

AN ORIENTATION DEVICE FOR A THERMODE ASSEMBLY OF A THERMOCOMPRESSSION BONDING APPARATUS

5 FIELD OF THE INVENTION

The present invention relates to an orientation device for a thermode assembly of a thermocompression bonding apparatus. The invention has particular application for orientating a surface of a heating element with respect to a surface of a product to be
10 heated by the heating element.

BACKGROUND

15 In thermocompression bonding apparatuses for bonding, for instance, a Liquid Crystal Display (LCD) substrate to a Flexible printed circuit, it is necessary to align a surface of the LCD substrate that will be contacted for heating with a surface of a heating element of a thermode assembly of a bonding apparatus during bonding. Such alignment may be done on a daily basis or even on a time shift basis by users.
20 In such instances, the two surfaces should be parallel to each other during the bonding process. Any misalignment will cause uneven heating, resulting in poor bonding.

There are some problems with existing orientation devices used for aligning the
25 surface to be heated on a product with the surface of the heating element contacting the surface to be heated of the product.

With reference to Figure 1, there is a first existing orientation device 100 having a first plate 102 and a second plate 104 arranged such that their major surface areas
30 face each other untouched with a gap 106 in-between. A spherical steel ball 108 (represented by dotted lines) sits in-between the first plate 102 and the second plate 104. The product (not shown) to be heated is placed on a working surface 110 of the first plate 102. The steel ball 108 is located at the centre of the first plate 102. The surfaces of the first plate 102 and the second plate 104 in contact with the spherical
35 steel ball 108 have spherical recesses (not shown) for the spherical steel ball 108 to sit in. The four corners of the first plate 102 are fastened by four fasteners 112 respectively into corresponding threaded holes (not shown) located in the second

plate 104. By twisting and untwisting the four fasteners 112, the first plate 102 will tilt and pivot accordingly in a "seesaw" manner about the spherical steel ball 108. The gap 106 provides space for the tilting of the first plate 102 as the tilting angle is adjusted.

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A problem with the first existing orientation device 100 is that at any point in time, at least two of the four fasteners 112 need to be adjusted in order to tilt the first plate 102 about the spherical steel ball 108. A lot is dependent on the judgment and skill of an operator to make the adjustments for aligning a surface to be heated on a product with a surface of the heating element contacting the surface to be heated on the product. The heating element is mounted to a thermode assembly.

With reference to Figure 2, there is a second existing orientation device 200 having a first sub-assembly 202 and a second sub-assembly 204. The first sub-assembly 202 has a substantially rectangular first plate 206 for mounting to a thermode assembly of a thermocompression bonding apparatus (not shown). The first sub-assembly 202 comprises two rods 208 (only the head of one rod 208 is visible in Figure 2) each slotted into a respective slot 205 (only one slot 205 is visible in Figure 2) located on a respective side surface 203. There are two such side surfaces 203. The two side surfaces 203 on which the respective slots 205 are located are mirror images of each other. The first plate 206 is arranged for orientation about a common longitudinal axis 210 of the two rods 208. The second sub-assembly 204 has a substantially rectangular second plate 212, a third plate 214 for mounting to a compression unit of the thermocompression bonding apparatus and a first shaft 216. The first shaft 216 extends through the second plate 212. The second plate 212 is arranged for orientation about an axis 218, more specifically, a longitudinal axis of the first shaft 216. The common longitudinal axis 210 of the two rods 208 is disposed orthogonally to the axis 218 of the first shaft 216. A first adjustment fastener 220 joins the second plate 212 and the third plate 214, and it is used for adjusting rotation of the second plate 212 about the longitudinal axis 218. A second adjustment fastener 222 joins the first plate 206 and the second plate 212, and it is used for adjusting orientation of the second plate 206 about the axis 210 of the two rods 208. In addition, there are four fasteners 224 (one of which is not shown in Figure 2) for locking the movement of the first plate 206 and another four fasteners 226 (two of which are not shown in Figure 2) for locking the movement of the second plate 212 after adjustments are made.

A problem with the second existing orientation device is that eight fasteners, i.e. the fasteners 224 and the fasteners 226, in total are required to lock the first plate 206 and the second plate 212 from movement. Tightening the eight fasteners 224 and 226 is time consuming. Furthermore, the threaded fastener surfaces of the first adjustment fastener 220 and the second adjustment fastener 222 have poor contact with the fastener walls of the first plate 206, second plate 212 and third plate 214 during alignment. The poor contact can cause adjustments to run.

