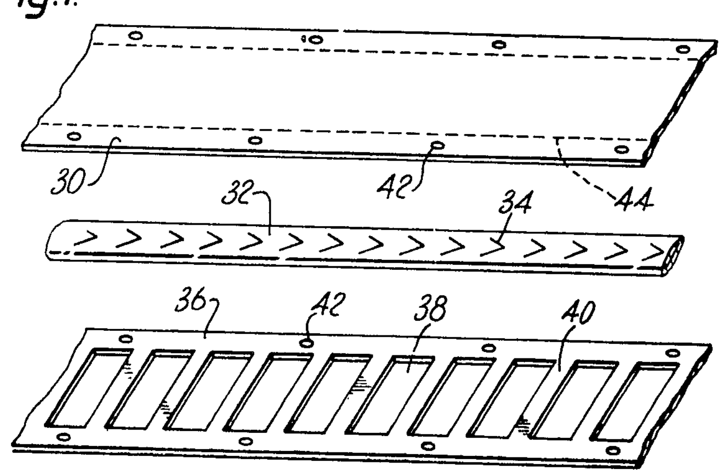

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Fig.1.

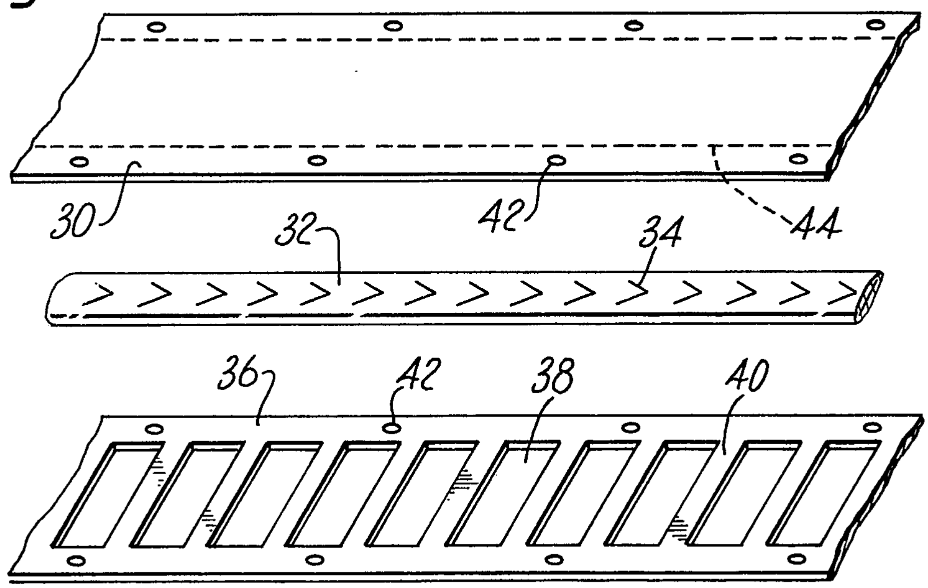


Fig.2.

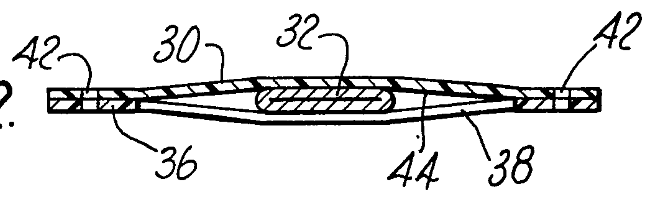


Fig.3.

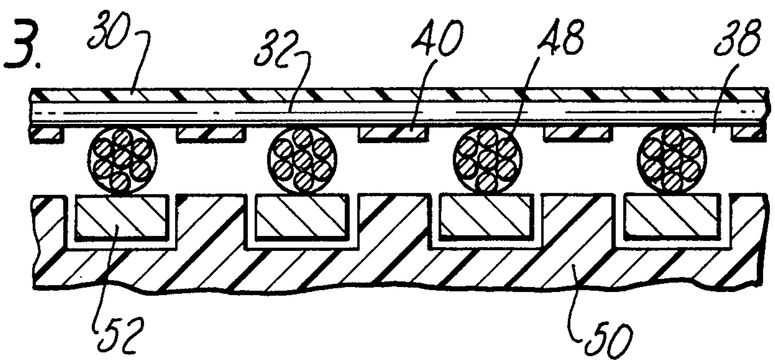
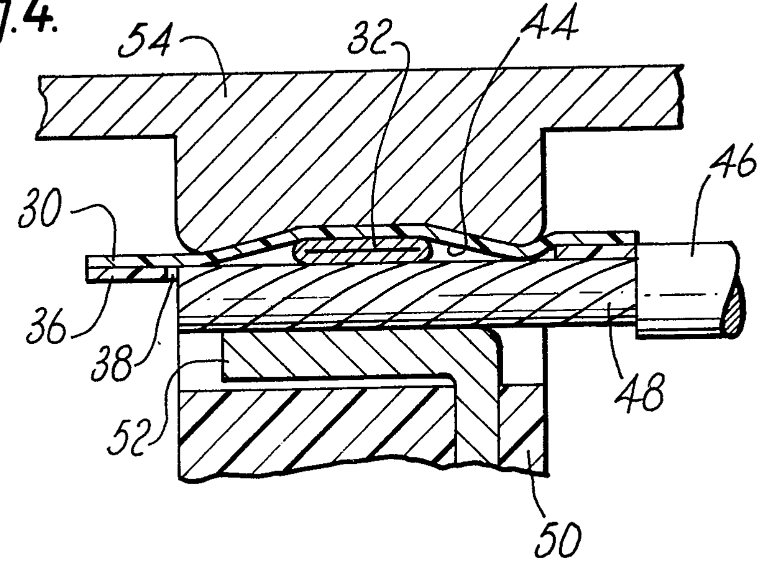


Fig.4.



