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(54) **METHOD AND DEVICE FOR APPLYING A SOLDER TO A SUBSTRATE**

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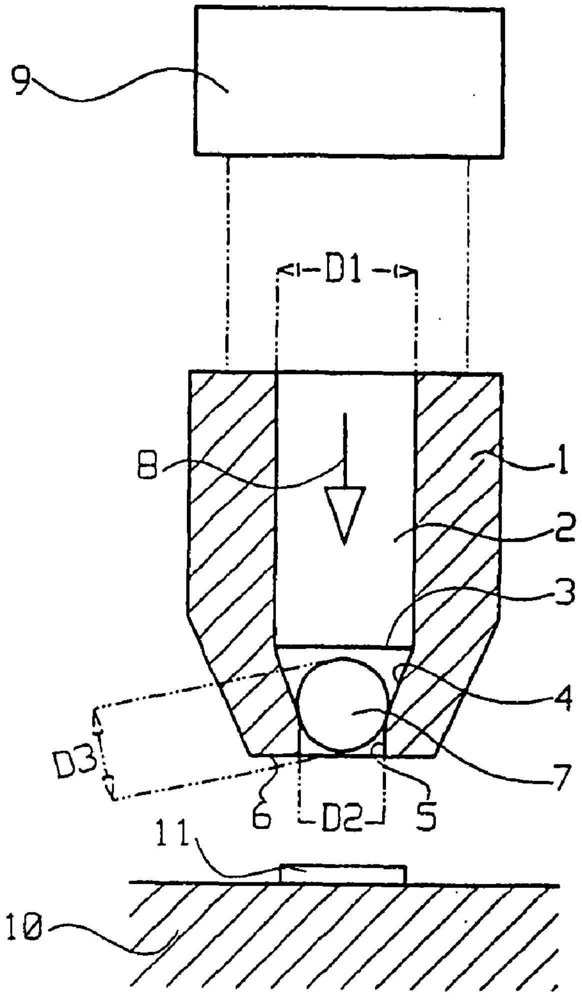
(57) **ABSTRACT**

The invention is a method for applying a solder to a substrate by positioning it in its solid physical condition, melting it and then impacting it against a substrate by means of compressed gas. The device for applying a solder (**7**) to a substrate (**10, 11**) comprises a holder (**1**) having a capillary bore (**2**) whose diameter, at the substrate end (**3**), has a contraction (**4**) whose diameter (D2) is smaller than the diameter (D3) of the solder globule (**7**).