10 SUMMARY

In accordance with an aspect of the present invention, there is provided an orientation device for a thermode assembly of a thermocompression bonding apparatus, the orientation device comprising a first sub-assembly having a first plate for mounting the thermode assembly; a first shaft, the first plate being arranged for orientation about an axis of the first shaft; and a second sub-assembly having a second plate for mounting on a compression actuator of the thermocompression bonding apparatus; a second shaft, the first plate being arranged for orientation about an axis of the second shaft; wherein the first shaft is disposed orthogonally to the second shaft; the orientation device further comprising a first adjustment mechanism coupled between the first plate and the second shaft for adjusting orientation of the first plate about the axis of the first shaft; and a second adjustment mechanism coupled between the second plate and the first shaft for adjusting orientation of the first plate about the axis of the second shaft.

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The first adjustment mechanism may comprise a first locking mechanism for locking a position of orientation of the first plate about the axis of the first shaft.

The second adjustment mechanism may comprise a second locking mechanism for locking a position of orientation of the first plate about the axis of the second shaft.

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The first adjustment mechanism may comprise a first fastening mechanism being arranged for the first plate to orientate about the axis of the second shaft based on an operation of the first fastening mechanism.

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The second adjustment mechanism may comprise a second fastening mechanism being arranged for the first plate to orientate about the axis of the first shaft based on an operation of the second fastening mechanism.

- 5 The first adjustment mechanism may further comprise a first bushing for housing a first ring, the first ring being rotatable in the bushing, wherein the first fastener is arranged for inserting through the first ring.

- 10 The second adjustment mechanism may further comprise a second bushing for housing a second ring, the second ring being rotatable in the second bushing, wherein the second fastener is arranged for inserting through the second ring.

- 15 The first fastening mechanism may comprise a first threaded fastener that is fastened through a first threaded opening located in one of the second plate and the first shaft, the first adjustment mechanism further comprising a first biasing member for biasing the first threaded fastener and the first threaded opening towards each other.

- 20 The second fastener mechanism may comprise a second threaded fastener that is fastened through a second threaded opening located in one of the second shaft and the first plate, the second adjustment mechanism further comprising a second biasing member for biasing the second threaded fastener and the second threaded opening towards each other.

- 25 The first shaft may be extended through the second shaft.

BRIEF DESCRIPTION OF THE DRAWINGS

- 30 Embodiments of the invention will be better understood and readily apparent to one of ordinary skill in the art from the following written description, by way of example only and in conjunction with the drawings, in which:

Figure 1 is a perspective view of a first prior art orientation device.

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Figure 2 is a perspective view of a second prior art orientation device.

Figure 3 is a first perspective view of an orientation device.

Figure 4 is a second perspective view of the orientation device.

5 Figure 5 is an exploded view of the orientation device.

Figure 6 is a front view of the orientation device.

Figure 7 is a front view of the orientation device with a first plate rotated
10 anticlockwise about a first axis.

Figure 8 is a front view of the orientation device with the first plate rotated clockwise
about a first axis.

15 Figure 9 is a right side view of the orientation device.

Figure 10 is a right side view of the orientation device with a first plate rotated
anticlockwise about a second axis.

20 Figure 11 is a right side view of the orientation device with a first plate rotated
clockwise about a second axis.

Figure 12 is a perspective view of the orientation device mounted to a thermode
assembly and to a compression actuator.

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DETAILED DESCRIPTION

Figures 3 and 4 show an orientation device 300 for a thermode assembly (not shown
30 in Figures 3 and 4) of a thermocompression bonding apparatus (not shown in
Figures 3 and 4). The orientation device 300 has a first sub-assembly having a first
plate 302 for mounting the thermode assembly of the thermocompression bonding
apparatus and a first shaft 322. The first plate 302 is arranged for orientation about
an axis of the first shaft 312. The orientation device 300 further has a second sub-
35 assembly having a second plate 304 for mounting on a compression actuator (not
shown) of the thermocompression bonding apparatus (not shown) and a second

shaft 324. The first plate 302 is arranged for orientation about an axis of the second shaft 310.

5 The first shaft 322 is disposed orthogonally to the second shaft 324. The orientation device 300 further comprising a first adjustment mechanism 306 coupled between the first plate 302 and the second shaft 324 for adjusting orientation of the first plate 302 about the axis of the first shaft 312 . The orientation device 300 also comprises a second adjustment mechanism 308 coupled between the second plate 304 and the first shaft 322 for adjusting orientation of the first plate 302 about the axis of the
10 second shaft 310.

