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Jannett et al.

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[45] **Oct. 16, 1973**

[54] **APPARATUS FOR HANDLING AND MAINTAINING THE ORIENTATION OF A MATRIX OF MINIATURE ELECTRICAL DEVICES**

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[21] Appl. No.: **131,393**

Related U.S. Application Data

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[52] **U.S. Cl.**..... **134/113,** 134/155, 134/166 R, 134/183, 248/363, 294/65.5

[51] **Int. Cl.**..... **B08b 3/08**

[58] **Field of Search**..... 134/113, 137, 154, 134/155, 165, 166 R, 182, 183, 201; 248/363; 294/65.5

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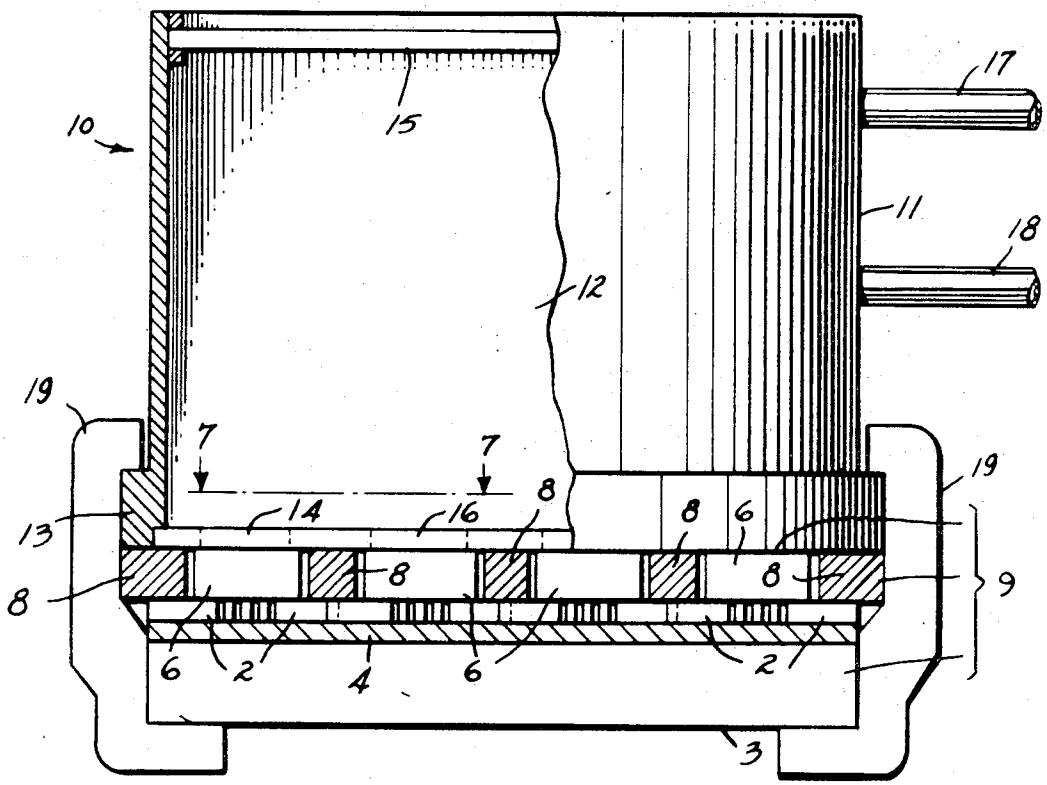
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Primary Examiner—Robert L. Bleutge
Attorney—Jack Schuman

[57] **ABSTRACT**

Grid is placed in channels of matrix of beam lead devices cemented with soluble adhesive to plate. Grid-matrix-plate assembly is drawn by vacuum onto first chuck with pattern of apertures at one end. Solvent is forced through first chuck and apertures to dissolve adhesive. Plate is removed and grid-matrix assembly transferred to second chuck which may be porous block operable with vacuum, magnetic block cooperating with magnetic grid, or a combination thereof. Second chuck may also be magnetic block having mesas and cooperating with magnetic grid, non-magnetic block having apertures through mesas operable with vacuum, or combination thereof. After transfer to second chuck, grid is removed and matrix expanded.

