United States Patent

[11] **3,590,462**

[72] Inventor **Jaroslav Mracek**
Trenton, N.J.

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[73] Assignee **Western Electric Company, Incorporated**
New York, N.Y.

[54] **METHOD AND APPARATUS FOR EXPANDING AN ARRAY OF ARTICLES**
16 Claims, 14 Drawing Figs.

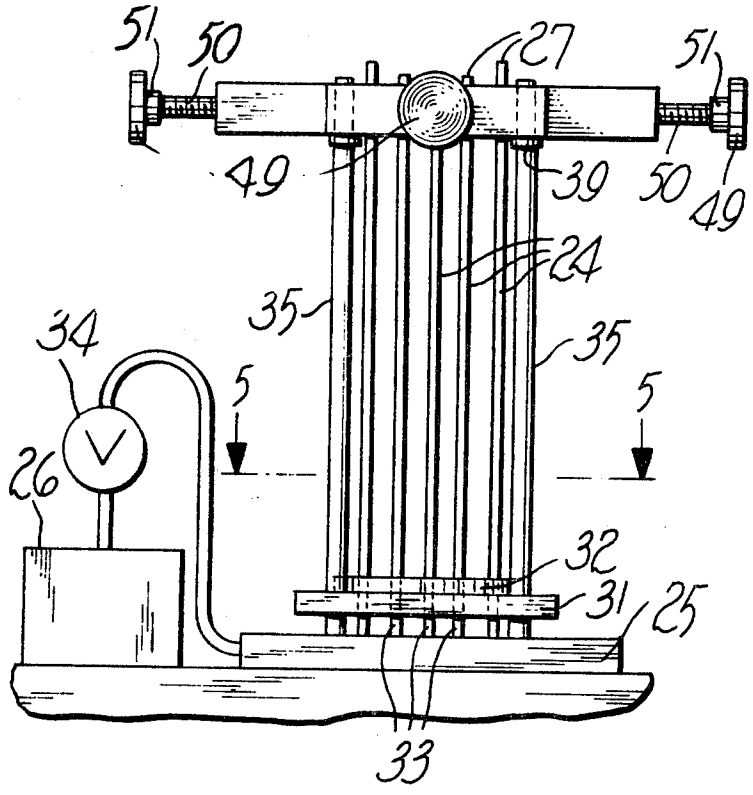
[52] **U.S. Cl.** **29/400,**
29/200, 29/203, 29/413, 29/423, 29/464
[51] **Int. Cl.** **B23p 17/00,**
B23p 19/00, B23q 3/00
[50] **Field of Search** 29/200, 200
D, 200 J, 200 P, 203 V, 421, 413, 400, 464, 423

[56] **References Cited**
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Primary Examiner—Thomas H. Eager
Attorneys—H. J. Winegar, R. P. Miller and W. M. Kain

ABSTRACT: A method and apparatus are provided for expanding a compact array of beam lead devices in such a manner as to maintain original relative orientation between the devices, thus permitting the easy removal of the devices from the expanded array. The devices are initially held by a vacuum on the ends of a compacted, flexed, array of tubes which are subsequently spread apart, either in groups or simultaneously, into an expanded configuration.