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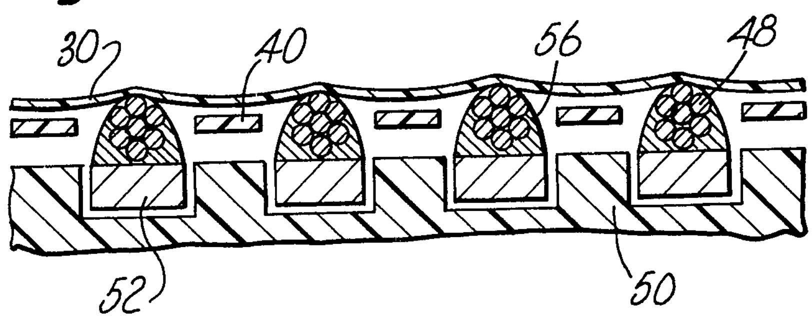


Fig.6.

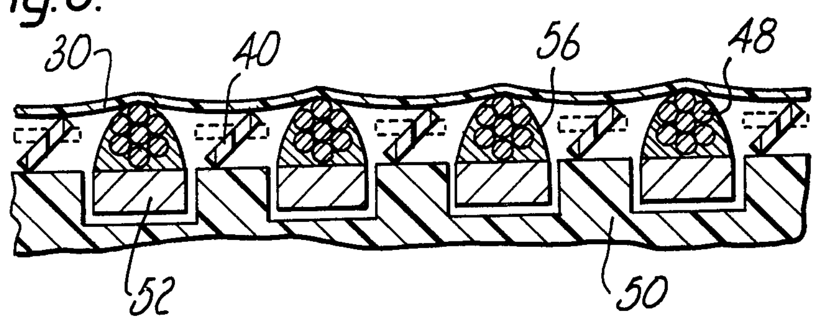


Fig.7.

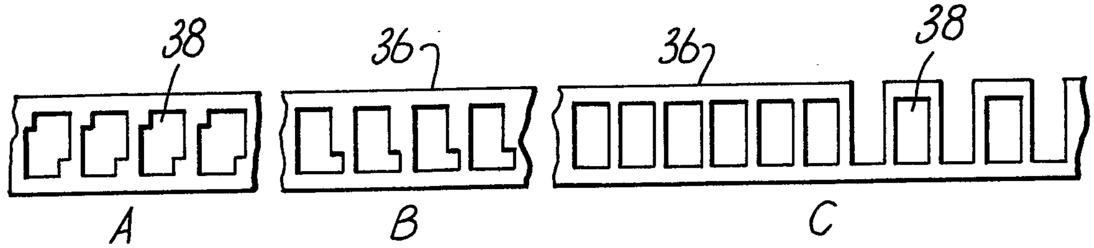


Fig.8.

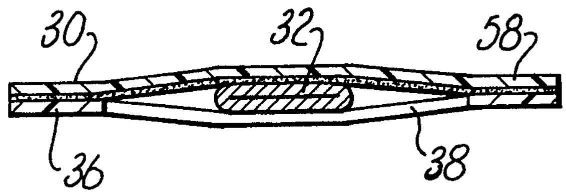


Fig.9.

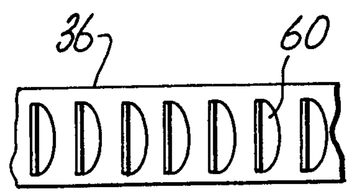


Fig.10.

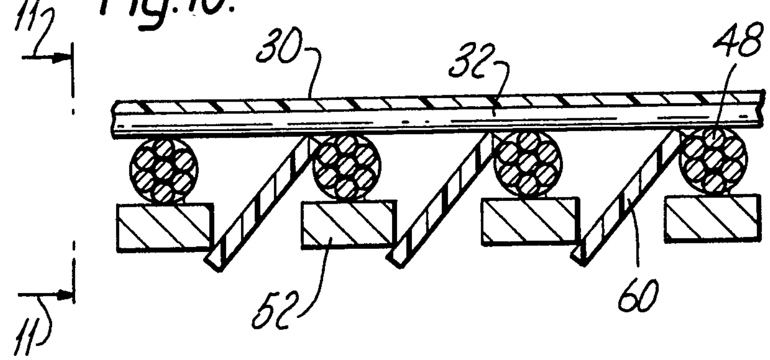


Fig.11.