9 Claims, 11 Drawing Figures



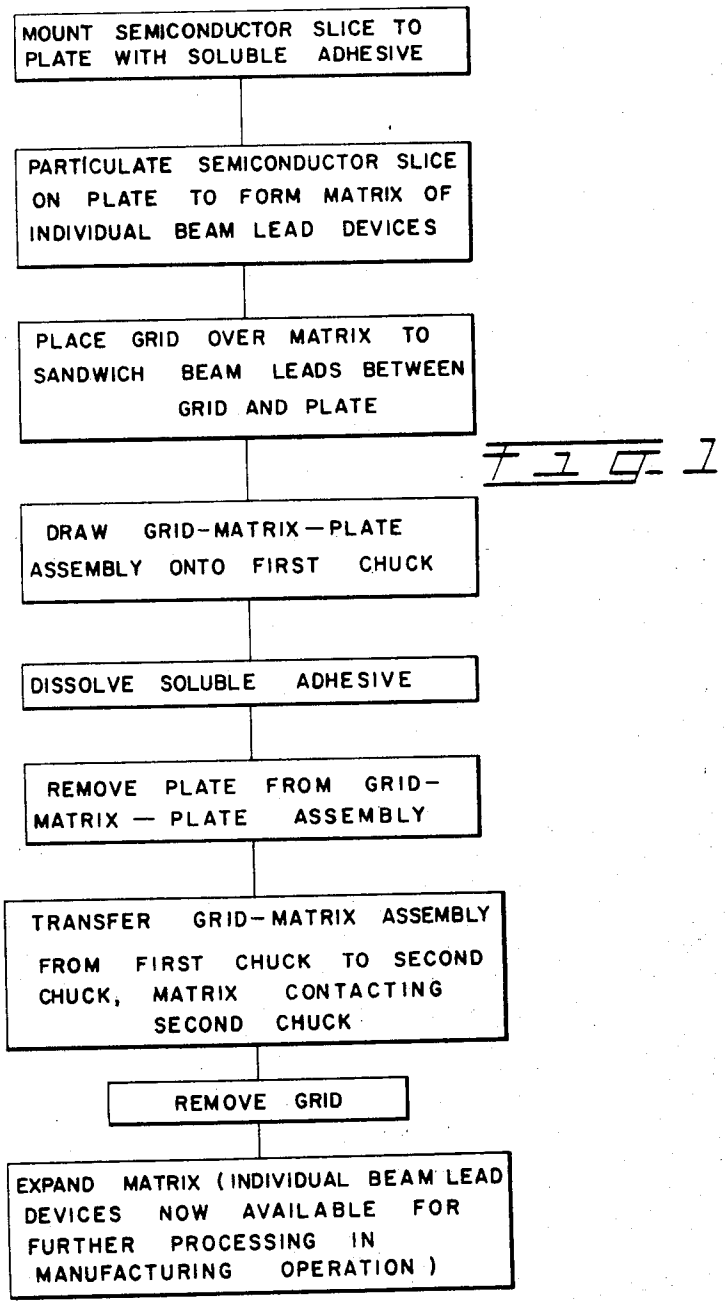

MOUNT SEMICONDUCTOR SLICE TO PLATE WITH SOLUBLE ADHESIVE
PARTICULATE SEMICONDUCTOR SLICE ON PLATE TO FORM MATRIX OF INDIVIDUAL BEAM LEAD DEVICES
PLACE GRID OVER MATRIX TO SANDWICH BEAM LEADS BETWEEN GRID AND PLATE
DRAW GRID-MATRIX-PLATE ASSEMBLY ONTO FIRST CHUCK
DISSOLVE SOLUBLE ADHESIVE
REMOVE PLATE FROM GRID-MATRIX-PLATE ASSEMBLY
TRANSFER GRID-MATRIX ASSEMBLY FROM FIRST CHUCK TO SECOND CHUCK, MATRIX CONTACTING SECOND CHUCK
REMOVE GRID
EXPAND MATRIX (INDIVIDUAL BEAM LEAD DEVICES NOW AVAILABLE FOR FURTHER PROCESSING IN MANUFACTURING OPERATION)