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SHEET 1 OF 2

FIG-1

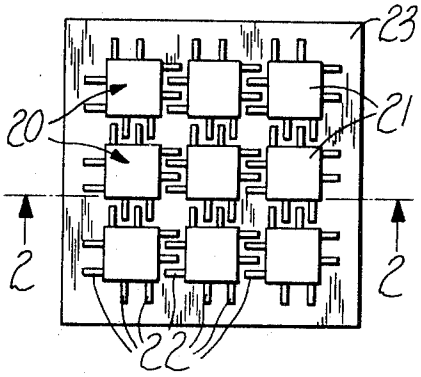


FIG-2

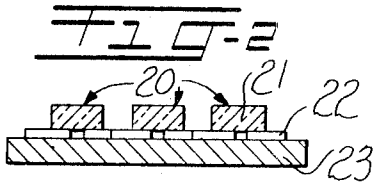
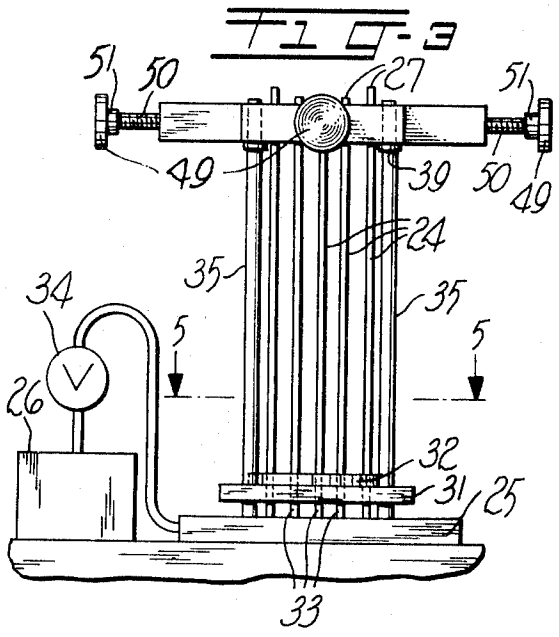