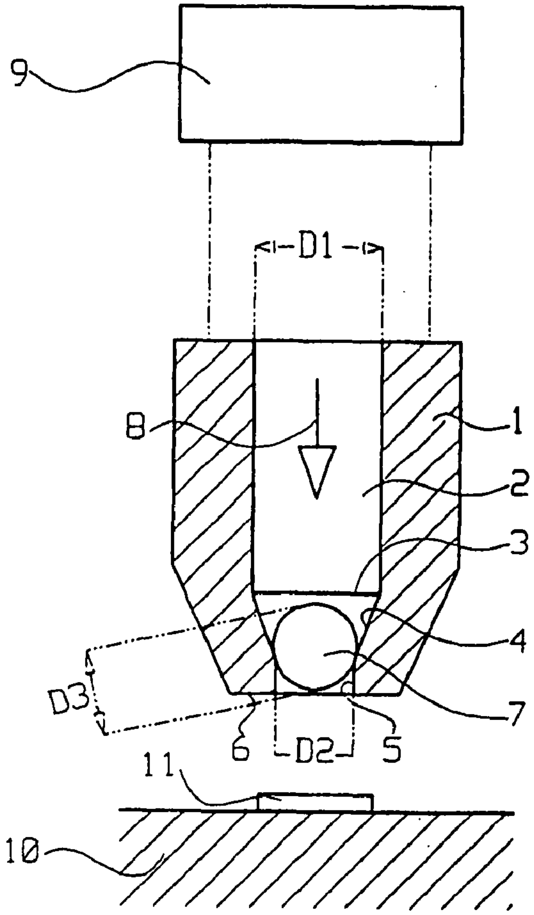


Fig. 1

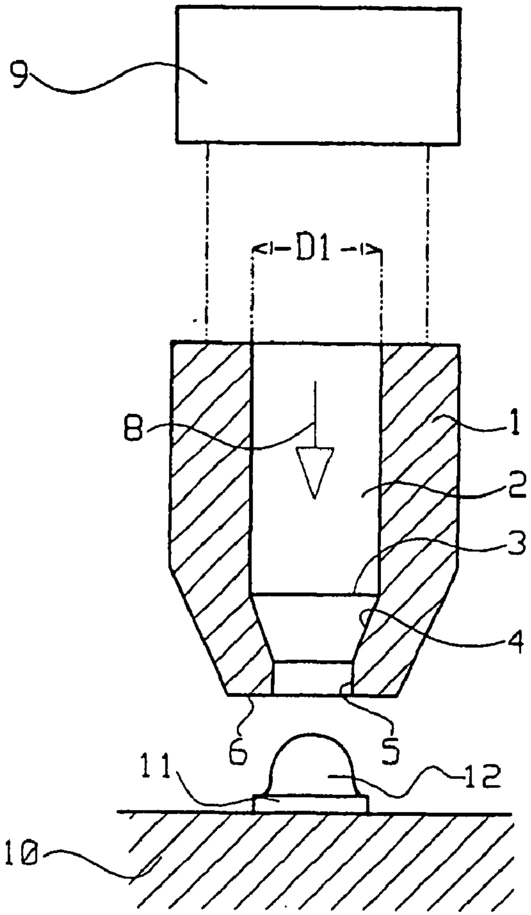


Fig. 2

METHOD AND DEVICE FOR APPLYING A SOLDER TO A SUBSTRATE

[**0001**] The invention concerns a process and a device for applying solder onto a substrate including providing solder in a sold aggregate state, positioning solder relative to the substrate, providing an energy source, and melting the solder by activating the supply of energy,

[**0002**] Such processes and devices are known from German patents DE 43 20 055 A1, DE 42 00 492 C2, and DE 195 33 171 A1. These processes and devices have a holder with a capillary. The holder is placed with its tip near the solder point, and then a solder ball is fed through the capillary and the solder ball contacts the solder point. The solder ball is then melted through the capillary. The melting is preferably performed using laser energy.

[**0003**] To transport the solder ball within the capillary, DE 43 20 055 A1 proposes to arrange a movable optical fiber within the capillary, so that the optical fiber acts as a ram for moving the solder ball and is simultaneously also used for feeding laser energy.

[**0004**] DE 195 33 171 A1 instead proposes to transport the solder ball by the force of gravity, vibration, particularly ultrasound, and an air flow. In addition, for DE 195 44 929 A1, solder balls are transported by the pressure of a protective gas.

[**0005**] In the prior art, however, the solder ball always contacts the substrate or the surface to be wetted with the solder material at the moment of melting. This requires that the tip of the holder must be positioned very close against the substrate, wherein on the one hand, the solder ball is still held in the capillary, and on the other hand, however, the solder ball is already in contact with the substrate. Because the solder balls in many cases have a diameter of a few microns, this requires extremely precise positioning of the holder and there is the risk that the holder will collide with parts on the substrate during positioning.

[**0006**] The problem of the invention is to improve upon the known process and device in such a way that a sufficiently precise placement of the solder material on the substrate is achieved while simultaneously reducing the positioning accuracy requirements of the holder.

[**0007**] This problem is solved by the features given in claims 1 and 3. Advantageous configurations and refinements of the invention can be found in the subordinate claims.

[**0008**] The fundamental principle of the invention is to position the solder in a solid aggregate state and to hold it at a distance from the substrate. Then, through the supply of energy, the solder is melted and finally pushed against the substrate by a compressed gas. Regarding the device, the capillary is tapered near the tip so that its diameter is smaller than the diameter of the solder ball.

[**0009**] Thus, the ball falls down to the tapered section and is held there. The holder is then positioned at a sufficient distance above the substrate. Then the ball is melted, preferably by laser light, and pushed against the surface to be soldered by compressed gas. The distance between the tip of the holder and the substrate is therefore no longer critical, so that in terms of this distance, the positioning accuracy requirements are reduced. simultaneous-ly, the positioning accuracy requirements in the plane of the substrate (X/Y plane) are also reduced. In the prior art, the ball could move in the X/Y plane at the solder position if the lower edge of the capillary from the substrate had a greater distance than the radius of the solder ball. In contrast, such a motion is not possible with the invention and the center of the capillary also corresponds to the center of the solder ball.