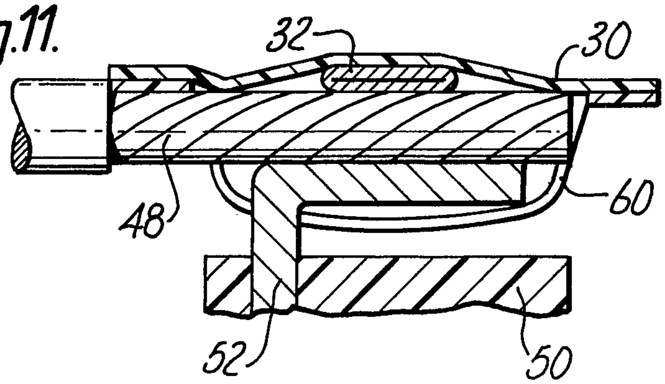


Fig.12.

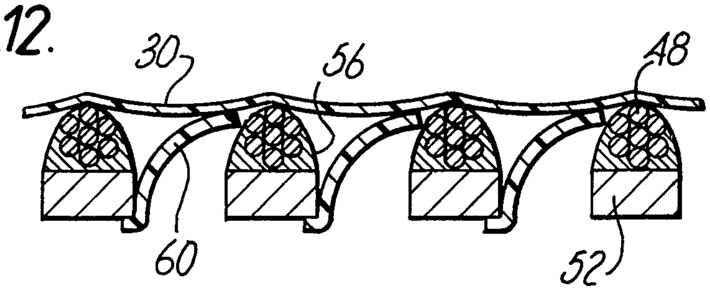


Fig.13.

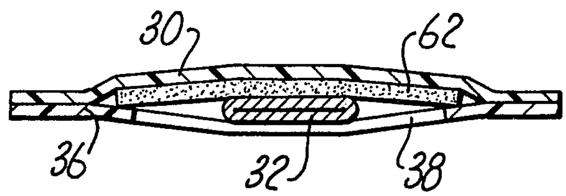


Fig.14.

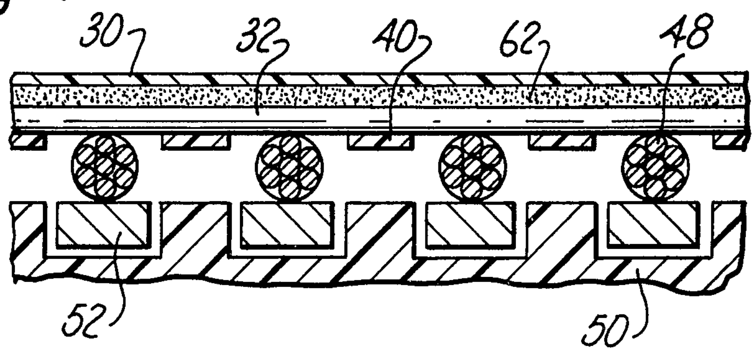


Fig.15.

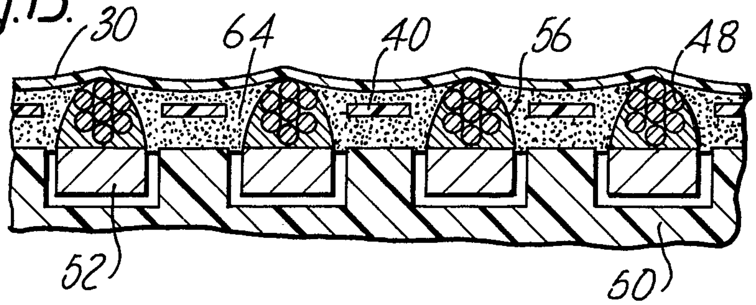


Fig.16.

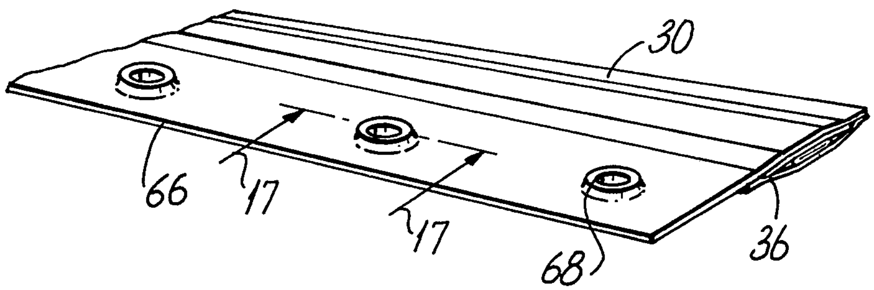


Fig.17.

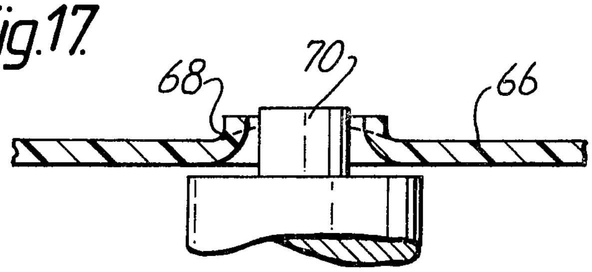


Fig.18.

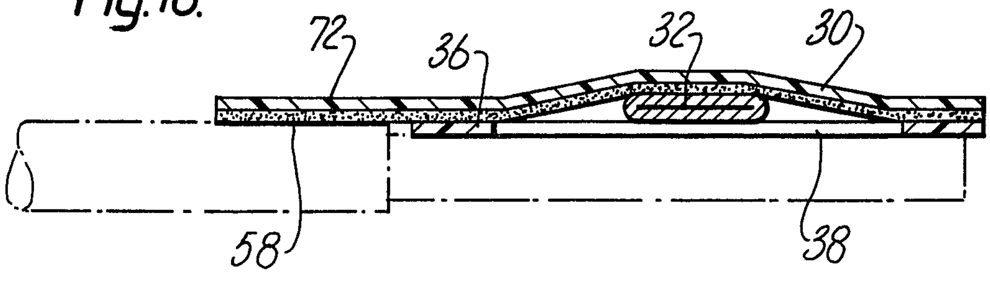


Fig.19.