FIG-3



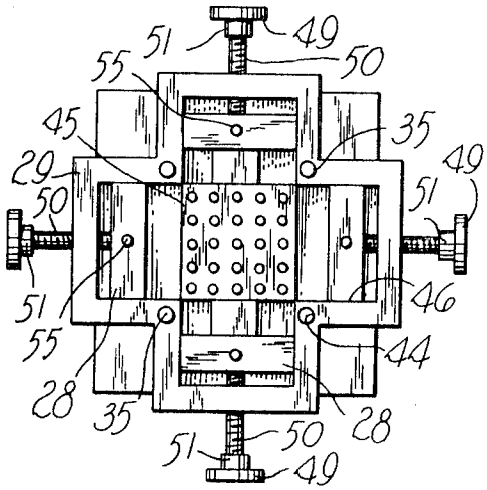


FIG-4

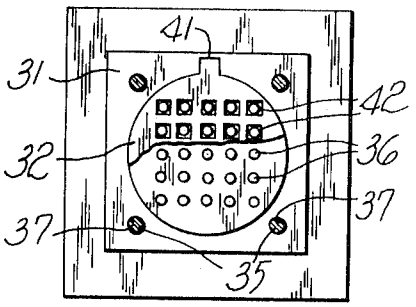


FIG-5

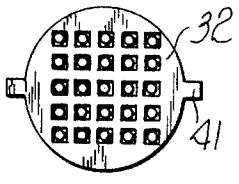


FIG-6

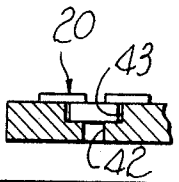


FIG-7

INVENTOR
J. MRACEK

BY R. P. Miller

ATTORNEY

FIG-8

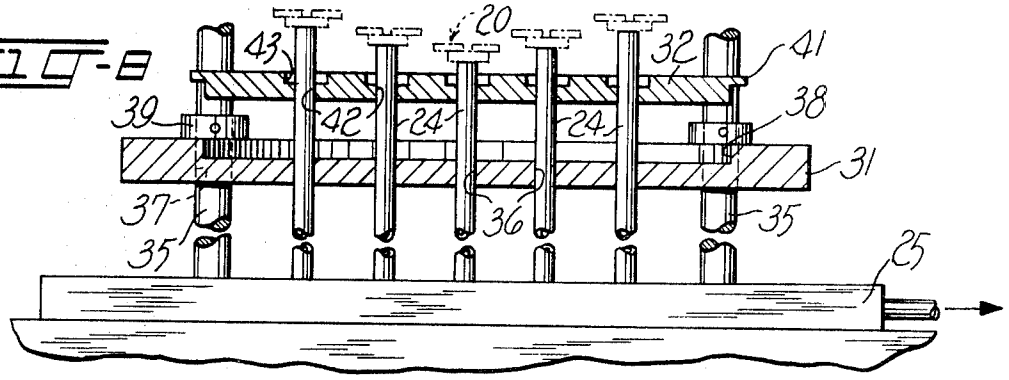


FIG-9

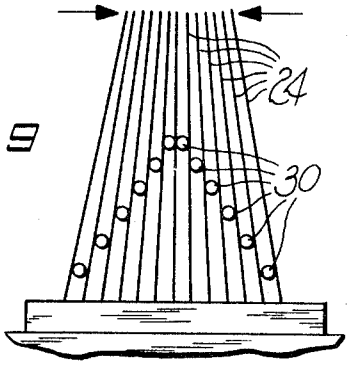


FIG-10

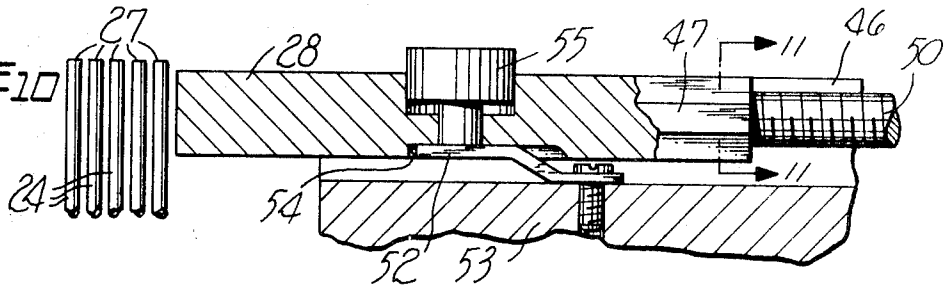
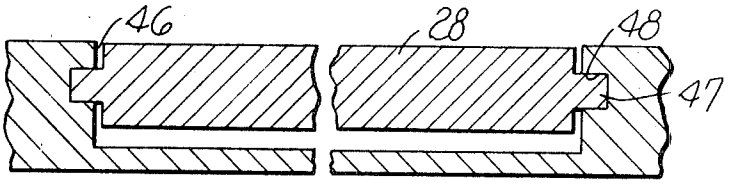


FIG-11



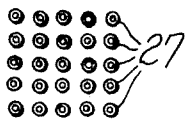


FIG-12

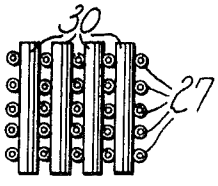


FIG-13

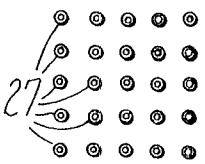


FIG-14

METHOD AND APPARATUS FOR EXPANDING AN ARRAY OF ARTICLES

BACKGROUND OF THE INVENTION 1. Field of the Invention

This invention relates methods and apparatus for expanding a compact array of articles more particularly, to a compacted bundle of tubes on which articles are held by a vacuum as the tubes are moved apart into an expanded array where the devices may be removed individually or in unison.

2. Technical Considerations and Prior Art

In many manufacturing processes articles are often formed in very compact arrays, hence, it is often necessary to separate or expand groups of articles to facilitate picking up of articles for use in assembly operations. Further, it is often desirable to remove or relocate these articles while maintaining the orientation of the articles. In order to maintain quality control of an article during various manufacturing steps, it is necessary to be able to relate the present location of an article in a group with respect to a previous location of that article, during a previous manufacturing step.

One such manufacturing process involves the separation and expansion of an array of solid state devices, known as beam lead devices, which are made from a particulated semiconductor slice so that these devices can be handled and bonded to thin film contact areas on a ceramic wafer. During the manufacture of beam lead devices, metal is deposited on at least one face of the semiconductor slice, which has an array of doped areas. The metal is etched to form a multitude of fragile, interleaved beam leads whereafter the wafer is particulated to provide a coordinate array of minute, beam lead devices. This process may be carried out in accordance with the techniques disclosed in the M. P. Lepselter Pat. No. 3,287,612 filed Dec. 17, 1963. Removing these closely located devices with interleaved beam leads while maintaining their original relative orientation and without bending the interleaved leads of adjacent devices present many problems.