The thermode assembly mounted to the first plate 302 has a heating element (not shown in the Figures) and the heating element is typically in the form of a metal strip or a metal block. The heating element is brought into contact or close contact with an
15 article or product (not shown in the Figures) to be bonded by heat during a bonding process. The heating element has a bonding surface at a fixed orientation with respect to a major planar surface of the first plate 302 when the thermode assembly is mounted to the first plate 302. The compression actuator mounted to the second plate 304 is a device for moving the thermode assembly towards or away from the
20 article at the appropriate time during the bonding process. More specifically, the compression actuator is a linear motion actuator for actuating movement of the thermo assembly in directions along an axis orthogonal to both the first shaft 322 and the second shaft 324.

25 The orientation device 300 is adjustable to orientate the first plate 302 for aligning the bonding surface of the heating element with a planar surface of the article to be bonded. Such alignment ensures even heating by the bonding surface of the heating element on the planar surface of the article. For certain articles, such as LCD substrates, there is low tolerance for misalignment. High accuracy of the alignment
30 ensures even heating. For instance, the minimum tolerance could be about 10 micron difference in the alignment of the bonding surface of the heating element with the planar surface of the article.

With reference to Figures 3, 4 and 5, the first adjustment mechanism 308 has at
35 least one locking mechanism, in this case, locking mechanisms 316, 332, for locking a position of orientation of the first plate 302 about the axis of the first shaft 312 after adjustments to the orientation device 300 have been made. Similarly, the second

adjustment mechanism 306 has at least one locking mechanism. In this case, locking mechanisms 314, 336, for locking a position of orientation of the first plate 302 about the axis of the second shaft 310 after adjustments to the orientation device 300 have been made. In Figures 3, 4 and 5, the locking mechanisms 332, 316, 336 and 314 are lock nuts and herein known as the first lock nut, the second lock nut, the third lock nut and the fourth lock nut respectively.

The orientation device 300 has a third plate 340 residing between the first plate 302 and the second plate 304. All the three plates 302, 304 and 340 are substantially rectangular. The third plate 340 is mounted to the second plate 304 via four mounting fasteners 402. The major planar surfaces of the third plate 340 and the second plate 304 are in contact with each other. The fasteners 402 are put through four corresponding holes 482 in the second plate 304 and fastened into four corresponding threaded openings 480 (only three of the openings are shown in Figure 5) in the third plate 340.

The third plate 340 has two indentations 438, one located on a first side of the third plate 340 and the other located on a second side of the third plate 340. The second side of the third plate 340 faces away from the first side of the third plate 340. There are two shaft holding plates 424, each having a portion for fitting into the indentations 438. The shaft holding plates 424 are secured to the third plate 340 by four fasteners 422. Each of the shaft holding plates 424 has a shaft holding portion extended in a direction towards the first plate 302. Two of the fasteners 422 are used to secure each of the shaft holding plates 424 to the third plate 340. The fasteners 422 are put through holes 462 in the shaft holding plates 424 and tightened into corresponding threaded openings 472 located in the indentations 438 of the third plate 340. The major planar surfaces of the shaft holding plates 424 are arranged in a manner orthogonal to the major planar surface of the third plate 340.

Each of the shaft holding plates 424 has an opening 428. Each end of the second shaft 324 is inserted into the respective opening 428 of one of the shaft holding plate 424. With this arrangement, the two shaft holding plates 424 hold the second shaft 324 in its position in the orientation device 300. The second shaft 324 has an opening 470 in the middle of its length for inserting the first shaft 322. After the first shaft 322 is extended through the opening 470 of the second shaft 324, the first shaft 322 and the second shaft 324 would be in crossed or orthogonal arrangement.

There are two shaft support pins 448, each with a cylindrical head. The two shaft support pins 448 has respective threaded ends for tightening the two shaft support pins 448 into two respective threaded holes 478 in the first plate 302. When the orientation device 300 is assembled, the portions of the first shaft 322 extending
5 away from the axis of the second shaft 310 rests on each cylindrical head of the shaft support pins 448.

The first plate 302 has two indentations 444, one located on a first side of the first plate 302 and the other located on a second side of the first plate 302. The second
10 side of the first plate 302 faces away from the first side of the first plate 302. The two indentations 444 face a direction orthogonal to the direction that the two indentations 438 of the third plate 340 are facing. There are two shaft holding plates 406, each having a portion for fitting into the indentations 444. The shaft holding plates 406 are secured to the first plate 302 by four fasteners 404. Each of the shaft holding plates
15 406 has a shaft holding portion extended in a direction towards the second plate 304. Two of the fasteners 404 are used to secure each of the shaft holding plates 406 to the first plate 302. The fasteners 404 are put through holes 474 in the shaft holding plates 406 and tightened into corresponding threaded openings 476 in the indentations 444 of the first plate 302. The major planar surfaces of the shaft holding
20 plates 406 are arranged in a manner orthogonal to the major planar surface of the first plate 302.