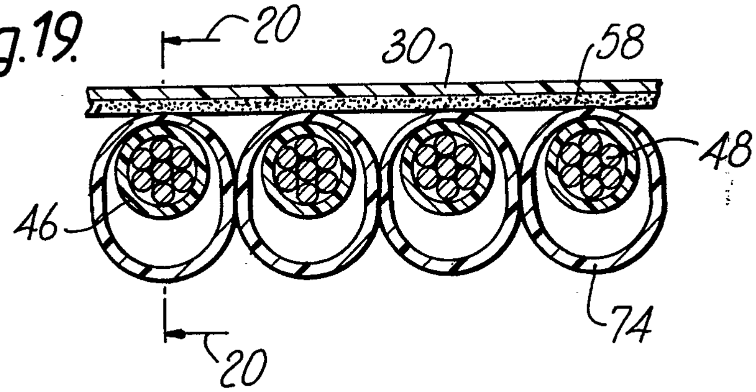


Fig.20.

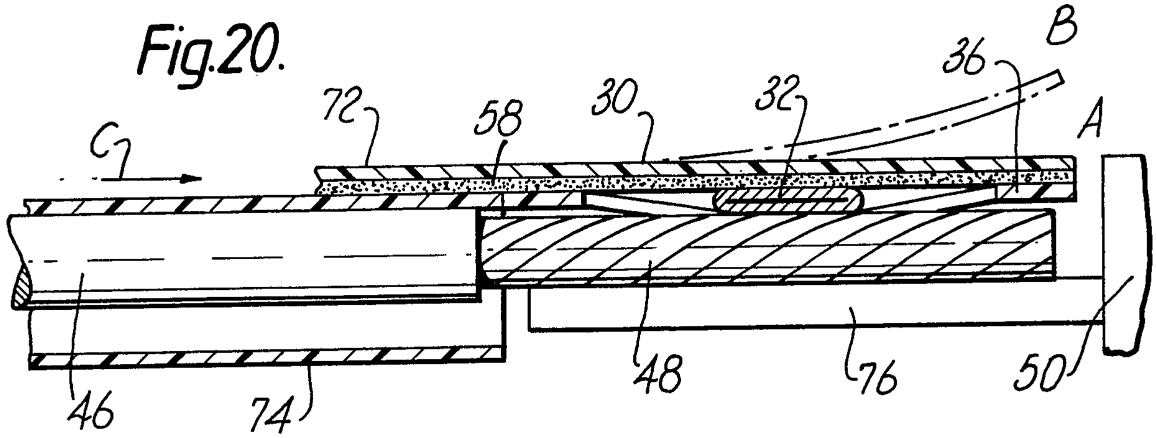


Fig.21.

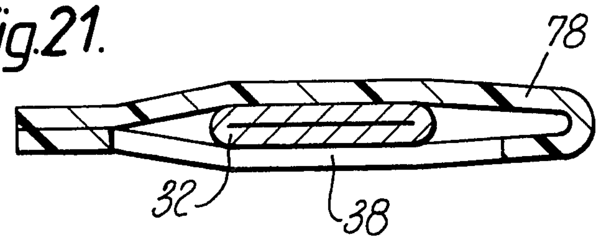
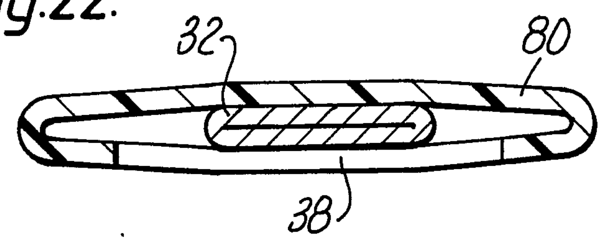


Fig.22.