If the interleaved leads of adjacent devices touch during separation, causing the minute devices to become randomly disassociated, it is necessary to manually pick up the devices one at a time and reorient them with the aid of a microscope. In addition, excessive handling of the beam lead devices may bend the leads, contaminate, break or otherwise render the devices useless. Further, it is advantageous to handle these extremely small, closely spaced devices in a single batch for as long as possible.

One method of expanding a compact array of small articles using a porous, stretchable, wafer-supporting diaphragm is described in copending application entitled "Method of and Apparatus for Separating Adjacent Objects Initially arranged in a Compact Planar Array," Ser. No. 551,709 filed May 20, 1966, by J. R. Bippus et al., abandoned after filing on Jan. 10, 1968 continuation-in-part application Ser. No. 696,873, now Pat. No. 3,448,510, granted June 10, 1969. The diaphragm, supporting the particulated wafer, is stretched producing a separation of the adjacent articles while maintaining the relative positions of the articles.

It is advantageous to provide facilities for supporting a compact matrix or array of articles which can be utilized to expand the array of articles without disturbing the relative orientation between the articles. Further, in some instances, it would be desirable to provide such a system without reliance on the elasticity, porosity and hygroscopic characteristics of a diaphragm. The facilities should also produce consistent expanded arrays of articles so that the articles can readily be utilized in automated processes.

SUMMARY OF THE INVENTION

It is an object of this invention to provide new and improved methods and apparatus for expanding arrays of articles. A further object of this invention is to provide a new and improved method and apparatus for separating minute devices, which are originally arranged in a compact planar array, such that the separated devices retain the same relative positions after separation as before separation but in an expanded form.

Another object is to separate beam lead devices without the interlaced, fragile leads touching, thus avoiding damage and disruption of the orientation of the devices.

It is an additional object of this invention to provide a method of separating devices that are initially arranged in a compact matrix without materially altering the initial positional relationships between the devices and then removing the devices, in a predetermined orientation, to facilitate immediate use or packaging for future use.

With these and other objects in view, the present invention contemplates placing a compact matrix or array of articles on the ends of a compact array of flexible tubes. The pattern of the ends of the tubes is arranged to correspond to the articles in the matrix. A vacuum may be applied to the tubes, thereby holding the articles on the tube ends. The compact array of tube ends may be expanded in one embodiment of the invention by inserting metal rods between rows of tubes and moving the rods towards the tube ends to flex the tubes. This procedure will separate the matrix of articles into expanded rows. A spreader plate or other rods may then be moved upwards along the length of the tubes to further flex the tubes, and complete the expansion of the matrix of articles.

When the articles to be separated are beam lead devices of the type disclosed in the previously identified Lepselter patent, the devices are separated into columns and then the devices in each column are separated into rows so that the interleaved fragile leads of the devices will not make contact and proper orientation will be maintained.

When the array of tubes is expanded, the articles are positioned to define a concave surface. A multiapertured tray may be now moved along the tubes toward the articles, whereupon the tray initially contacts the center device or devices and then successive surrounding groups until all the devices have been picked up. This will preclude the necessity of breaking the total vacuum instantaneously thereby requiring less force and a smoother upward motion of the tray. The devices are removed in a single batch, in an expanded orientation, ready to be packaged or used in manufacturing processes.

BRIEF DESCRIPTION OF THE DRAWINGS

A more comprehensive understanding of the invention may be had by considering the following drawings in conjunction with the detailed description, wherein:

FIG. 1 is a plan view of a compact array of beam lead devices bonded to a carrier;

FIG. 2 is a cross-sectional view of FIG. 1 taken along line 2–2 showing a row of devices on the carrier;

FIG. 3 is a side-elevational view of a beam lead matrix expander which includes the features and principles of the invention;

FIG. 4 is a plan view of the beam lead matrix expander particularly showing facilities for compacting an expanded array of tubes to which vacuum is then applied to hold an array of beam lead devices;

FIG. 5 is a cross-sectional view of FIG. 3 taken along line 5–5 showing a spreader plate and a portion of a tray for receiving an expanded array of the beam lead devices;

FIG. 6 shows a plan view of the tray;

FIG. 7 shows a cross-sectional view of one beam lead device seated in depression about a hole in the tray;

