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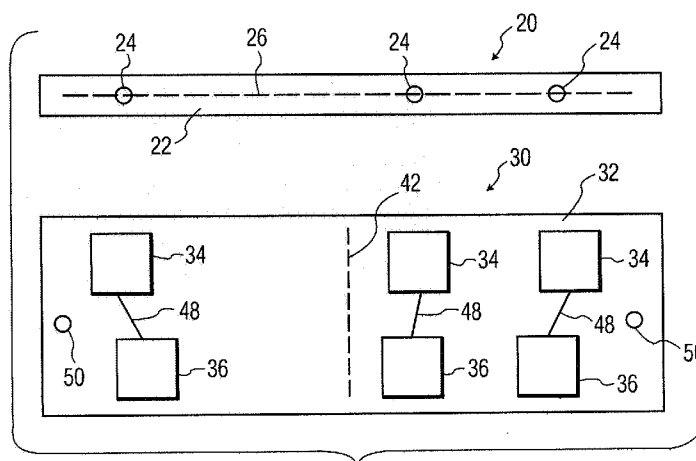
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(54) Title: VARIED PITCH CONNECTION DEVICE AND METHOD



(57) Abstract: A varied pitch connection device and alignment method using said device. The device includes a plurality of first bond pads (36) disposed on a bond pad surface (32); a plurality of second bond pads (34) disposed on the bond pad surface (32); and a plurality of connections (48), each connection (48) connecting a first bond pad to a corresponding second bond pad. Each of the plurality of second bond pads (34) is spaced a greater distance (46) from a reference line (42) than the corresponding first bond pad, each of the plurality of first bond pads (36) and the corresponding one of the plurality of second bond pads (34) define a pitch line (52) whereby each of a plurality of connection bumps (24) of a bump device (20) is alignable with one of the plurality of pitch lines (52) when the bump line (26) is parallel to a first axial line (38) along which the first bond pads (36) are arranged. The invention overcomes alignment problems occurring when an IC chip is bonded to a substrate whose dimensions/size may vary to conditions e.g. plastic substrate used for flat paned displays.

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Title: VARIED PITCH CONNECTION DEVICE AND METHOD

This invention relates generally to connection devices, and more specifically to varied pitch connection devices for integrated circuit (IC) bonding.

Tolerances for bonding IC chips on substrates have become
5 increasingly important with the increase in the number of components on circuit boards and the increase in the number of connections per IC. Uncertainties in dimensions between the IC chips and substrates cause misalignment of connections, and unintended open and shorted connections. Such uncertainties arise from changes in material dimensions and/or
10 uncertainties in material dimensions.

One example of this problem is flip-chip bonding, also known as chip-on-glass bonding. Flip-chip bonding provides a convenient way to make a large number of electrical connections between a silicon IC chip and a large substrate, such as a display backplane. The pattern and spacing of the
15 connection IC bumps on the IC chip is fixed at manufacture. The substrate can change size due to manufacturing stresses. The connection IC bumps on the IC chip and bond pads on the substrate have to be accurately matched to provide good electrical connections. When the pattern and spacing of the bond pads on the substrate are manufactured to match the pattern and spacing of the
20 connection IC bumps on the IC chip, and the substrate changes size, alignment errors result.

Flip-chip bonding is used in manufacturing thin film transistor (TFT) flat panel display screens. A thin plastic substrate is laminated to a rigid support to provide lithographical accuracy during TFT processing. The
25 pattern and spacing of bond pad locations on the photo masks used during TFT processing are the same as the pattern and spacing of connection IC bumps on the IC chips, so the structures on the substrate on the rigid support have the same pattern and spacing as on the photo masks. When the substrate is delaminated from the rigid support, the substrate shrinks due to mechanical

stresses built up during processing. The substrate shrinks by a small factor, such as from 0.1% to 0.3%. The shrinkage varies from one substrate to another over a statistical spread. The pattern and spacing of the connection IC bumps on the IC chip do not change, so there is misalignment between the connection
5 IC bumps and the bond pads. A similar misalignment problem occurs when the substrate expands rather than shrinks.

Presently proposed solutions to this problem reduce manufacturing flexibility or are ineffective. The pattern and spacing of bond pad locations on the photo masks can match the pattern and spacing of connection IC bumps on
10 the IC chips, and the IC chips bonded to the substrate before the substrate is delaminated from the rigid support, but then the photo masks cannot be used for a process in which the IC chips are bonded to the substrate after the substrate is delaminated from the rigid support. The pattern and spacing of bond pad locations on the photo masks can be adjusted for the expected
15 shrinkage of the substrate, and the IC chips bonded to the substrate after the substrate is delaminated from the rigid support, but then the photo masks cannot be used for a process in which the IC chips are bonded to the substrate before the substrate is delaminated from the rigid support. In addition, the shrinkage is difficult to model and varies from substrate to substrate, so
20 misalignment problems will occur.

It is an object of the invention to provide a connection device wherein misalignment problems for IC chips, notably in a flip-chip bonding area, are counteracted.