Fig. 1

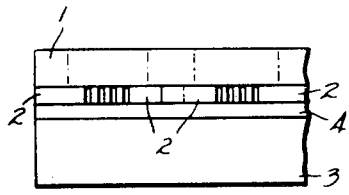


FIG 2

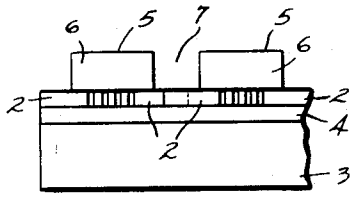


FIG 3

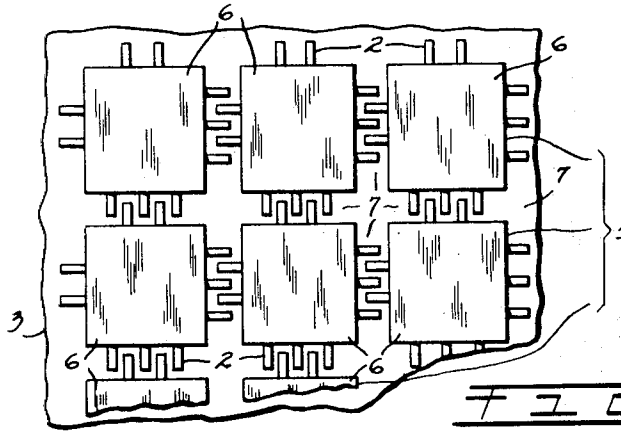
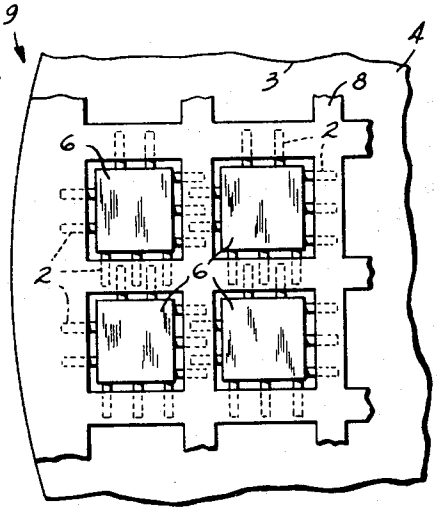