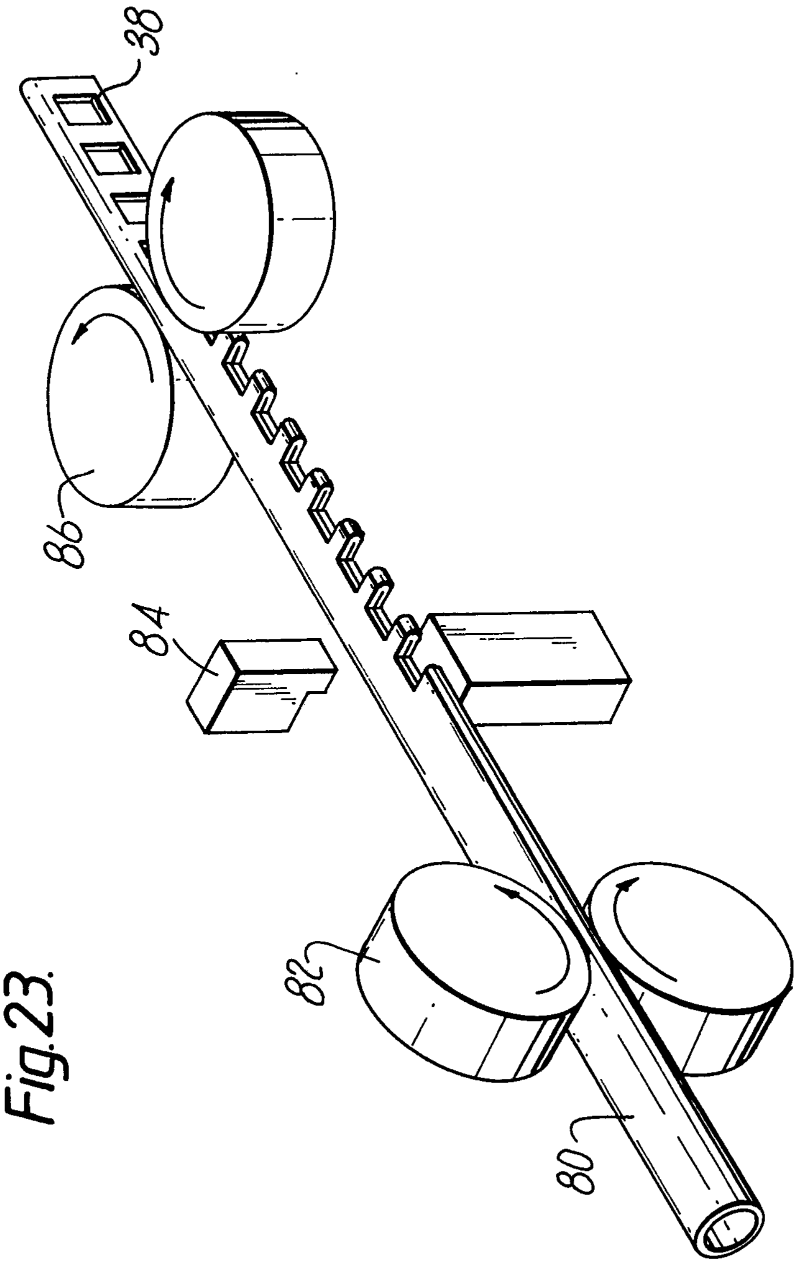


Fig.23.

SPECIFICATION

Solder delivery system

This invention relates to a solder delivery system, and particularly to a solder delivery system for use in terminating a plurality of closely-spaced conductors to a connector.

Joining flat cable or ribbon cable to connectors can be accomplished by a number of different methods, with soldering being probably the most reliable. However, if all the solder terminations must be done by hand, the costs involved and the time required to perform a multiplicity of repetitive soldering operations far outweigh any gains in reliability. In addition, as connector pin spacing decreases, due to higher interconnection densities, the reliability of hand soldering decreases because of the possibility of solder bridging the terminations and shorting out adjacent connectors. It would therefore be desirable to have a solder system in which all the leads can be soldered to the connector simultaneously, rapidly and reliably for a wide range of numbers of terminations and spacings.

In the past, various systems have been developed for simultaneously applying a plurality of bodies of solder to a number of closely spaced electrical terminals. According to one such system, for example, a small discrete portion of solder is positioned adjacent each terminal to be soldered, and the entire system then heated to fuse each solder portion simultaneously. Such a system, however, requires small portions of solder to be extremely precisely positioned, and is accordingly very difficult to manufacture.

It is also known to use a single continuous piece of solder to solder a large number of terminals simultaneously. In one such arrangement a bare solder wire extends along a terminal strip and, on heating, the solder melts and coalesces on the individual contacts to form independent connections.

It is an object of the present invention to provide a solder delivery system that is easy to manufacture and which minimises, or at least substantially alleviates, the problems encountered with known delivery systems, such as, for example, the formation of solder bridges between adjacent terminals.

Accordingly the present invention provides a solder delivery system comprising two layers of material and a strip of solder disposed therebetween, at least one of said layers having one or ore windows therein said window or windows being arranged to direct solder from said strip on heating the delivery system to a temperature sufficiently high to melt the solder, said material being such as to withstand said temperature.

Although the solder delivery system of the present invention is particularly advantageous where solder from a single strip is directed by a plurality of windows, it is envisaged that the solder delivery system may also find application where there is only one window.

It will be understood that it is necessary for the layers to withstand said temperature to the extent that they are able to direct the flow of solder from the solder strip on said heating of the solder delivery system. The material of the layers may be, for example, a suitable polymeric material, which may be cross linked to render it recoverable.

Several embodiments of solder delivery system each in accordance with the present invention will now be described by way of example, with reference to the accompanying drawings, wherein:

Figure 1 is an exploded view of a first embodiment of solder delivery system;

Figure 2 depicts the embodiment of Fig. 1 in cross-section.