One aspect of the present invention provides a varied pitch
25 connection device for a connection bump device with a plurality of connection bumps disposed along a bump line including a plurality of first bond pads disposed on a bond pad surface, each of the plurality of first bond pads being an axial distance from a reference line along a first axial line perpendicular to the reference line; a plurality of second bond pads disposed on the bond pad
30 surface, each of the plurality of second bond pads corresponding to one of the

plurality of first bond pads; and a plurality of connections, each of the plurality of connections connecting one of the plurality of first bond pads to the corresponding one of the plurality of second bond pads. Each of the plurality of second bond pads is the axial distance times a pitch factor from the reference
5 line along a second axial line parallel to the first axial line, each of the plurality of first bond pads and the corresponding one of the plurality of second bond pads define a pitch line being one of a plurality of pitch lines, and each of the plurality of connection bumps is alignable with one of the plurality of pitch lines when the bump line is parallel to the first axial line.

10 Another aspect of the present invention provides an alignment method including providing a connection bump device; providing a bond pad surface having a varied pitch connection device; determining a correction factor; determining a y-displacement for the connection bump device relative to the varied pitch connection device from the correction factor; and moving the
15 connection bump device relative to the varied pitch connection device by the y-displacement.

Another aspect of the present invention provides a system for aligning a connection bump device with a varied pitch connection device including means for determining a correction factor; means for determining a
20 y-displacement for the connection bump device relative to the varied pitch connection device from the correction factor; and means for moving the connection bump device relative to the varied pitch connection device by the y-displacement.

The foregoing and other features and advantages of the invention
25 will become further apparent from the following detailed description of the presently preferred embodiment, read in conjunction with the accompanying drawings. The detailed description and drawings are merely illustrative of the invention rather than limiting, the scope of the invention being defined by the appended claims and equivalents thereof.

FIG. 1 is a front view of a varied pitch connection device made in accordance with the present invention;

FIG. 2 is a detail view of the varied pitch connection device of FIG. 1 made in accordance with the present invention;

5 FIG. 3 is a front view of a varied pitch connection device with intermediate bond pads made in accordance with the present invention;

FIG. 4 is a front view of a varied pitch connection device with overlapping bond pads made in accordance with the present invention;

10 FIG. 5 is a front view of a varied pitch connection device with continuous bond pads made in accordance with the present invention;

FIG. 6 is a front view of a varied pitch connection device with parallel bond pad sets made in accordance with the present invention; and

FIG. 7 is a block diagram of a system for alignment of a varied pitch connection device made in accordance with the present invention.

15 FIGS. 1 & 2 are a front view and detail view, respectively, of a varied pitch connection device made in accordance with the present invention. The varied pitch connection device permits adjustment of a connection for changes in substrate dimension and/or manufacturing variations.

A varied pitch connection device 30 is paired with a connection bump
20 device 20. The connection bump device 20 includes a number of connection bumps 24 disposed along a bump line 26 on a connection bump surface 22. The varied pitch connection device 30 is disposed on a bond pad surface 32, and includes a number of first bond pads 36 and a number of second bond pads 34. Both the first bond pads 36 and the second bond pads 34 are disposed on the
25 bond pad surface 32. Each of the first bond pads 36 corresponds to one of the second bond pads 34, with the first bond pad 36 and the corresponding second bond pad 34 defining a pitch line 52. A number of connections 48 connect each of the first bond pads 36 to the corresponding second bond pad 36. The first bond pads 36 are aligned along a first axial line 38 and the second bond
30 pads 34 are aligned along a second axial line 40. The first axial line 38 and the

second axial line 40 are perpendicular to a reference line 42. Each of the first bond pads 36 is an axial distance 44 from the reference line 42 along the first axial line 38. Each of the second bond pads 34 is a second axial distance 46 from the reference line 42 along the second axial line 40. For a first bond pad 5 36 and corresponding second bond pad 34, the length of the second axial distance 46 is the axial distance 44 times a pitch factor. The pitch factor can be greater than or less than one depending on the desired slope of the pitch lines 52. Each of the connection bumps 24 of the connection bump device 20 is alignable with one of the pitch lines 52 when the bump line 26 is parallel to 10 the first axial line 38, i.e., the connection bump device 20 can be shifted relative to the varied pitch connection device 30 until each of the connection bumps 24 lines up with one of the pitch lines 52. Once the connection bumps 24 are aligned with the pitch lines 52, the connection bump device 20 can be bonded to the varied pitch connection device 30.

15 The varied pitch connection device 30 can include alignment marks 50 for use in determining a correction fraction for the bond pad surface 32 and/or aligning the connection bump device 20 with the varied pitch connection device 30 during assembly. The separation distance, i.e., the gap, between adjacent first bond pads 36 and between adjacent second bond 20 pads 34 is selected to be greater than the bump diameter of the connection bumps 24 so that the connection bumps 24 do not bridge between adjacent first bond pads 36 or second bond pads 34. In one embodiment, the pad pitch is about 50 micrometers and the gap between bond pads is as low as about 15 micrometers.