FIG 4

FIG 5



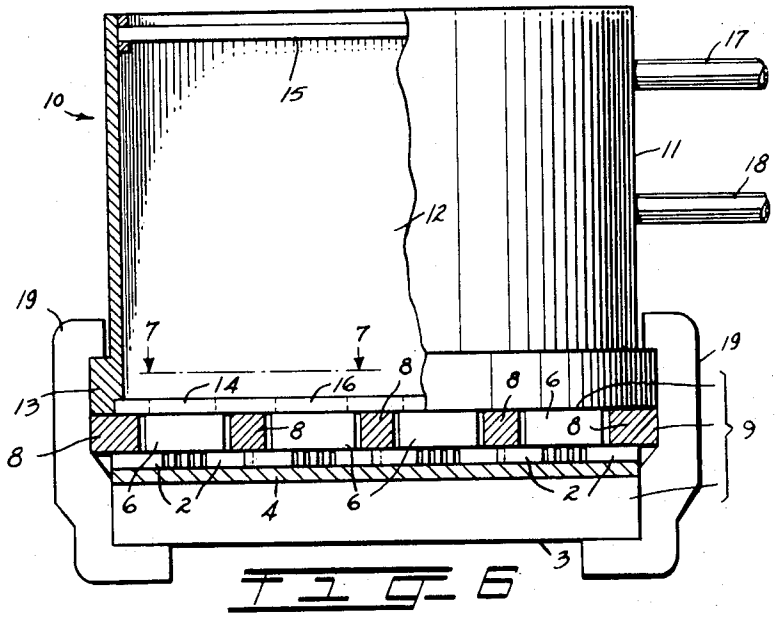


FIG 6

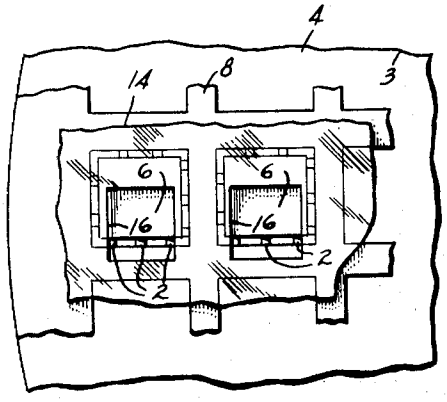


FIG 7

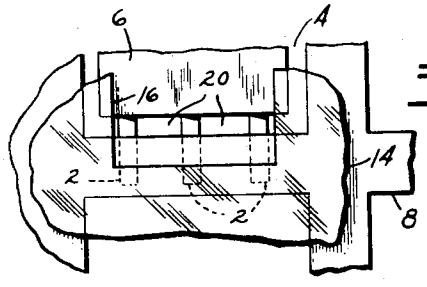


FIG 8

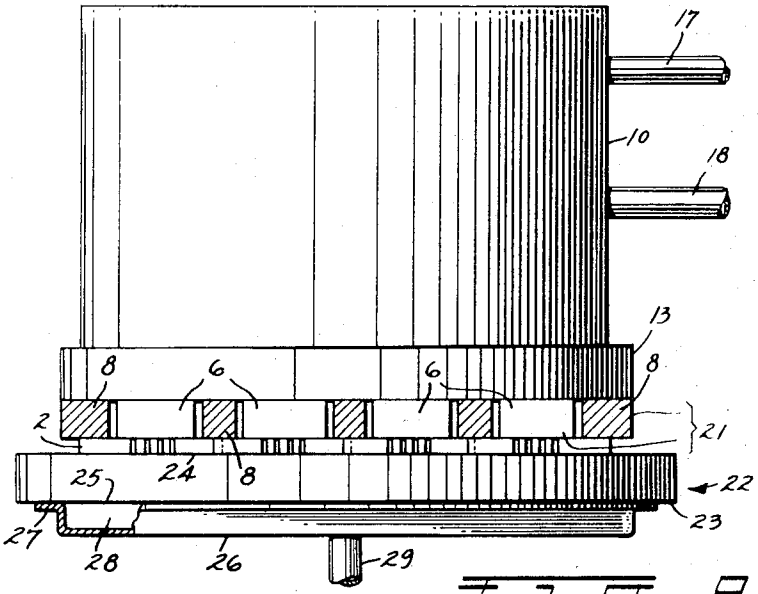


FIG. 9

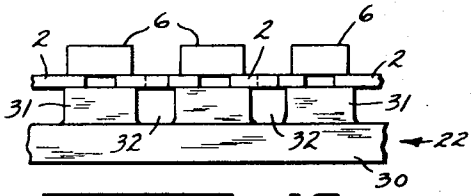


FIG. 10

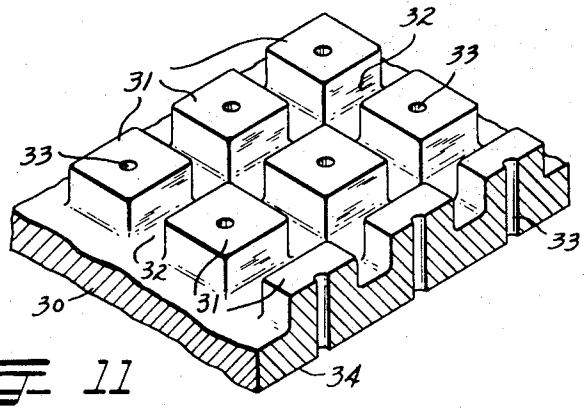


FIG. 11

APPARATUS FOR HANDLING AND MAINTAINING THE ORIENTATION OF A MATRIX OF MINIATURE ELECTRICAL DEVICES

CROSS REFERENCE TO RELATED APPLICATION

This application is a division of application Ser. No. 866,981 filed Oct. 16, 1969 and now U. S. Pat. 3,681,139.

BACKGROUND OF THE INVENTION

1. Field of the Invention

Broadly speaking, this invention relates to apparatus for handling an array or matrix of miniature articles. More specifically, this invention relates to apparatus for handling an array or matrix of closely spaced microminiature electrical devices in fixed predetermined orientation.

2. Description of the Prior Art

In many manufacturing operations, it is necessary to handle groups of individual workpieces. Often, such workpieces are miniature, or even microminiature, in size and are produced in a compact array or matrix.

One such operation involves the manufacture of microminiature beam lead electrical devices. These beam lead devices may be manufactured in a compact array or matrix from a particulated semiconductor wafer having cantilevered beam leads extending outwardly from doped regions in the semiconductor wafer. The beam lead devices may, for example, have dimensions ranging down to approximately 0.017 inches on a side. It would be a distinct advantage to handle these microminiature beam lead devices in large batches (e.g., as they exist in the matrix) for as long as possible in the manufacturing operation, due to their small size and also to minimize individual handling which could contaminate, break or otherwise render useless these devices.

Moreover, it is very desirable to maintain the individual beam lead devices of the array or matrix fixed in a predetermined orientation relative to each other. Firstly, beam lead devices originating from adjacent portions of the parent semiconductor wafer will have nearly identical electrical characteristics and, where "matching" circuits are to be fabricated, the desirability of utilizing nearly identical beam lead devices in these "matching" circuits is apparent. Consequently, there is an advantage in maintaining the originally adjacent beam lead devices in the same relative positions during the various manufacturing operations. Parenthetically, the maintenance of this relative orientation throughout the manufacturing process permits continuous monitoring of the positions of those beam lead devices which have failed electrical tests. Secondly, inasmuch as the leads of the beam lead devices may be ultimately bonded to a patterned array of thin film contact areas on a ceramic wafer or substrate for eventual use in electrical circuits, these leads should be maintained in a predetermined orientation relative to the thin film contact area arrays until the mutual bonding is effected. In the event that this orientation is lost, the beam lead devices must be handled individually and optically oriented under a microscope before bonding to the thin film contact area array.