Figures 3 to 5 are sectional views depicting the use of the embodiment of Fig. 1 for terminating a plurality of conductors;

Figure 6 is a sectional view depicting the use of a second embodiment of solder delivery system for terminating a plurality of conductors;

Figure 7 is a plan view showing three alternate shapes for the windows in the layer of material bordering the solder strip, for use in any of the embodiments of delivery system;

Figure 8 is a sectional view showing a third embodiment of solder delivery system employing an adhesive;

Figure 9 is a plan view showing the window-containing layer of a fourth embodiment of solder delivery system;

Figures 10 to 12 are sectional views showing the use of the embodiment of Fig. 9 for terminating a plurality of conductors;

Figure 13 is a sectional view showing a fifth embodiment of solder delivery system containing a sealant;

Figures 14 and 15 are sectional views showing the use of the embodiment of Fig. 13 for terminating a plurality of conductors;

Figure 16 is a perspective view of a sixth embodiment of solder delivery system where one of the layers of material bordering the solder strip has been extended and heat-recoverable features formed therein;

Figure 17 is a side elevation of the system of Fig. 16 showing a use of the heat-recoverable features;

Figure 18 is a sectional view of a seventh embodiment of solder delivery system where one of the layers of material has been extended and secured to a substrate;

Figure 19 is a sectional view of an eighth embodiment employing heat-recoverable tubings;

Figure 20 is a sectional view showing the use of the embodiment of Fig. 19 in terminating a plurality of conductors;

Figure 21 is a sectional view showing a folded polymeric sheet forming the layers of material of the solder delivery system;

Figure 22 is a sectional view showing a polymeric tube forming the layers of material of the solder delivery system; and

Figure 23 is a schematic view showing a method of manufacture of the windows in the solder delivery system.

Referring to the drawings Fig. 1 shows a first embodiment of solder delivery system comprising an upper polymeric layer 30, a solder strip 32, which may have perforations 34 to enable better flux flow, and a lower polymeric layer 36, having windows 38 therein. The solder strip 32 is positioned over said windows 38, the solder thereby being arranged to flow through windows 38 on melting. The windows 38 are bordered by a plurality of window frames 40.

As used herein, solder includes any metal or metallic alloy used to join metallic surfaces by melting that metal or metallic alloy and then allowing it to cool, and a solder strip includes an elongated, continuous element of solder of any cross-section for example a round, square or flat cross-section. Such a solder strip may contain a flux core and/or may be coated on all or a part of its outer surface with a flux coating. The strip may be perforated to enable better flow of a flux core. Also, as used herein, a window includes any opening that permits solder to pass through it, the windows and bordering frames therefore acting to direct the flow of solder. Accordingly the term windows includes rectangular apertures, which may be, for example, bordered on all four sides by frames, or only on three sides the fourth side remaining open. A row of such three sided framed windows being in the form, therefore, of a generally comb shaped structure.

In the embodiment shown in Fig. 1, the upper and lower polymeric layers 30 and 36 are attached together in laminate form by heat-welding at a plurality of points 42. Of course, this heat-welding may be performed along the entire edges of the polymeric layers, and not just at a series of points, if so desired. A fluxing agent 44 may be coated onto the underside of the upper polymeric layer 30 by any suitable means, either before assembly of the solder delivery system or after it has been assembled.

Fig. 2 is a cross-sectional view of the first embodiment of the solder delivery system, in its assembled form. The solder strip 32 is seen to be sandwiched between the upper and lower polymeric layers 30 and 36.

Figs. 3 to 5 depict the use of the solder delivery system to terminate a plurality of conductors to, for example, a connector body. In Fig. 3, the system is seen in cross-section positioned above a plurality of conductors 48, each of which lies over a connector tab 52 emerging from a connector body 50. In the drawings the conductors 48 are shown aligned with the centre of the tabs 52, but is an advantage of the system of the present invention that considerable misalignment of the conductors with their corresponding tabs will not adversely affect the quality of the soldered joints produced.

Fig. 4 depicts the assembly of Fig. 3 in cross-section parallel to the conductors. A wire 46 has a conductor 48 which lies above the connector tab 52. A heating tool platen 54 is shown positioned above the assembly. This platen may be heated, for example, electrically or by focused, high-intensity infrared radiation applied to its upper surface. On the application of heat and pressure the upper polymeric layer 30 rapidly softens to allow close contact between the platen 54 and the solder 32 and conductor 48. Heat rapidly transfers to the connector tab 52, as all the items have low thermal mass. The flux present, either in the flux coating 44 or associated with the solder strip 32, is directed onto the conductor and connector tab and cleans them so that the solder will form a sound joint. During the time the solder is molten, the polymeric window frames 40 will resist wetting by the molten solder and may swell due to the heating, thus effectively preventing the formation of solder bridges. The heating tool platen 54 remains in contact with the assembly throughout the heating-cooling cycle. This maintains conductor-table contact until the solder joints are formed. The precise shape of the platen 54 may be chosen to optimize heat flow to the metal parts, while minimizing heat damage to the plastic connector body or cable insulation. While the platen 54 will generally be of unitary construction and rigid, it is also envisaged that the platen may comprise an elastomeric portion or may be of spring-loaded "piano-key" construction (with the "keys" being made, for example, from 0.64 or 1.28mm wide leaf springs (reeds)). Such a platen would accomodate connector tabs and/ or conductors of different heights and thicknesses and ensure the application of adequate pressure and heat to the joints.

Fig. 5 shows the completed termination, where flowed solder 56 joins the conductors 48 to the connector tabs 52. The window frames 40 help prevent the formation of solder bridges between adjacent conductors or tabs.

Fig. 6 depicts a completed termination when a second embodiment of the system has been used. In this second embodiment, the lower polymeric layer has been rendered recoverable, and in this case heat-recoverable. in such a way that, on heating, the window frames 40 rotate, as shown by the arrows, from their original positions (shown in phantom) so as to block the flow of solder between adjacent conductors more effectively.