25 The bond pad surface 32 can be any surface capable of supporting bond pads for making connections. In one embodiment, the bond pad surface 32 is a plastic substrate, such as a thin plastic substrate that can be laminated to a rigid support to provide lithographical accuracy during TFT processing. In another embodiment, the bond pad surface 32 is a flexible or 30 rigid circuit board. In yet another embodiment, the bond pad surface 32 is a

glass substrate. A connection bump device 20 with connection bumps 24, such as an IC chip with IC bumps, can be bonded to the bond pads on the substrate before or after the substrate is delaminated from the rigid support. The connection bump device 20 can be any device with a connection bump surface
5 capable of supporting connection bumps for making connections, such as integrated circuit (IC) chips, IC packages, Tape Carrier Packages (TCP), Flexible Printed Circuits (FPC), or the like.

The pattern and spacing of the connection bumps 24 on the connection bump device 20 is complementary to the pattern and spacing of the
10 first bond pads 36 and the second bond pads 34 on the varied pitch connection device 30. The first bond pads 36 and the second bond pads 34 can be regularly spaced with a consistent distance between adjacent bond pads or irregularly spaced with varying distances between adjacent bond pads. For regularly spaced bond pads, the pitches of the first bond pads 36 and the second bond
15 pads 34 are selected so that the pitch of the connection bumps 24 is between the pitch of the first bond pads 36 and pitch of the second bond pads 34. The sets of bond pads with the first bond pads 36 and the second bond pads 34 can be repeated to provide parallel bond pad sets and/or regular grids of bond pad sets.

20 The first bond pads 36, second bond pads 34, and connections 48 can be selected to bond with the connection bumps 24. In one embodiment, the first bond pads 36 and the second bond pads 34 overlap and form the connection 48, so that the bond with the connection bumps 24 can be anywhere along the first bond pads 36 and the second bond pads 34. In another embodiment, the
25 connection 48 is wide enough that the connection bumps 24 can bond with the connection 48.

FIG. 3, in which like elements share like reference numbers with FIG. 1, is a front view of a varied pitch connection device with intermediate bond pads made in accordance with the present invention. In this example, a
30 number of intermediate bond pads are located between the first bond pads and

the second bond pads. The intermediate bond pads provide additional contact area to adjust and attach the connection bumps of the connection bump devices.

The varied pitch connection device 30 includes a number of
5 intermediate bond pads 60 located between the first bond pads 36 and the second bond pads 34. The intermediate bond pads 60 are disposed on the bond pad surface 32. The intermediate bond pads 60 are operably connected to the first bond pads 36 and the second bond pads 34 by first connections 62 and second connections 64. In one embodiment, the first connections 62 and second
10 connections 64 are a single connection between the first bond pads 36 and the second bond pads 34 and the intermediate bond pads 60 are connected to the single connection. In one embodiment, the intermediate bond pads 60 overlap the first bond pads 36 and the second bond pads 34, so that the connections between bond pads are made through the bond pads themselves.

15 FIG. 4, in which like elements share like reference numbers with FIG. 3, is a front view of a varied pitch connection device with overlapping bond pads made in accordance with the present invention. In this example, a number of intermediate bond pads overlap the first bond pads and the second bond pads. The intermediate bond pads provide additional contact area to
20 adjust and attach the connection bumps of the connection bump devices. The varied pitch connection device 30 includes a number of intermediate bond pads 60 located between and overlapping the first bond pads 36 and the second bond pads 34. The intermediate bond pads 60 are disposed on the bond pad surface 32. Those skilled in the art will appreciate that any number of
25 intermediate bond pads desired for a particular application can be located between each corresponding pair of the first bond pads 36 and the second bond pads 34.

FIG. 5, in which like elements share like reference numbers with FIG. 1, is a front view of a varied pitch connection device with continuous bond
30 pads made in accordance with the present invention. In this example, the

continuous bond pads are continuous between a first end and a second end. The continuous bond pads provide a smooth transition to adjust and attach the connection bumps of the connection bump devices. The varied pitch connection device 30 includes a number of continuous bond pads 70. The continuous bond pads 70 are disposed on the bond pad surface 32. Each of the continuous bond pads 70 extends between a first bond pad end 72 and a second bond pad end 74. The intermediate bond pad portion 76 connects the first bond pad end 72 and the second bond pad end 74. Those skilled in the art will appreciate that the intermediate bond pad portion 76 is the equivalent of the connection 48 of FIG. 1 connecting the first bond pads 36 to the second bond pads 34, widened to provide area for attachment of the connection bumps of the connection bump devices.

FIG. 6, in which like elements share like reference numbers with FIG. 5, is a front view of a varied pitch connection device with parallel bond pad sets made in accordance with the present invention. In this example, the two parallel bond pad sets provide connections for two parallel connection bump sets on a connection bump device. The varied pitch connection device 30 includes a first bond pad set 80 and a second bond pad set 82. Each of the bond pad sets includes a number of continuous bond pads 70. Those skilled in the art will appreciate that any number of bond pad sets can be used as desired for a particular application, as required to match connection bump sets on a connection bump device. In one embodiment, the bond pad sets can be provided in a regular grid. In another embodiment, the bond pads within the bond pad set can be regularly spaced with the same spacing between adjacent bond pads. In another embodiment, the bond pads within the bond pad set can be irregularly spaced with different spacing between adjacent bond pads.