Each of the shaft holding plates 406 has an opening 468. Each end of the first shaft 322 is inserted into the respective opening 468 of one of the shaft holding plates 406.
25 With this arrangement, the two shaft holding plates 406 hold the first shaft 322 in its position in the orientation device 300.

The first adjustment mechanism 308 has a first fastening mechanism, the first fastening mechanism having a first fastener 326 for adjusting orientation of the first
30 plate 302 about the axis of the second shaft 310 based on an operation of the first fastening mechanism. The operation of the first fastening mechanism in this case is the twisting of the first fastener 326 in clockwise or anticlockwise direction. The first fastener 326 has a threaded body and a fastener head for assisting twisting of the first fastener 326. The first fastener 326 joins the second plate 304 to the first shaft
35 322 and is arranged for inserting through a first ring 432 of a spherical bearing 434 located in the second plate 304. The first lock nut 332 is used to lock the first fastener 326 to the second plate 304 and prevent further movement of the first

fastener 326 relative to the second plate 304. The first fastener 326 is able to twist freely when it is inserted through the first ring 432 and when the first lock nut 332 is loosened.

- 5 The spherical bearing 434 sits in a recess 456 in the second plate 304. The recess 456 is located in an extension 450 of the second plate 304. The extension 450 is planar to the major planar surface of the second plate 304 and it extends from the centre of the length of the second plate 304. The extension 450 has a hole for the tail end of the first fastener 326 to extend through. The spherical bearing 434 has a first
- 10 bushing or liner 426 for housing the first ring 432. The first ring 432 has an external spherical surface. The first bushing 426 has an inner spherical concave surface matching the shape of the external spherical surface of the first ring 432. The first ring 432 is rotatable relative to the first bushing 426 due to the spherical surfaces.
- 15 The spherical bearing 434 advantageously provides consistent contact between the first fastener 326 and the first ring 432. In particular, the inner walls of the first ring 432 are in consistent contact with the body of the first fastener 326. If the first fastener 326 moves relative to the spherical bearing 434 during adjustment, the first ring 432 would rotate relative to the first bushing 426 thereby keeping the inner walls
- 20 in consistent contact with the body of the first fastener 326. The diameter of the first ring 432 is just marginally larger than the diameter of the first fastener 326 (not referring to the diameter of the head of the first fastener 326) to ensure the first fastener 326 has snug contact with the inner wall of the first ring 432. With such an arrangement, adjustments to the orientation of the first plate 302 using the
- 25 orientation device 300 would not be affected by displacement of the body of the first fastener 326 relative to the inner walls of the first ring 432. In existing orientation devices, during adjustments, fasteners similar to the first fastener 326 undesirably abut against unmovable walls in the openings they extend through. If a fastener of such an existing orientation device moves during adjustment, it would likely displace
- 30 relative to the unmovable walls and affect the accuracy of the adjustment of the existing orientation device.

In the assembly of the orientation device 300, after the first fastener 326 has been put through the spherical bearing 434 and the extension 450, a first washer 436 is

35 placed into the threaded tail end of the first fastener 326. Following that, the first lock nut 332 is fastened to the threaded tail end of the first fastener 326. Prior to tightening the first lock nut 332 against the first washer 326, the tail end of the first

fastener 326 is twisted through a threaded opening 338 located at one end of the first shaft 322. A second washer 458 is placed into the tail end of the first fastener 326 after the first fastener 326 is twisted through the threaded opening 338. After which, the second lock nut 316 is fastened to the threaded tail end of the first fastener 326 and tightened against the second washer 458. With such an arrangement, the first fastener 326 can no longer move relative to the second plate 304 and relative to the first shaft 322. Hence together, the first lock nut 332 and the second lock nut 316 prevent further movement of the first fastener 326 relative to the second plate 304 and relative to the first shaft 322 after adjustments are made to alter orientation of the first plate 302 about the axis of the second shaft 310.

Adjustments to alter degree of orientation of the first plate 302 about the axis of the second shaft 310 is done by altering the length 344 of the first fastener 326 between the first shaft 322 and the second plate 304. This length 344 is altered by fastening or un-fastening the first fastener 326 from the threaded opening 338 in the first shaft 322. Prior to length alteration, the first lock nut 332 and the second lock nut 316 needs to be loosened. After the first lock nut 332 and the second lock nut 316 are loosened, the length 344 can be lengthened by twisting the first fastener 326 in a direction to extract the first fastener 326 from the threaded opening 338 and the length 344 can be shortened by twisting the first fastener 326 in a direction to tighten the first fastener 326 into the threaded opening 338.