A heat-recoverable article such as the lower, heat-recoverable, polymeric, layer of Fig. 6, is an article the dimensional configuration of which may be made substantially to change when subjected to heat treatment.

Usually these articles recover, on heating, towards an original shape from which they have previously been deformed but but the term "heat-recoverable", as used herein, also includes an article which, on heating, adopts a new configuration, even if it has not been previously deformed.

In the production of heat-recoverable articles, the polymeric material may be cross-liked at any stage in the production of the article that will enhance the desired dimensionally recoverability. One manner of producing a heat-recoverable article comprises shaping the polymeric material into the desired heat-stable form, subsequently cross-linking the polymeric material, heating the article to a temperature above the crystalline melting point or, for amorphous materials the softening point, as the case may be, of the polymer, deforming the article and cooling the article whilst in the deformed state so that the deformed state of the article is retained. In use, since the deformed state of the article is heat-unstable, application of heat will cause the article to assume its original heat-stable shape.

Fig. 7 shows some possible alternative shapes of the window means for different connector designs. In Fig. 7A, inset corners are used to align the solder strip in the centre of the windows; in Fig. 7B, at the bottom edge. The windows may also be shaped to aid in directing the solder flow. In Fig. 7C, portions of the lower polymeric layer have been cut away to accomodate connector features, and to direct the flow of solder transversely of the row of windows.

Fig. 8 depicts a third embodiment of the solder delivery system. In this embodiment, the upper and lower polymeric layers 30 and 36 are not heat-welded together, but rather are joined by an adhesive 58. This adhesive also serves to locate the solder strip 32. The adhesive may be a pressure-sensitive adhesive, for example, one coated on the upper polymeric layer 30 before assembly, or may be a curable adhesive such as one cured by ultraviolet light or radiation. An advantage of curable adhesive is that it may be rendered non-flowing at soldering temperatures. If a radiation-curable adhesive is employed, cross-linking of the polymeric layers (if desired) and curing of the adhesive may be performed simultaneously.

In Fig. 9, the lower polymeric layer 36 of a fourth embodiment is shown. In this embodiment, windows have not been cut out from the layer but louvered windows 60 have been formed in it. As with the layer of the second embodiment, this layer 36 has been rendered heat-recoverable.

Fig. 10 depicts the embodiment of Fig. 9 in use, the louvers 60 completely separating the conductor-tab pairs from each other.

A cross-sectional view in the direction indicated by the arrows in Fig. 10 is shown in Fig. 11, illustrating the manner in which the louvers 60 act.

Fig. 12 depicts the assembly of Fig. 10 after heating. The flowed solder 56 has joined the conductors 48 to tabs 52, while the louvers 60 have recovered to pull the upper layer 30 towards the joint. Such an arrangement is especially suitable when it is intended that the polymeric layers remain in place on the joints instead of being removed.

Fig. 13 shows in cross-section a fifth embodiment of the solder delivery system which additionally comprises a sealant 62. Such a sealant may be, for example, a thermoplastic, hot-melt, mastic.

In Fig. 14, the system of Fig. 13 is shown positioned above a set of conductors 48 and a connector having tabs 52.

In Fig. 15, the assembly of Fig. 14 is shown after heating. The flowed solder 56 forms joints between the conductors 48 and tabs 52 while the flowed sealant 64 encapsulates these joints. The use of a sealant stabilizes the joints, lengthens the electrical leakage paths, and helps to immobilize conductive or ionix materials. This use is particularly appropriate when it is intended that the upper polymeric layer 30 should remain in place above the conductors 48.

In Fig. 16, a sixth embodiment of solder delivery system is shown. One or both of the polymeric layers have been extended to form an extension 66, into which have been introduced additional heat-recoverable features, in this case, alignment holes 68. The alignment holes 68 may be used for example, as a fastening socket in this extension 66.

Fig. 17 shows a mode of use of the heat-recoverable features 68 shown in Fig. 16. When the features 68 are placed over a boss 70, for example, a locating boss on the body of the connector on which the system is to be employed, and heated, such as when the solder joints are made, the features recover to the position shown in phantom to lock the polymeric layers onto the boss. Especially if the boss is mushroom-shaped, the system will be fastened to the boss in such a way that removal will require substantial force.

In Fig. 18, a seventh embodiment is shown, wherein the upper polymeric layer 30 has been extended to form an extension 72 which is coated with an adhesive 58. Use of this embodiment enables the strip to be fastened to, for example, the cable as shown in phantom, which is to be terminated to a connector. Although only one side of the layer 30 has been shown extended, it is of course possible for both sides to be extended to adhere to both the cable and a connector. In this way, the soldered joints may be completely encapsulated.

Fig. 19 depicts an eighth embodiment of the solder delivery system in which a plurality of heat-shrinkable tubes 74 have been attached by adhesive to the extension 72 of the upper polymeric layer 30. This embodiment is particularly suitable for termination of individual conductors and/or terminations to protruding tabs.