Preferably, the varied pitch connection device, as is discussed with reference to the foregoing, is arranged on a display unit. More preferably, the varied pitch connection device is arranged on a flexible display, which may be conceived to be rollable on a roller or wrappable about a carrier. Suitable

example of such flexible display is known, for example, from WO 2004/114259. In a preferred embodiment a display or a flexible display is arranged in a portable device, like a mobile phone, a palmtop computer, an organizer, or the like. In the display unit or the flexible display unit comprising at least one
5 electronic component electrically connected to a substrate by means of a flip-chip bonding, for the flip-chip bonding discussed in the foregoing the varied pitch connection device may be used.

FIG. 7 is a block diagram of an alignment system for a varied pitch
10 connection device made in accordance with the present invention. The system adjusts the position of a connection bump device with connection bumps relative to a varied pitch connection device with bond pads so that the connection bumps and the bond pads align.

Referring to FIG. 7, the exemplary varied pitch connection
15 alignment system 100 includes a connection bump device 102 with at least one connection bump set 104, a substrate 108 having at least one varied pitch connection device 110, an alignment monitoring device 112 operably connected to a processor 114, and a positioner 116 operably connected to the
processor 114 for positioning the connection bump device 102 relative to the
20 substrate 108 and the varied pitch connection device 110. The connection bump set 104 includes connection bumps 106. The varied pitch connection device 110 includes at least one bond pad set 118 with bond pads 120 and alignment marks 122. Those skilled in the art will appreciate that the varied pitch connection device 110 can be any of the embodiments described above,
25 such as the two bond pad, intermediate bond pad, overlapping bond pad, and/or continuous bond pad devices, as desired for a particular purpose.

In operation, the alignment monitoring device 112 monitors the connection bump set 104 and the varied pitch connection device 110. In one embodiment, the alignment monitoring device 112 is a video monitoring device
30 for optically monitoring the connection bump set 104 and the varied pitch

connection device 110. In one embodiment, the alignment monitoring device 112 measures an actual mark distance between the alignment marks 122 and provides the actual mark distance to the processor 114. The actual mark can also be referred to as an alignment mark. It is appreciated that for the alignment mark either a specifically arranged mark, or an existing feature of the bond pad can be used. In the latter case an extra manufacturing step for introducing specific markers may be avoided. The processor 114 compares the actual mark distance to a design mark distance, such as the distance between marks on the photo mask, to determine a correction factor.

5 The correction factor can be the actual mark distance divided by the design mark distance, or the inverse. In another embodiment, the correction factor can be a predetermined correction factor for expected or measured manufacturing differences. The processor 114 determines a y-displacement for the connection bump device 102 relative to the varied pitch connection device 110 from the correction factor, such as by determining the y-displacement from a source stored in the processor 114, such as a formula providing the y-displacement as a function of the correction factor or a look-up table listing the y-displacement for different correction factors. The processor 114 can then direct the positioner 116 to move the connection bump device 102 relative to the varied pitch connection device 110 by the y-displacement to align the connection bumps 106 with the bond pads 120. Those skilled in the art will appreciate that the movement of the connection bump device 102 relative to the varied pitch connection device 110 can be accomplished by moving the connection bump device 102, the varied pitch connection device 110, or both the connection bump device 102 and the varied pitch connection device 110. In one embodiment, the alignment of the connection bump device 102 with the varied pitch connection device 110 can be confirmed with the alignment monitoring device 112 and the processor 114, and a new y-displacement determined when an alignment error exists. When the alignment error is acceptable, the bond pads 120 can be bonded to the connection bumps 106. The

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alignment method precisely matches the bond pads 120 with the connection bumps 106 regardless of any dimension change of the substrate 108.

While the embodiments of the invention disclosed herein are presently considered to be preferred, various changes and modifications can be made without departing from the scope of the invention. Those skilled in the art will appreciate that the figures show a limited number of bond pads and connection bumps for clarity of illustration. In practice, a large number of bond pads and connection bumps with small dimensions and positioned closely together with tight tolerances are typically used. The scope of the invention is indicated in the appended claims, and all changes that come within the meaning and range of equivalents are intended to be embraced therein.

Claims

1. A varied pitch connection device for a connection bump device with a plurality of connection bumps disposed along a bump line comprising:

5 a plurality of first bond pads 36 disposed on a bond pad surface 32, each of the plurality of first bond pads 36 being an axial distance 44 from a reference line 42 along a first axial line 38 perpendicular to the reference line 42;

a plurality of second bond pads 34 disposed on the bond pad surface 32, each of the plurality of second bond pads 34 corresponding to one
10 of the plurality of first bond pads 36; and

a plurality of connections 48, each of the plurality of connections 48 connecting one of the plurality of first bond pads 36 to the corresponding one of the plurality of second bond pads 34;

wherein each of the plurality of second bond pads 34 is the axial
15 distance 44 times a pitch factor from the reference line 42 along a second axial line 40 parallel to the first axial line 38,

each of the plurality of first bond pads 36 and the corresponding one of the plurality of second bond pads 34 define a pitch line 52 being one of a plurality of pitch lines 52, and

20 each of the plurality of connection bumps 24 is alignable with one of the plurality of pitch lines 52 when the bump line 26 is parallel to the first axial line 38.