The second adjustment mechanism 306 has a second fastening mechanism, the second fastening mechanism having a second fastener 328 for adjusting orientation of the first plate 302 about the axis of the first shaft 312 based on an operation of the second fastening mechanism. The operation of the second fastening mechanism in this case is the twisting of the second fastener 328 in clockwise or anticlockwise direction. The second fastener 328 has a threaded body and a fastener head for assisting twisting of the second fastener 328. The second fastener 328 joins the second shaft 324 to the first plate 302 and is arranged for inserting through a second ring 412 of a rod end bearing 416. The third lock nut 336 is used to lock the second fastener 328 to the second ring 412 and prevent further movement of the second fastener 328 relative to the second ring 412. The second fastener 328 is able to twist freely when it is inserted through the second ring 412 and when the third lock nut 336 is loosened.

The rod end bearing 416 is made up of two parts, that is, a spherical bearing end 464 resembling the spherical bearing 434 and a rod end 440. The rod end 440 is joined to the spherical bearing end 464 and it resembles a rod. The rod end 440 is threaded to enable it to be tightened into a threaded opening 486 located at one end
5 of the second shaft 324 thereby securing the rod end bearing 416 to the second shaft 324. The spherical bearing end 464 has a second bushing or liner 460 for housing the second ring 412. The second ring 412 has an external spherical surface. The second bushing 460 has an inner spherical concave surface matching the shape of the external spherical surface of the second ring 412. The second ring 412 is
10 rotatable in the second bushing 460 due to the spherical surfaces. A grease nipple 414 extends from the spherical bearing end 464 for pumping grease into the inner space of the spherical bearing end 464 to lubricate the rotation of the second ring 412 relative to the second bushing 460.

15 The second plate 304 has a hole 452 in which the second fastener 328 is inserted through. In the assembled orientation device 300, the hole 452 enables tools to gain access to the fastening head of the second fastener 328 for fastening the second fastener 328.

20 The rod bearing end 416 has to be sufficiently fastened to the threaded opening 486 of the second shaft 324 and orientated such that the second fastener 328 could be inserted through the second ring 412 when the second fastener 328 is fastened through the hole 452 in the second plate 304. A fifth lock nut 418 and a third washer 420 are used to lock the orientation of the rod bearing end 416. In the assembly of
25 the orientation device 300, prior to twisting the rod end 440 of the rod bearing end 416 into the threaded opening 486, the fifth lock nut 418 is fastened to the threaded portion of the rod end 440. Following that, the third washer 420 is put through the threaded portion of the rod end 440. After the rod bearing end 416 is sufficiently fastened into the second shaft 324, the fifth lock nut 418 is tightened to abut the
30 washer 420 against the area of the second shaft 324 surrounding the threaded opening 486 to lock the orientation of the rod bearing end 416. In this manner, the rod bearing end 416 is fixed in orientation relative to the second shaft 324 and would not twist relative to the second shaft 324 when the second adjustment mechanism 306 is being used.

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The rod end bearing 416 advantageously provides consistent contact between the second fastener 328 and the second ring 412. In particular, the inner walls of the

second ring 412 are in consistent contact with the body of the second fastener 328. If the second fastener 328 moves relative to the rod end bearing 416 during adjustment, the second ring 412 would rotate relative to the second bushing 460 thereby keeping the inner walls in consistent contact with the body of the second fastener 328. The diameter of the second ring 412 is just marginally larger than the diameter of the second fastener 328 (not referring to the diameter of the head of the second fastener 328) to ensure the second fastener 328 has snug contact with the inner wall of the second ring 412. With such an arrangement, adjustments to the orientation of the first plate 302 using the orientation device 300 would not be affected by displacement of the body of the second fastener 328 relative to the inner walls of the second ring 412. In existing orientation devices, during adjustments, fasteners similar to the second fastener 328 undesirably abut against unmovable walls in the openings they extend through. If a fastener of such an existing orientation device moves during adjustment, it would likely displace relative to the unmovable walls and affect the accuracy of the adjustment of the existing orientation device.

In the assembly of the orientation device 300, after the second fastener 328 has been put through the spherical bearing end 464, a fourth washer 466 is placed into the threaded tail end of the second fastener 328. Following that, the third lock nut 336 is tightened to the threaded tail end of the second fastener 328. Prior to tightening the third lock nut 336 against the fourth washer 466, the tail end of the second fastener 328 is twisted through a threaded opening 454 located at the first plate 302. A fifth washer 408 is placed into the tail end of the second fastener 328 after the second fastener 328 is twisted through the threaded opening 454. After which, the fourth lock nut 314 is fastened to the threaded tail end of the second fastener 328 and tightened against the fifth washer 408. With such an arrangement, the second fastener 328 can no longer move relative to the first plate 302 and relative to the second shaft 324. Hence together, the third lock nut 336 and the fourth lock nut 314 prevent further movement of the second fastener 328 relative to the first plate 302 and relative to the second shaft 324 after adjustments are made to alter orientation of the first plate 302 about the axis of the first shaft 312.