It is clear from the foregoing that the efficient handling in the manner described of microminiature electrical devices, particularly of the beam lead type, is quite a difficult problem which simply has not been solved by the prior art. The present invention provides an eminently satisfactory solution to this problem.

SUMMARY OF THE INVENTION

One of the objects of this invention is to provide improved apparatus for handling an array or matrix of miniature articles.

Another of the objects of this invention is to provide improved apparatus for handling an array or matrix of closely spaced mircominiature electrical devices in fixed predetermined orientation.

Other and further objects of this invention will become apparent during the course of the following description and by reference to the accompanying drawings and appended claims.

Briefly, and with particular reference to the handling of a matrix of microminiature beam lead devices formed from a semiconductor slice and mounted to a plate by means of a soluble adhesive, we have discovered that the foregoing objects may be attained by placing a grid over the matrix whereby the beam leads are sandwiched between the grid and the plate and are thus captured, drawing the grid-matrix-plate assembly onto a first chuck which will maintain the orientation of the several beam lead devices of the matrix during subsequent solution of the soluble adhesive, removing the plate from the grid-matrix-plate assembly after solution of the soluble adhesive, transferring the grid-matrix assembly from the first chuck to a second chuck, and removing the grid while the second chuck maintains the orientation of the several beam lead devices of the matrix. Afterwards, the matrix may be expanded. We have also discovered that the foregoing objects may further be attained by providing improved chuck construction as hereinafter disclosed.

BRIEF DESCRIPTION OF THE DRAWINGS

Referring now to the drawings, in which like numerals represent like parts in the several views:

FIG. 1 represents a flow diagram of various principal steps in the method of the invention, the first two steps which are representative of certain conventional practices being included to provide the present invention in a readily understandable frame of reference;

FIG. 2 represents diagrammatically a partial view in elevation showing a semiconductor slice or wafer, prepared in an appropriate and conventional manner with a plurality of sets of interlaced beam leads adhered to a plate by means of a soluble adhesive, the individual beam lead devices subsequently to be prepared from the semiconductor slice being indicated by phantom lines;

FIG. 3 represents diagrammatically a partial view in elevation generally similar to FIG. 2 and shows the matrix of individual beam lead devices formed after particulation in a conventional manner of the parent semiconductor slice or wafer;

FIG. 4 represents diagrammatically a partial view in plan showing the matrix of individual beam lead devices formed after particulation of the parent semiconductor slice or wafer;

FIG. 5 represents diagrammatically a partial view in plan showing the grid in position over the matrix of beam lead devices;

FIG. 6 represents a vertical view partially in section, showing the grid-matrix-plate assembly drawn onto a first chuck, the view of the first chuck being partially

broken away to show certain details of construction, further showing two of several spring clips holding the grid-matrix-plate assembly to the first chuck during one phase of the operation;

FIG. 7 represents a partial view in plan, as seen from the line 7—7 of FIG. 6, showing the offset of the perforations in the bottom of the first chuck relative to the matrix of beam lead devices;

FIG. 8 represents a view similar to FIG. 7 showing on a larger scale one of the perforations in the bottom of the first chuck offset with respect to one of the beam lead devices of the matrix;

FIG. 9 represents a vertical diagrammatic view, partially in section, of the second chuck receiving the grid-matrix assembly from the first chuck;

FIG. 10 represents a partial view in elevation showing one embodiment of second chuck holding the matrix of beam lead devices, the first chuck and grid having been removed, and the matrix of individual beam lead devices now ready for expansion;

FIG. 11 represents an enlarged perspective view of a variation of the embodiment of second chuck shown in FIG. 10, partially broken away to show certain details in construction.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Semiconductor slice or wafer 1 which, by known techniques such as diffusion or doping, has been provided with a grid-like pattern of electrically pertinent areas and which also by known techniques has been provided with a plurality of sets of interlaced beam leads 2, each set of beam leads 2 being associated with one of the electrically pertinent areas, is conventionally cemented to plate 3 by means of a soluble adhesive 4, as shown in FIG. 2. A composition which has been found to function satisfactorily as an adhesive, for the purposes of this invention, is a hydrocarbon product sold under the trademark "Biwax" (Biwax Corporation, Des Plaines, Illinois), and a suitable solvent for this composition has been found to be trichlorethylene. The film of adhesive 4 is shown only diagrammatically in the drawings, it being understood that beam leads 2 are usually fully embedded in the adhesive 4, the said adhesive 4 contacting the bottom of semiconductor slice 1.