FIG. 8 is a partial side elevation of the beam lead matrix expander showing the tubes expanded and the tray about to pick up the beam lead devices;

FIG. 9 is a schematic side elevation of the tubes with the first tube ends compacted to define a planar surface together with spreader rods inserted between rows of tubes;

FIG. 10 is an enlarged cross-sectional view of a slide and an associated leaf spring mounted in the frame;

FIG. 11 is a partial cross-sectional view of FIG. 10 taken along line 11-11 showing a tongue and groove mounting for the slide in the frame;

FIG. 12 is a plan view of a compact array of tube ends;

FIG. 13 is a plan view of expanded rows of tube ends with a spreader rod shown between two of the rods and

FIG. 14 is a plan view of a fully expanded array of rows and columns of tube ends.

DETAILED DESCRIPTION OF THE DRAWINGS

In order to illustrate and explain the principles and features of the invention, the description will refer to the manufacture, expansion, handling and transfer of arrays of beam lead devices of the type disclosed in afore identified patent to M. P. Lepselter. It is to be understood that arrays of other types of articles and workpieces may be advantageously expanded, handled and transferred by utilization of the invention.

In the manufacture of beam lead devices **20** (see FIGS. 1 & 2) having a body **21** and attached beam leads **22**, a large number of small devices are produced from a single slice (not shown) of semiconductor material such as silicon. Impurites or dopants for active elements are diffused, in sequence, at a plurality of selected locations, in a regular, compact, patterned array, over the surface of the slice. Usually the devices **20** are formed in a matrix or gridlike array with uniformly spaced rows and columns. A film of electrically conductive material, such as gold, is deposited on the slice over the doped active locations and then selectively eroded or etched to form the leads **22** for the devices **20**. The resultant leads **22** may be interleaved, as shown in FIG. **1**, in order to form a more compact array of devices **20** thereby producing more devices for a given surface area of slice material. The slice is temporarily bonded by wax or other releasable cement to a carrier or base plate **23** and the devices **20** separated from one another by etching or micromachining techniques leaving the interleaved leads **22** projecting from each device in cantilevered fashion.

Considering first the apparatus in general for separating the array of devices **20** into an expanded array and referring to FIG. **3**, there is shown a plurality of spaced, flexible tubes or rods **24** arranged in a bundle and attached to a base manifold **25** which is connected to a vacuum source **26**. First or upper ends **27** of the tubes **24** are compressed by moving together pairs of oppositely disposed slides **28** (see FIG. 4) mounted in a frame **29** located about the first tube ends. A carrier **23** is inverted and the wax bonded array of beam lead devices **20** (see FIG. **1**) to be expanded is placed on first ends **27** of tubes **24** and held in place by a vacuum applied to the tubes from source **26**. The wax is melted or dissolved to release the wax bond between the carrier and the devices, whereafter the carrier **23** is removed. The first tube ends **27** are then moved outwardly by placing rods **30** (see FIGS. **9** & **13**) between rows of tubes **24** and moving the rods upwardly thus separating the first tube ends **27** into a plurality of parallel rows with the devices **20** attached thereto. The separation of the devices **20** is completed by advancing an apertured spreader plate **31** (see FIGS. **3** & **8**) toward the first tube ends **27**. The spreader plate **31** (see FIGS. **3**, **5** & **8**) supports and moves an apertured tray **32** which is moved into position to receive the devices **20**. The first ends **27** are of different The frame **29** is removed from the apparatus and the tray **20** is moved past the first tube ends **27** to pick up the devices **20** in their expanded orientation.

Considering now the apparatus in greater detail, the plurality of flexible tubes **24**, preferably made of stainless steel, have their first ends **27** free as shown in FIGS. **3** & **4**. The tubes **24** are arranged in rows and columns to correspond to the pattern of devices **20**. The first ends **27** are of different lengths, those tubes **24** about the periphery of the bundle being longer than those about the center so as to define a concave or dished shaped surface in the expanded, unflexed condition as best illustrated in FIG. **8**. Second ends **33** of the tubes are fixedly secured, in a spaced array to the manifold base **25**. The manifold base **25** is connected through a valve **34** to the vacuum source **26**. The base manifold **25** also supports four columns or guide rods **35** which are located about and parallel to the bundle of tubes **24** (see FIGS. **3** & **4**).