Adjustments to alter degree of rotation of the first plate 302 about the axis of the first shaft 312 is done by altering the length 342 of the second fastener 328 between the rod end bearing 416 and the first plate 302. This length 342 can be altered by fastening or un-fastening the second fastener 328 from the threaded opening 454 in

the first plate 302. Prior to length alteration, the third lock nut 336 and the fourth lock nut 314 needs to be loosened. After the third lock nut 336 and the fourth lock nut 314 are loosened, the length 342 can be lengthened by twisting the second fastener 328 in a direction to extract the second fastener 328 from the threaded opening 454 and
5 the length 342 can be shortened by twisting the second fastener 328 in a direction to tighten the second fastener 328 into the threaded opening 454.

The first adjustment mechanism 308 may have a first biasing member, in this case, a first compression spring 320, for biasing the first fastener 326 and the threaded
10 opening 338 towards each other. This is so that a gap, if any, between threads of the first fastener 326 and threads in the threaded opening 338 do not contribute to orientation of the first plate 302 about the axis of the second shaft 312. It is appreciated that such a gap could cause inaccuracy to the adjustment of the orientation of the first plate 302.

15 Similarly, the second adjustment mechanism 306 may have a second biasing member, in this case, a second compression spring 318, for biasing the second fastener 328 and the threaded opening 454 towards each other so that a gap, if any, between threads of the second fastener 328 and threads in the threaded opening
20 454 do not contribute to orientation of the first plate 302 about the axis of the first shaft 310. It is appreciated that such a gap could cause inaccuracy to the adjustment of the orientation of the first plate 302.

The first compression spring 320 is used to bias downward facing surfaces of the
25 fastener threads on the first fastener 326 against upward facing surfaces of the fastener threads in the threaded opening 338. Similarly, the second compression spring 318 is used to bias downward facing surfaces of the fastener threads on the second fastener 328 against upward facing surfaces of the fastener threads in the threaded opening 454. Said downward facing surfaces are surfaces generally facing
30 in the direction of the first plate 302 and said upward facing surfaces of the fastener threads are surfaces generally facing in the direction of the second plate 304. It is appreciated that other types of biasing member other than the compression springs 318 and 320 may also be used, for example, leaf springs and the like.

35 The first compression spring 320 is located between the third plate 340 and the first shaft 322. The first compression spring 320 sits in a cavity 442 located on the first shaft 322 near to the opening 470 of the second shaft 324. The cavity 442 is located

on the side of the first shaft 322 such that the second shaft 324 is located in between the cavity 442 and the threaded opening 338 of the first shaft 322. The cavity 442 is facing the third plate 340. In the assembled orientation device 300, one end of the first compression spring 320 is pushing against the third plate 340 and the other end
5 of the first compression spring 320 is pushing against the first shaft 322. As the third plate 340 is fixed to the second plate 340, the first compression spring 320 is essentially continuously biasing the first shaft 322 away from the second plate 340.

The biasing forces of the spring 320 translate into forces pushing downward facing
10 surfaces of the threads on the first fastener 326 against upward facing surfaces of the threads in the threaded opening 338. The threads of the first fastener 326 and the threads in the threaded opening 338 are biased in this manner so that minimum or no gaps appear between the downward facing surfaces of the threads on the first
15 fastener 326 and the upward facing surfaces of the threads in the threaded opening 338. Without such gaps, the first fastener 326 would not unintentionally move relative to the threaded opening 338 or move when the second lock nut 316 is tightened to keep the first fastener 326 in its adjusted position. If such gaps exist, the first
20 fastener 326 may unintentionally move relative to the threaded opening 338 by the distance of the gaps, causing the first plate 302 to undesirably rotate about the axis of the first shaft 312 and lead to inaccuracy in the adjustments of the orientation device 300.

The second compression spring 318 is located between the first plate 302 and the second shaft 324. The second compression spring 318 sits in a cavity 484 located
25 on the first plate 302 at a distance away from a position between the shaft support pins 448. The cavity 484 is also located such that the first shaft 322 is in between the rod end bearing 416 and the cavity 484. The second compression spring 318 is seated in the cavity 484 at a location under the second shaft 324. The cavity 484 is facing the third plate 340. In the assembled orientation device 300, one end of the
30 second compression spring 318 is pushing against the first plate 302 and the other end of the second compression spring 318 is pushing against the second shaft 324. As such, the second compression spring 318 is continuously biasing the first plate 302 away from the second shaft 324.