Semiconductor slice or wafer 1 is then particulated or subdivided by suitable conventional means and methods such as chemical etching to produce a matrix 5 of individual beam lead devices 6 cemented to plate 3 through the soluble adhesive 4, the individual beam lead devices 6 being separated from each other by channels 7 as shown in FIGS. 3 and 4. It will be apparent that the relative orientation of beam lead devices 6 remain the same, after particulation, as their originating electrically pertinent areas of the parent semiconductor slice 1. Particulation of semiconductor slice 1 may, if desired, extend to particulation of the film or layer of soluble adhesive 4.

Thus far has been described, very generally, operations which are known and practiced in the art, whereby a matrix of individual beam lead devices are produced from a semiconductor slice mounted to a plate by means of a soluble adhesive. The matrix of cemented beam lead devices is, at this point, ready for the application of the method of the present invention.

Grid 8, designed to register with channels 7, is positioned over matrix 5 and inserted into the said channels 7 to sandwich or capture the interlaced beam leads 2 between the grid 8 and the plate 3, as shown in FIG. 5. The height of grid 8 should be such as not to project above the tops of beam lead devices 6 when fully seated in channels 7. The grid 8, matrix 5 of beam lead devices 6 and plate 3, when brought into juxtaposition as just described, may for convenience be termed the grid-matrix-plate assembly 9.

Grid-matrix-plate assembly 9 is now drawn onto a first chuck 10, as shown in FIG. 6. First chuck 10 comprises cylindrical housing 11 having chamber 12 therein, a peripheral flange 13 at one end of the housing 11, light-pervious (i.e., transparent or translucent) plate 14 of suitable material mounted to that end of housing 11 adjacent flange 13, and a transparent plate 15 of suitable material mounted to the opposite end of housing 11. Plate 14 is provided with a grid of apertures 16 extending therethrough having the same spacing as the beam lead devices 6 in matrix 5. Apertures 16 are slightly smaller than the beam lead devices 6, as shown in FIG. 7. Housing 11 is further provided with a valved conduit 17 adapted to communicate with a source of vacuum (not shown), and with a valved conduit 18 for a purpose hereinafter to be described.

In drawing the grid-matrix-plate assembly 9 onto the first chuck 10, the assembly 9 is viewed through plates 14 and 15, a slight separation between assembly 9 and plate 14 being maintained to permit adjustment of their relative positions. Assembly 9 is thus moved to such a position relative to apertures 16 that the said apertures 16 are slightly offset from the beam lead devices 6 as more particularly shown in FIG. 7, during all of which time vacuum is applied to chamber 12 through conduit 17. When the positioning shown in FIG. 7 has been attained, beam lead devices 6 are allowed to contact plate 14, the vacuum in chamber 12 maintaining the offset position shown in FIG. 7, grid 8 now being sandwiched or interposed between beam leads 2 and plate 14. Fastening means 19, which may, for example, constitute spring clips as shown in FIG. 6, are spaced around first chuck 10 and the grid-matrix-plate assembly 9, engaging one side of plate 3 and flange 13 as shown, to hold the assembly 9 securely in position in first chuck 10. Conduit 17 may now be disconnected from the source of vacuum.

As more particularly shown in FIG. 8, small passageways 20 extend through each aperture 16 of plate 14 bounded by beam lead devices 6, grid 8, and beam leads 2. In this manner, communication is effected between chamber 12 and the film of soluble adhesive 4 on plate 3 for a purpose to be described.

A solvent capable of dissolving adhesive 4 is introduced into chamber 12 through conduit 18. Conduit 17 being closed by a valve (not shown) and thus disconnected from the source of vacuum, the solvent passes from chamber 12 through apertures 16 in plate 14 out through passageways 20 into contact with adhesive 4, whereupon the adhesive 4 is dissolved. The solvent, with dissolved adhesive 4, may drain into a suitable receptacle (not shown). If desired, one of the conduits 17 or 18 may be connected alternately to a source of vacuum and to a source of solvent in which event the other of said conduits 17 or 18 may be dispensed with.

After solution of adhesive 4, conduit 18 is closed by a valve (not shown) thus disconnecting chamber 12

from the source of solvent, and conduit 17 is again connected to the source of vacuum. Fastening means 19 are now removed from the first chuck 10 and the grid-matrix-plate assembly 9. Plate 3 is removed from contact with beam leads 2, the vacuum in chamber 12 acting through apertures 16 against the matrix 5 of beam lead devices 6 and thereby holding matrix 5 against first chuck 10 in the proper orientation, grid 8 remaining sandwiched or interposed between plate 14 of first chuck 10 and the beam leads 2. The grid 8 and matrix 5 in juxtaposition may, for convenience, be termed the grid-matrix assembly 21. It may be desirable, in this phase of operation, to tilt first chuck 10 and grid-matrix assembly 21 approximately 180° from the position shown in FIG. 6 particularly where the weight of grid 8 is such that the vacuum in first chuck 10 cannot hold the grid-matrix assembly 1 in the position shown in FIG. 6, or where the weight of grid 8 when directly bearing on beam leads 2 might damage the said beam leads 2.