[**0010**] Another advantage is that all of the laser energy is definitely incident on the solder ball and cannot pass the solder ball.

[**0011**] The compressed gas for pushing the melted solder material is preferably a protective gas, e.g., an inert gas.

[**0012**] The solder can be not only solder tin, but also other meltable materials, e.g., also plastics.

[**0013**] In the following, the invention is described in more detail with reference to an embodiment in connection with the drawing. Shown are:

[**0014**] **FIG. 1, a** schematic diagram of the device before melting of the solder ball; and

[**0015**] **FIG. 2, a** diagram similar to **FIG. 1**, but after the melting of the solder ball.

[**0016**] **FIG. 1** shows schematically a holder **1** with a capillary **2**, which has a first diameter D1. At the lower end **3** of the capillary **2** there is a conical tapered section, which runs to a conical point starting from the first diameter D1 down to a second diameter D2 and thus forms a tapered outlet **5** at the tip **6** of the holder. The diameter D1 and D2 are set relative to the diameter D3 of the solder ball **7** such that the first diameter D1 of the capillary **2** is larger than the diameter of the solder ball and the second diameter D2 at the outlet **5** of the tapered section is smaller than the diameter D3 of the solder ball. In this way, the solder ball is easily guided from above in the direction of arrow **8** to the tapered section **4**, even just by the force of gravity. The solder ball is held at the tapered section **4** and it partially seals the capillary from the top. In an optimum arrangement, there is absolutely no gap, through from which light, particularly laser light, could exit the capillary, when there is a solder ball **7** in the tapered section **4**.

[**0017**] The feeding of a solder ball to the capillary is performed in a known way (cf., e.g., DE 195 44 929 A1 or DE 195 33 171 A1) by a device, which is designated in general by the reference numeral **9**, for gathering single balls, for feeding, for control, and for generating laser light.

[**0018**] As illustrated in **FIG. 1**, the holder with the solder ball still held at the tip of the holder is positioned above a substrate **10**, e.g., in the region of a conductive trace **11**, at a certain vertical distance from the substrate or the conductive trace **11**. In this position, there is no contact between the solder ball **7** and the conductive trace **11**. Then the solder ball **7** is melted by laser light or some other energy source and pushed out of the capillary by compressed gas and "accelerated", so that it wets the surface to be wetted, e.g., the conductive trace **11**, as a "bumper"**12**, as illustrated in **FIG. 2**.

[**0019**] Because the melted solder ball is accelerated by compressed gas, which is preferably activated in pulses, and thus strikes the substrate with some velocity, the wetting is also improved, because the melted solder material also penetrates into small surface irregularities, gaps, or the like in the substrate or the conductive trace due to the impact pulse.

What is claimed is:

1. A process for applying solder on a substrate comprising providing solder in a sold aggregate state, positioning solder relative to the substrate, providing an energy source, and melting the solder by activating the supply of energy, characterized in that the positioning is realized by spacing solder a predetermined distance from the substrate, and impacting the solder against the substrate by action of a compressed gas after melting of the solder.

2. A process according to claim 1, characterized in that the melting is performed through laser energy.

3. A device for applying solder onto a substrate comprising a holder having a capillary therein in which a solder ball can be positioned relative to the substrate, the end of the capillary (**2**) nearer the substrate having a tapered section (**4**), whose smallest diameter (D2) is smaller than the diameter (D3) of the solder ball (**7**).

4. A device according to claim 3, characterized in that the tapered section (**4**) is conical from a larger diameter (D1) of the capillary (**2**) to a smaller discharge diameter (D2).

5. A device according to claim 3, characterized in that a compressed gas source (**9**) is connected to the capillary (**2**).

6. A device according to claim 5, characterized in that means is provided for the compressed gas to be activated in pulses.

7. A device according to claim 5, characterized in that the compressed gas is an inert or protective gas.

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