2. The device of claim 1 wherein the bond pad surface 32 is selected
25 from the group consisting of a plastic substrate, a flexible circuit board, a rigid circuit board, and a glass substrate.

3. The device of claim 1 wherein the connection bump device 20 is selected from the group consisting of integrated circuit (IC) chips, IC packages, Tape Carrier Packages (TCP), and Flexible Printed Circuits (FPC).

5 4. The device of claim 1 wherein the plurality of first bond pads 36 are regularly spaced.

5. The device of claim 1 wherein the plurality of first bond pads 36 are irregularly spaced.

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6. The device of claim 1 wherein each of the plurality of connections 48 is a continuous bond pad connecting one of the plurality of first bond pads 36 to the corresponding one of the plurality of second bond pads 34.

15 7. The device of claim 1 wherein a first separation distance between adjacent first bond pads 36 and a second separation distance between adjacent second bond pads 34 are selected as being greater than a bump diameter of one of the plurality of connection bumps 24.

20 8. The device of claim 1 further comprising a plurality of intermediate bond pads 60, each of the plurality of intermediate bond pads 60 being located between one of the plurality of first bond pads 36 and the corresponding one of the plurality of second bond pads 34, and being operably connected to the one of the plurality of first bond pads 36 and the corresponding one
25 of the plurality of second bond pads 34.

9. The device of claim 8 wherein each of the plurality of intermediate bond pads 60 overlaps the one of the plurality of first bond pads 36 and the corresponding one of the plurality of second bond pads 34.

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10. The device of claim 1 further comprising:
a plurality of third bond pads disposed on the bond pad surface 32,
each of the plurality of third bond pads being a third axial distance from the
reference line along a third axial line perpendicular to the reference line;
5 a plurality of fourth bond pads disposed on the bond pad
surface 32, each of the plurality of fourth bond pads corresponding to one
of the plurality of third bond pads; and
a plurality of third connections, each of the plurality of third
connections connecting one of the plurality of third bond pads to the
10 corresponding one of the plurality of fourth bond pads;
wherein each of the plurality of fourth bond pads is the third axial
distance times a third pitch factor from the reference line along a fourth axial
line parallel to the third axial line.
- 15 11. A display unit comprising a varied pitch connection device according to
any one of the preceding claim.
12. A display according to claim 11, wherein the display is flexible,
preferably rollable or wrappable.
- 20 13. An apparatus comprising a display according to claim 11 or 12.
14. An alignment method comprising:
25 providing a connection bump device;
providing a bond pad surface having a varied pitch connection
device;
determining a correction factor;
determining a y-displacement for the connection bump device
30 relative to the varied pitch connection device from the correction factor; and

moving the connection bump device relative to the varied pitch connection device by the y-displacement.

15. The method of claim 14 wherein the varied pitch connection
5 device has alignment marks and the determining a correction factor comprises:

measuring an actual mark distance between the alignment marks; and

10 comparing the actual mark distance to a design mark distance to determine the correction factor.

16. A method according to claim 14, wherein for the alignment marks features of the bond pad are used.

15 17. The method of claim 14 or 15, wherein the measuring comprises measuring the actual mark distance between the alignment marks with a video monitoring device.

18. The method of claim 14 wherein the determining a correction
20 factor comprises determining a predetermined correction factor.

19. The method of claim 14 further comprising confirming alignment of the connection bump device with the varied pitch connection device with an alignment monitoring device.

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20. The method of claim 14 wherein the determining a y-displacement comprises determining the y-displacement from a source selected from the group consisting of a formula and a look-up table.

30 21. The method of claim 14 wherein the varied pitch connection device

has bond pads and the connection bump device has connection bumps, and the method further comprises bonding the bond pads to the connection bumps.

22. A method according to any preceding claim 14 – 21, further comprising
5 a step of arranging the varied pitch connection device on a display unit, preferably on a flexible display unit.

23. A method according to claim 22, the display unit or the flexible display unit comprising at least one electronic component electrically connected to a
10 substrate by means of a flip-chip bonding, wherein for the flip-chip bonding the varied pitch connection device is used.

24. A system for aligning a connection bump device with a varied pitch connection device
15 comprising:
means for determining a correction factor;
means for determining a y-displacement for the connection bump device relative to the varied pitch connection device from the correction factor; and
20 means for moving the connection bump device relative to the varied pitch connection device by the y-displacement.

25. The system of claim 24 wherein the varied pitch connection device has alignment marks and the means for determining a correction factor
25 comprises:
means for measuring an actual mark distance between the alignment marks; and
means for comparing the actual mark distance to a design mark distance to determine the correction factor.

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26. The system of claim 25 wherein the means for measuring comprises means for optically measuring the actual mark distance between the alignment marks.

5 27. The system of claim 24 wherein the means for determining a correction factor comprises means for determining a predetermined correction factor

28. The system of claim 24 further comprising means for confirming
10 alignment of the connection bump device with the varied pitch connection device.