As an alternative to introducing solvent into chamber 12, after disconnecting chamber 12 from the source of vacuum, the solvent may be applied externally to adhesive 4 simply by dipping the grid-matrix-plate assembly 9, held as hereinbefore described to first chuck 10 by fastening means 19, in a container of solvent. This would eliminate the previously described operation of relatively offsetting apertures 16 and beam lead devices 6. As a further alternative, the vacuum source need not be disconnected from chamber 12 and the solvent externally applied as just described; in addition to eliminating the previously described operation of relatively offsetting apertures 16 and beam lead devices 6, this further alternative would eliminate the need for fastening devices 19.

In the phase of operation above described (viz., solution of the adhesive 4 by means of a solvent to free plate 3), beam lead devices 6 might tend to move or float on a capillary film of solvent between the said beam lead devices 6 and plate 14. Grid 8, nesting in channels 7, positively prevents such motion which otherwise might result in disorientation of the beam lead devices 6.

In any event, with the grid-matrix assembly 21 held to first chuck 10 by means of vacuum, grid 8 being interposed between beam leads 2 of matrix 5 and plate 14, the next step in the method of the present invention is to transfer grid-matrix assembly 21 to a second chuck 22 in such manner that beam leads 2 are interposed between grid 8 and the second chuck 22. Thus, when the second chuck 22 has engaged and holds matrix 5, the first chuck 10 can be disconnected from the source of vacuum and removed from the grid-matrix assembly 21.

One embodiment of second chuck 22 comprises a block 23 of porous material, such as foamed plastic, one side 24 of which engages beam leads 2, the opposite side 25 thereof being subjected to a vacuum by suitable means known to the art.

Such means may, for example, comprise open mouthed bell 26 with flange 27 closely fitted to block 23, the said bell 26 having a chamber 28 communicating with side 25 of block 23, and with conduit 29 communicating between chamber 28 and a source of vacuum (not shown). The applied vacuum is exercized through the porous block 23 to hold to side 24 thereof the individual beam lead devices 6 of the matrix 5 in fixed and known orientation.

Another embodiment of second chuck 22 comprises a magnetized block attracting grid 8 which, in this embodiment, has been formed from suitable magnetic material. Thus, beam leads 2 will be sandwiched between grid 8 and the magnetized block.

Yet another embodiment of second chuck 22 comprises a porous magnetized block (formed of such material as sintered nickel) functioning as both embodiments of second chuck 22 hereinabove described. Thus, the block will attract this magnetic grid 8 to sandwich beam leads 2 between the grid 8 and the block and, also, a vacuum applied to one side of the block will be exercized through the porous block body to hold to the opposite side of the block the individual beam lead devices 6 of the matrix 5.

Still other embodiments of second chuck 22 are shown in FIGS. 10 and 11 and may employ the effects of vacuum and/or magnetism to hold the grid-matrix assembly 21. The embodiment of second chuck 22 shown in FIG. 10 comprises a magnetic block 30 having thereon a matrix of mesas 31 in the same geometrical arrangement as the matrix 5 of beam lead devices 6, there being a grid of channels 32 among the mesas 31. Magnetic block 30 attracts magnetic grid 8 thereby sandwiching beam leads 2 between grid 8 and the tops of mesas 31. In the variation of embodiment shown in FIG. 11, apertures 33 extend entirely through nonmagnetic block 30 from the rear face 34 thereof to the tops of the mesas 31; upon application of vacuum by suitable means (such as the open-mouthed bell 26 and conduit 28 shown in FIG. 9) to the rear face 34 of the block 30, the matrix 5 of beam lead devices 6 will be held fast to the tops of mesas 31. In yet another variation of embodiment, combining the features shown in FIGS. 10 and 11, block 30 is both magnetic, thus attracting magnetic grid 8, and has apertures 33 for the application of vacuum to the beam lead devices 6 as hereinabove described, whereby the matrix 5 is held fast in proper orientation.