35 The biasing forces of the second compression spring 318 translate into forces pushing downward facing surfaces of the threads on the first fastener 328 against upward facing surfaces of the threads in the threaded opening 454. The threads of

the first fastener 328 and the threads in the threaded opening 454 are biased in this manner so that minimum or no gaps appear between the downward facing surfaces of the threads on the second fastener 328 and the upward facing surfaces of the threads in the threaded opening 454. Without such gaps, the second fastener 328 would not unintentionally move relative to the threaded opening 454 or move when the fourth lock nut 314 is tightened to keep the second fastener 328 in its adjusted position. If such gaps exist, the second fastener 328 can unintentionally move relative to the threaded opening 454 by the distance of the gaps, causing the first plate 302 to undesirably rotate about the axis of the second shaft 310 and lead to inaccuracy in the adjustments of the orientation device 300.

Figure 6 shows the orientation device 300 when no adjustments are made to orientate the first plate 302 about the axis of the first shaft 312 i.e. the major planar surface of the first plate 302 and the major planar surface of the second plate 304 are at zero degree with respect to each other.

Figure 7 shows the orientation device 300 when adjustments are made by twisting the second fastener 328 to lengthen the exposed length 342 of the second fastener 328 between the rod end bearing 416 and the first plate 302. The lengthening causes the first plate 302 to orientate anti-clockwise (in Figure 7) about the axis of the first shaft 312. In Figure 7, the major planar surface of the first plate 302 and the major planar surface of the second plate 304 are at 1 degree with respect to each other, which is the maximum degree in which the first plate 302 can orientate anti-clockwise (in Figure 7) about the axis of the first shaft 312.

Figure 8 shows the orientation device 300 when adjustments are made by twisting the second fastener 328 to shorten the exposed length 342 of the second fastener 328 between the rod end bearing 416 and the first plate 302. The shortening causes the first plate 302 to orientate clockwise (in Figure 8) about the axis of the first shaft 312. In Figure 8, the major planar surface of the first plate 302 and the major planar surface of the second plate 304 are at 1 degree with respect to each other, which is the maximum degree in which the first plate 302 can orientate clockwise (in Figure 8) about the axis of the first shaft 312.

Figure 9 shows the orientation device 300 when no adjustments are made to rotate the first plate 302 about the axis of the second shaft 310 i.e. the major planar surface

of the first plate 302 and the major planar surface of the second plate 304 are at zero degree with respect to each other.

Figure 10 shows the orientation device 300 when adjustments are made by twisting
5 the first fastener 326 to lengthen the exposed length 344 of the first fastener 326 between the first shaft 322 and the second plate 304. The lengthening causes the first plate 302 to orientate anti-clockwise (in Figure 10) about the axis of the second shaft 310. In Figure 10, the major planar surface of the first plate 302 and the major planar surface of the second plate 304 are at 2 degree with respect to each other,
10 which is the maximum degree in which the first plate 302 can orientate anti-clockwise (in Figure 10) about the axis of the second shaft 310.

Figure 11 shows the orientation device 300 when adjustments are made by twisting
the first fastener 326 to shorten the exposed length 344 of the first fastener 326
15 between the first shaft 322 and the second plate 304. The shortening causes the first plate 302 to orientate clockwise (in Figure 11) about the axis of the second shaft 310. In Figure 11, the major planar surface of the first plate 302 and the major planar surface of the second plate 304 are at 2 degree with respect to each other, which is the maximum degree in which the first plate 302 can orientate clockwise (in Figure
20 11) about the axis of the second shaft 310.

Figure 12 shows the orientation device 300 being mounted with a thermode assembly 900 and mounted to a compression actuator 800. With reference to Figure 5 as well, the first plate 302 has four fastener openings 488 for receiving fasteners to
25 join the thermode assembly 900 to the first plate 302. The second plate 304 has three evenly spaced openings, 490 and 492 positioned along a common axis. One central opening 492 is located in the centre of the major rectangular planar surface of the second plate 304. Two side openings 490 are located a distance from the central opening. The side openings 490 do not overlap the hole 452 for accessing
30 the second fastener 328. The three openings, 490 and 492 are for receiving mounting shafts extended from the compression actuator 800. It is appreciated that the four fastening openings 488 and the three openings 490 and 492 could be arranged in other ways depending on how the thermode assembly 900 and the compression actuator 800 are designed for mounting to the first plate 302 and the
35 second plate 304.