29. The system of claim 24 wherein the means for determining a y-displacement comprises means for determining the y-displacement from a
15 source selected from the group consisting of a formula and a look-up table.

30. The system of claim 24 wherein the varied pitch connection device has bond pads and the connection bump device has connection bumps, and the system further comprises means for bonding the bond pads to the connection
20 bumps.

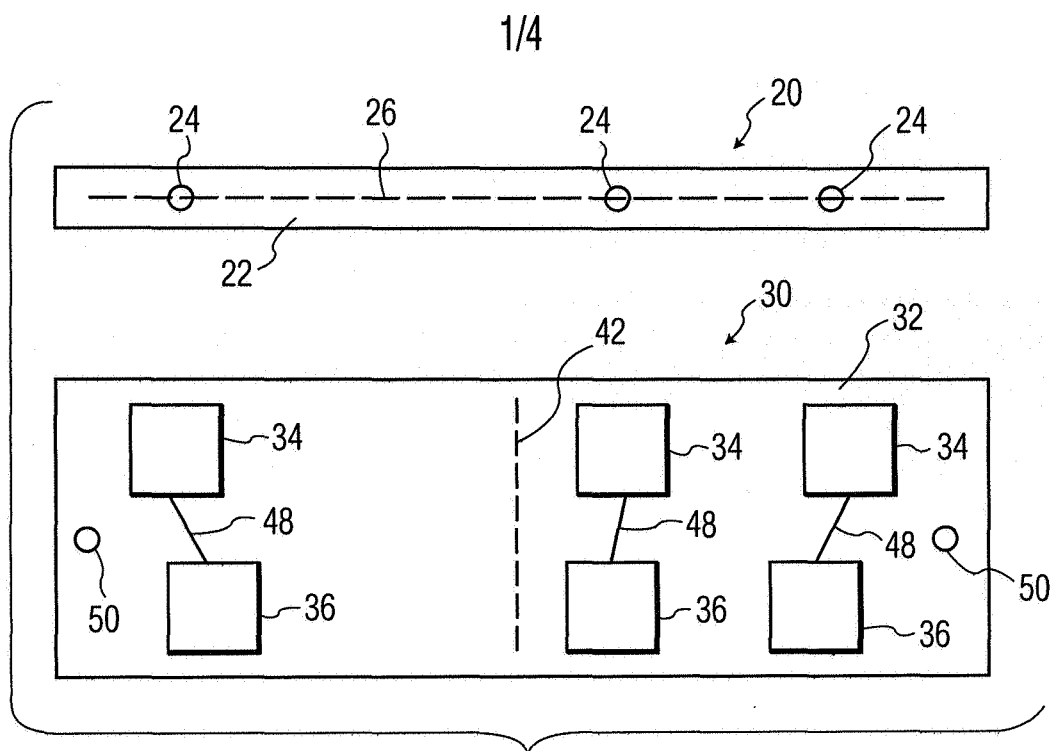


FIG. 1

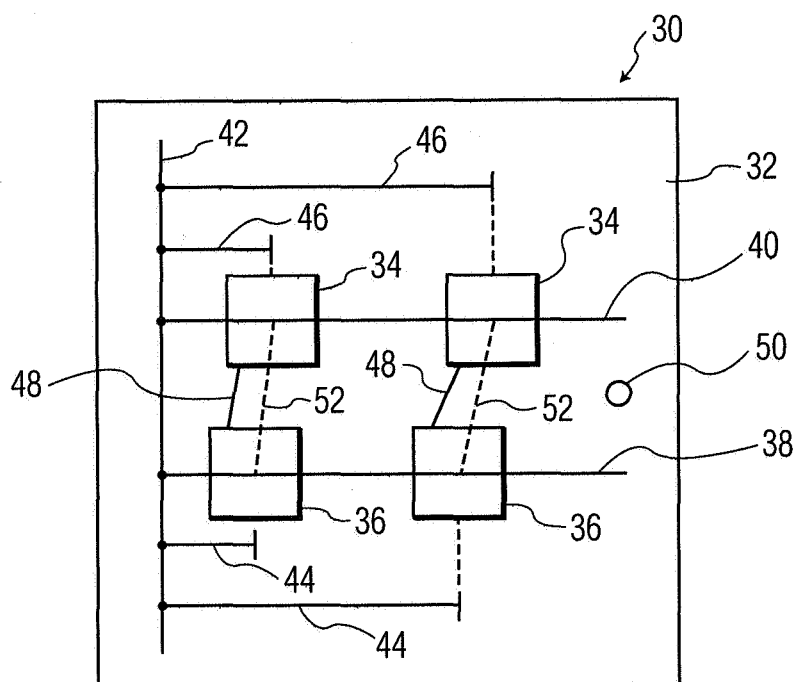


FIG. 2

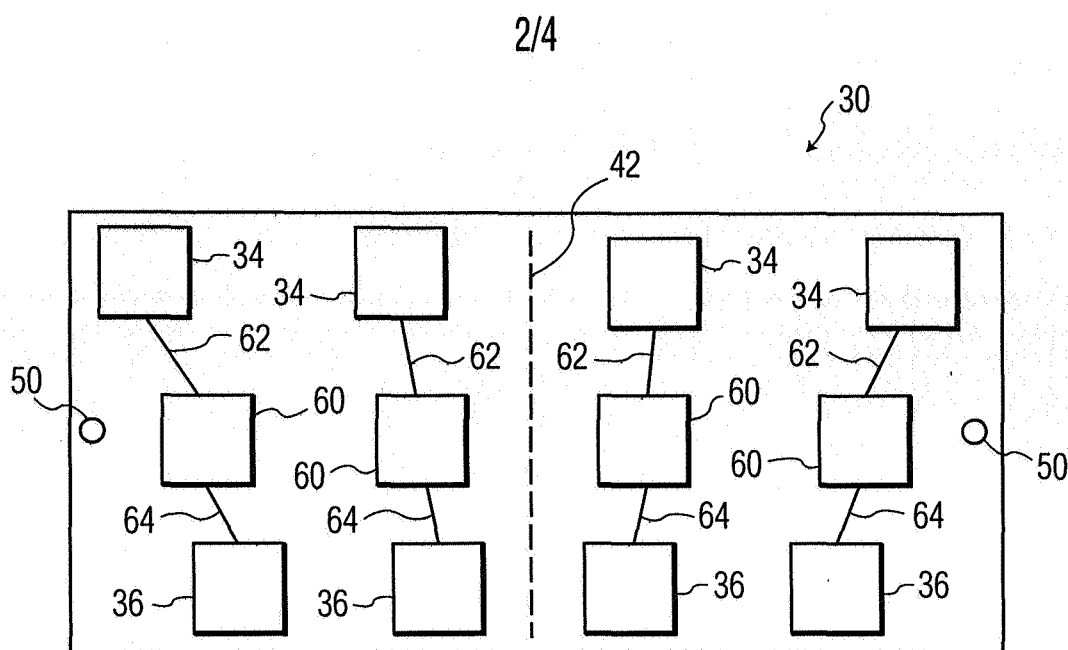


FIG. 3

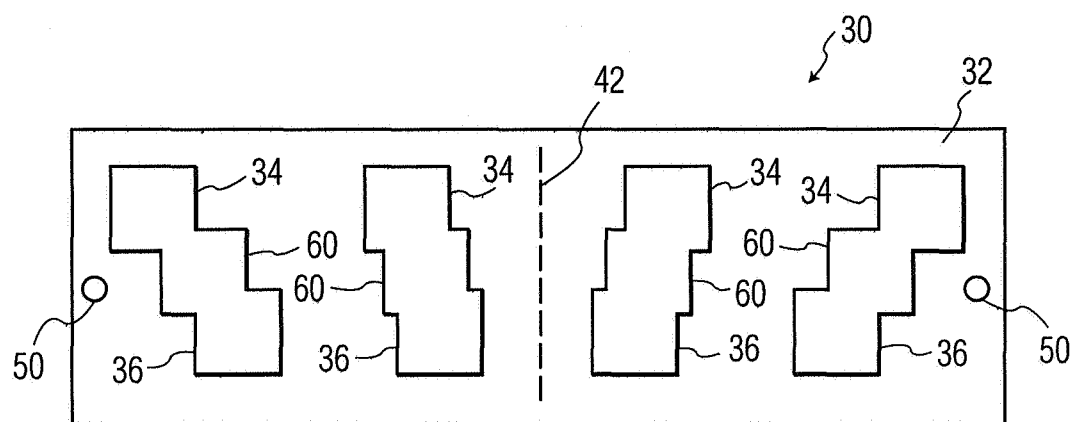


FIG. 4

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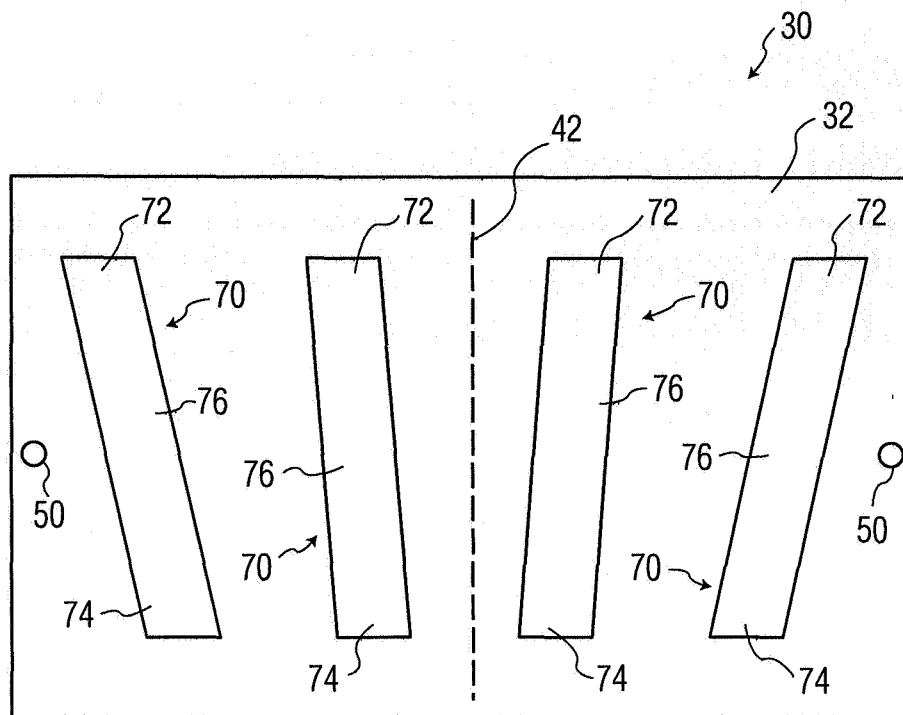