Fig. 20 shows the mode of use of this embodiment. Tabs 76 protrude from connector body 50. Each of a plurality of wires 46 is placed through a heat-shrinkable tube 74 so that the conductor 48 lies over a tab 76. Then, with the body of the solder delivery system in position A, the assembly is heated in only the region of the tabs so as to solder the conductors to the tabs. When the soldering operation is complete, the upper polymeric layer is pulled up to position B (shown in phantom) and the tubes 74 slid forward in the direction of arrow C by pulling on the layer 30. When the tubes 74 each completely cover the soldered tab-conductor pairs, the polymeric layer 30 may be peeled completely free and the tubes 74 shrunk, by e.g., a hot-air gun or infrared lamp, to completely insulate the joints.

In Fig. 21, a ninth embodiment is shown, in which the upper and lower polymeric layers 30 and 36 are part of a single polymeric sheet 78 which is folded about the solder strip 32 after the windows 38 have been formed in the sheet 78. The upper and lower layers 30 and 36 may be joined on the side opposite the fold by any suitable method, such as heat-welding or the use of an adhesive. While Fig. 21 depicts only the simplest form of this embodiment and corresponds generally to Figs. 2 and 8 in that regard, it is of course possible for other features such as, for example, the heat-recoverable window frames of Figs. 6 or 9, the sealant of Fig. 13, or the extensions of Figs. 16–20 to be incorporated together with the folded sheet feature of this embodiment.

Fig. 22 illustrates a tenth embodiment in which the upper and lower polymeric layers are part of a polymeric tube 80. Windows 38 have been formed in this tube 80 and the tube flattened in such a way that the solder strip 32, which has been inserted in the tube, lies above the window means 38. A sealant or adhesive may also be placed within the tube, though this is not depicted in the Figure.

Fig. 23 illustrates a method of forming the windows 38 in the tube 80 of Fig. 22. The tube is flattened by a set of rollers 82 and a punch or cutter 84 used to cut one edge of the flattened tube. The tube may then be re-flattened by a set of rollers 86 at 90° to the first set of rollers 82, to provide windows 38. The tube may be used without re-flattening when windows through more than one layer and openings to the side are desired. Depending on the polymer properties, a simple re-flattening of the tube may be sufficient to form the windows, or it may be desirable to hold the tube flat by the use of an internal adhesive or by heat-welding portions of the tube together.

For the solder delivery system of the present invention, as depicted, for example, by each of the embodiments shown, the upper and lower layers of material bordering the solder strip should preferably be made of materials capable of resisting temperatures as high as 400°C for the time needed to melt and flow the solder, which is generally about 15 seconds. Suitable materials include, for example, polyvinylidene fluoride, poly(parabanic acid), and poly(pyromelittimide) or other high-temperature polyamides or -imides. These polymers may be cross-linked by either chemicals or radiation to improve their high-temperature properties.

In embodiments in which the polymeric layers are not of unitary construction, a typical thickness for the upper polymeric layer is about 0.10mm while a typical thickness for the lower polymeric layer is about 0.18mm. Of course, when the polymeric layers comprise a single folded sheet or a tube, the thickness of the upper and lower layers is the same, and is typically in the range of from about 0.10mm to about 0.18mm. Depending on the application, the solder strip is about 0.15mm thick.

The width of the polymeric layers will, of course, depend on the application to some extent, but may be, for example, about 5.00mm with the width of the windows being approximately the length of the connector tab.

CLAIMS

1. A solder delivery system comprising: two layers of material and a strip of solder disposed therebetween, at least one of said layers having one or more windows therein, said window or windows being arranged to direct the solder from said strip on heating the delivery system to a temperature sufficiently high to melt the solder, said material being such as to withstand said temperature.

2. A solder delivery system according to Claim 1, wherein said window or windows extend through both said layers.

3. A solder delivery system according to Claim 1 or 2, wherein at least one of said layers comprises a polymeric material.

4. A solder delivery system according to any preceding Claim, wherein said window or windows comprise generally rectangular apertures.

5. A solder delivery system according to any preceding Claim, wherein said window or windows are louvered.

6. A solder delivery system according to

any preceding Claim, wherein at least one of said layers is heat-recoverable.

7. A solder delivery system according to Claim 6, wherein said layer having window or windows therein is the heat-recoverable layer.

8. A solder delivery system according to any preceding Claim, wherein said layers comprise separate pieces of material joined along their edges.

9. A solder delivery system according to any preceding Claim, wherein said layers comprise a folded sheet.

10. A solder delivery system according to any preceding Claim, wherein said layers comprise a tube.

11. A solder delivery system according to any preceding Claim, comprising adhesive or sealant disposed between said layers and on that side of said solder strip which is away from the window or windows.

12. A solder delivery system according to any preceding Claim, comprising a flux disposed between said layers.

13. A solder delivery system according to any preceding Claim, wherein at least one of said layers has a portion extending in a direction away from that of said solder strip.

14. A solder delivery system according to Claim 13, wherein said extended portion comprises a heat-recoverable material.

15. A solder delivery system according to Claim 13 or 14, wherein said extended portion comprises adhesive for bonding said system to a substrate.

16. A solder delivery system according to any one of Claims 13 to 15, wherein said extended portion comprises a plurality of heat-recoverable tubings, said tubing being attached on that side of said system which contains said window or windows, being directed away from said solder strip, and being aligned with said window or windows, said tubings being arranged to receive substrates and to dispose parts thereof adjacent said window or windows.

17. A solder delivery system substantially as hereinbefore described with reference to the accompanying drawings.

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