With reference to Figures 3, 4 and 5, it is appreciated that the spherical bearing 434 or a similar component located in the second plate 304 could be relocated to reside in the first shaft 322 instead. Accordingly, the threaded opening 338 at the first shaft 322 would be relocated to the second plate 304. In this manner, the roles of the adjustment components located on the second plate 304 and at the first shaft 322 are reversed. The first shaft 322 however would require re-designing to incorporate, for instance, a bearing similar to the rod end bearing 416 as described herein and the second plate 304 would require re-designing to have a threaded opening similar to the threaded opening 338 for receiving the first fastener 326. The direction of insertion of the first fastener 326 will be inverted accordingly.

Similarly, the rod end bearing 416 or a similar component that is joined to the second shaft 324 could be relocated to reside at the first plate 302 instead. Accordingly, the threaded opening 454 at the first plate 302 would be relocated to the second shaft 324. In this manner, the roles of the adjustment components located on the first plate 302 and at the second shaft 324 are reversed. The first plate 302 however would require re-designing to incorporate, for instance, a bearing similar to the spherical bearing 434 as described herein and the rod end bearing 416 joined to the second shaft 324 would require re-designing to have a threaded opening similar to the threaded opening 454 for receiving the second fastener 328. The direction of insertion of the second fastener 328 will be inverted accordingly.

It is appreciated that all the threads in the fasteners (for example, 326, 328, 402, 404, 422 in Figure 5) and threading in the threaded holes or openings (for example, 338, 454, 472, 480, 476 in Figure 5) discussed herein has right hand threads. Left hand threads could be used as well.

It is appreciated that the fasteners (for example, 326, 328, 402, 404, 422 in Figure 5) discussed herein include threaded screws, bolts and the like.

Many modifications and other embodiments can be made to the orientation device 300 by those skilled in the art having the understanding of the above described disclosure together with the drawings. Therefore, it is to be understood that the orientation device 300 is not to be limited to the above description contained herein only, and that possible modifications are to be included in the claims of the disclosure.

CLAIMS

1. An orientation device for a thermode assembly of a thermocompression bonding apparatus, the orientation device comprising:
 - 5 a first sub-assembly having:
 - a first plate for mounting the thermode assembly;
 - a first shaft, the first plate being arranged for orientation about an axis of the first shaft; and
 - a second sub-assembly having:
 - 10 a second plate for mounting on a compression actuator of the thermocompression bonding apparatus;
 - a second shaft, the first plate being arranged for orientation about an axis of the second shaft;
- wherein:
 - 15 the first shaft is disposed orthogonally to the second shaft;
- the orientation device further comprising:
 - a first adjustment mechanism coupled between the first plate and the second shaft for adjusting orientation of the first plate about the axis of the first shaft; and
 - 20 a second adjustment mechanism coupled between the second plate and the first shaft for adjusting orientation of the first plate about the axis of the second shaft.
2. The orientation device as claimed in claim 1, the first adjustment mechanism comprising a first locking mechanism for locking a position of orientation of the first plate about the axis of the first shaft.
3. The orientation device as claimed in claims 1 or 2, the second adjustment mechanism comprising a second locking mechanism for locking a position of orientation of the first plate about the axis of the second shaft.
4. The orientation device as claimed in any one of the preceding claims, the first adjustment mechanism comprising a first fastening mechanism being arranged for the first plate to orientate about the axis of the second shaft based on an operation of the first fastening mechanism.

5. The orientation device as claimed in any one of the preceding claims, the second adjustment mechanism comprising a second fastening mechanism being arranged for the first plate to orientate about the axis of the first shaft based on an operation of the second fastening mechanism.

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6. The orientation device as claimed in claim 4, the first adjustment mechanism further comprising a first bushing for housing a first ring, the first ring being rotatable in the bushing, wherein the first fastener is arranged for inserting through the first ring.

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7. The orientation device as claimed in claim 5, the second adjustment mechanism further comprising a second bushing for housing a second ring, the second ring being rotatable in the second bushing, wherein the second fastener is arranged for inserting through the second ring.

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8. The orientation device as claimed in any one of claims 4 to 7, wherein the first fastening mechanism comprises a first threaded fastener that is fastened through a first threaded opening located in one of the second plate and the first shaft, the first adjustment mechanism further comprising a first biasing member for biasing the first threaded fastener and the first threaded opening towards each other.

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9. The orientation device as claimed in any one of claims 5 to 8, wherein the second fastener mechanism comprises a second threaded fastener that is fastened through a second threaded opening located in one of the second shaft and the first plate, the second adjustment mechanism further comprising a second biasing member for biasing the second threaded fastener and the second threaded opening towards each other.

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- 30 10. The orientation device as claimed in any one of the preceding claims, wherein the first shaft is extended through the second shaft.