FIG. 5

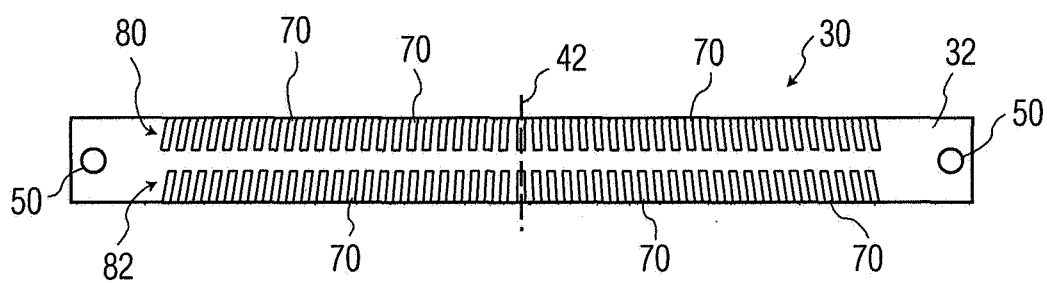


FIG. 6

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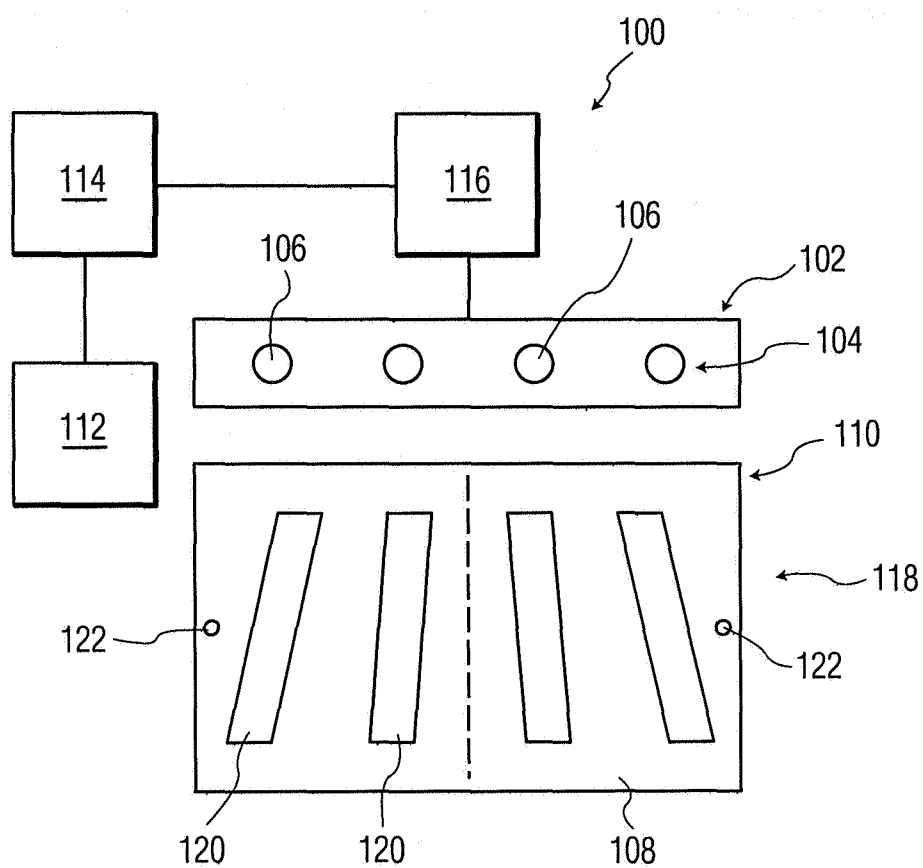


FIG. 7

INTERNATIONAL SEARCH REPORT

International application No

PCT/NL2007/050285

A. CLASSIFICATION OF SUBJECT MATTER

INV. H01L23/498 H01L21/60 H01L23/544

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H01L H05K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 2005/009219 A1 (YUZAWA HIDEKI [JP]) 13 January 2005 (2005-01-13) figures 1,2 paragraphs [0020] - [0023], [0025] - [0029], [0033] - [0036] claim 4 -----	1-7,10, 11,13-30 12
X Y	US 2006/049494 A1 (URUSHIDO TATSUHIRO [JP]) 9 March 2006 (2006-03-09) figures 1-9 paragraphs [0023] - [0028], [0031] -----	1-7,10, 11,13, 14,24 12
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Date of the actual completion of the international search

28 September 2007

Date of mailing of the international search report

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