With the matrix 5 held on any of the embodiments of second chuck 22 hereinabove described, further additions of solvent may be applied to remove all traces of adhesive 4 which may remain on beam leads 2. A particular advantage of the embodiments of second chuck 22 shown in FIGS. 10 and 11 resides in the presence of channels 32. The interlaced beam leads 2 of the beam lead devices 6 extend over channels 32. Solvent, forced through the channels 32, will more efficiently remove the remaining traces of adhesive 4 from the beam leads 2. The beam lead devices 6 may then, if desired, be washed and dried.

Grid 8 may now be lifted out of channels 7 in matrix 5.

Matrix 5 may then be expanded (i.e., the beam leads 2 of adjacent beam lead devices 6 are removed from interlaced relationship) thereby to permit the individual beam lead devices 6 to easily be separated from the matrix 5 for further processing in the manufacturing operation.

It will be apparent, from all of the foregoing, that the apparatus of the present invention maintains all of the beam lead devices 6 in known and constant orientation from the particulation of semiconductor slice 1 up to and including the expansion of matrix 5.

What is claimed is:

1. Apparatus for holding a matrix of articles to be washed by a fluid, said apparatus comprising:
a. a housing, one end of said housing having a pattern of apertures extending therethrough, said end being adapted to engage said matrix of articles,
b. a chamber within said housing and adapted to communicate with said matrix of articles through said pattern of apertures,
c. conduit means communicating between said chamber and a source of vacuum to hold said matrix of articles in contact with the apertured end of said housing or selectively communicating between said chamber and a source of fluid to wash said matrix of articles through said pattern of apertures.

2. Apparatus as in claim 1, said apertures being smaller than said articles.

3. Apparatus as in claim 1, further comprising:
d. fastening means on said housing adapted to hold said matrix of articles in contact with the apertured end of said housing when said conduit means has been disconnected from said source of vacuum.

4. Apparatus for holding a matrix of articles to be washed by a fluid, said apparatus comprising:
a. a housing having a first end and a second end,
b. a first transparent plate mounted to the first end of said housing,
c. a second light-pervious plate mounted to the second end of said housing, said second plate having a pattern of apertures extending completely therethrough and adapted to correspond with said matrix of articles, said second plate being adapted to engage said matrix of articles,
d. a chamber within said housing between said first and second plates and adapted to communicate with said matrix of articles through said pattern of apertures,
e. conduit means communicating between said chamber and a source of vacuum to hold said matrix of articles in contact with said second plate or selectively communicating between said chamber and a source of fluid to wash said matrix of articles through said pattern of apertures,
f. said first transparent plate and said second light-pervious plate providing an optical path adapted to permit visual comparison of the relative positions of the matrix of articles and the pattern of apertures.

5. Apparatus as in claim 4, said apertures being smaller than said articles.

6. Apparatus as in claim 4, further comprising:
g. fastening means on said housing adapted to hold said matrix of articles in contact with said second plate when said conduit means has been disconnected from said source of vacuum.

7. Apparatus for holding a planar matrix of beam lead devices to be washed by a fluid, each of said beam lead devices having a plurality of beam leads extending beyond the perimeter thereof, said apparatus comprising:
a. a block,
b. a pattern of mesas extending from one face of said block, the tops of said mesas lying in one common plane, the pattern of mesas being adapted to register with and support the matrix of beam lead devices,
c. a pattern of channels among said mesas and adapted to underly said beam leads when said matrix of beam lead devices is registered with and supported by said pattern of mesas,
d. said pattern of channels providing passageways for fluid to wash said beam lead devices,
e. a plurality of apertures extending through said block to the faces of said mesas,
f. means to apply a vacuum to said apertures to hold said matrix of beam lead devices to the faces of said mesas.

8. Apparatus as in claim 7, further comprising:
g. said block and mesas being formed from magnetic material,
h. a magnetic grid adapted to be attracted by said magnetic block and mesas, said magnetic grid being adapted to register with said pattern of channels and overly said beam leads extending over said pattern of channels.

9. Apparatus for holding a planar matrix of beam lead devices to be washed by a fluid, each of said beam lead devices having a plurality of beam leads extending beyond the perimeter thereof, said apparatus comprising:
a. a block,
b. a pattern of mesas extending from one face of said block, the tops of said mesas lying in one common plane, the pattern of mesas being adapted to register with and support the matrix of beam lead devices,
c. said block and mesas being formed from magnetic material,
d. a pattern of channels among said mesas and adapted to underly said beam leads when said matrix of beam lead devices is registered with and supported by said pattern of mesas,
e. said pattern of channels providing passageways for fluid to wash said beam lead devices,
f. a magnetic grid adapted to be attracted by said magnetic block and mesas, said magnetic grid being adapted to register with said pattern of channels and overly said beam leads extending over said pattern of channels.

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