The spreader plate **31** (see FIG. **5**) is slidable mounted on the columns **35**. This spreader plate **31** is substantially flat with a multitude of apertures or holes **36** drilled or otherwise formed therein to slidably receive the tubes **24**. The apertures **36** are arranged with the same spacing as the spacing between the second ends **33** of the tubes. Located near the periphery of the spreader plate **31** is a group of four guide holes **37** through which protrude the columns **35**. A central section of the spreader plate **31** has a circular indentation or depression **38** (see FIG. **8**) in which the apertures **36** are formed. The spreader plate **31** may be slidably moved along the tubes **24**, guided by the columns **35**. Movement of the spreader plate **31** is limited in its lower travel by the base **25** and in its upper travel by adjustable stops **39** located on and near the free ends of the columns **35** but below the height of first tube ends **27**.

The spreader plate **31** provides support for the tray **32** which is flat and disc shaped. The tray has two lifting tabs **41** diametrically opposed on the perimeter of the tray (see FIGS. **5** & **6**) to overly the spreader plate **31**. Tray **32** is removably seated in the depression **38** of the spreader plate **31** and has a multitude of holes or apertures **42** corresponding to and aligned with apertures **36** of the spreader plate. Located about each tray hole **42** (see FIG. **7**) is a slight depression or indentation **43** having a shape similar to the body **21** of a device **20**. Tray **32** rests on the spreader plate **31** and will follow the motion of the spreader plate until lifted by the tabs **41** from the spreader plate.

The frame **29**, cruciform in shape, is provided with guide apertures **44** into which project the ends of columns **35**. The frame **29** is slidably mounted on the columns **35** and is supported by bearing against the stops **39**. The frame **29** has a centrally located, square-shaped opening **45** through which project the first tube ends **27** (see FIGS. **3** & **4**). Guideways **46** are machined in the cross arms of frame **29** (see FIGS. **4** & **11**). Slidably mounted within the guideways **46** are flat slides **28**. The slides have a pair of oppositely disposed tongues **47** (see FIG. **11**) on the sides to slidably fit into grooves **48** located in the sides of guideways **46**. The slides **28** may be advanced inwardly to deflect the first tube ends **27** by turning knobs **49** connected to screws **50** mounted in threaded bores formed in outer sections of the frame **29**. When the four slides **28** have reached their maximum inward travel, limited by bosses **51** on the screws **50**, four leaf springs **52**, secured to the bottom plates **53** of the frame **29**, snap into slots or indentations **54** formed in the underside of the slides, thus locking the slides in place (see FIG. **10**).

If the screws **50** are backed away from slides **28**, the leaf springs **52** will hold the slides in the locked positions. To unlock the slides **28** spring release buttons **55** slidably mounted in holes formed in the individual slides, are depressed forcing the end of the leaf springs **52** out of slots **54**. The slides **28** are still retained in the inward positions because the leaf springs are selected to be strong enough to exert a frictional force on the undersides of the slides **28** to overcome the forces exerted by the deflected first tube ends **27** adjacent the inner vertical surfaces of the slides.

The spreader rods **30**, made of round stock, are provided to be inserted between rows of tubes **24** (see FIGS. **9** & **13**) near the second tube ends **33** but above the spreader plate **31**. The rods **30** are moved upwardly; sequentially, the center rod is advanced first dividing the first tube ends **27** into two groups. A rod **30** adjacent to the center rod is now moved upwardly and the sequence of moving the rods upwardly proceeds by moving each succeeding rod in one group and then moving each succeeding rod in the other group. The movement of the center rod against the entire bundle of rods insures that a maximum reaction holding force will be exerted on this rod while the remaining rods are moved to the upper position. This procedure results in moving of the ends **27** from the positions illustrated in FIG. **12** to the positions showed in FIG. **13**.

In practice of the invention, with the tube ends 27 expanded (see FIGS. 3 & 4) and the frame 29 is removed, the spreader plate 31 supporting a tray 32 is moved down along the columns 35 and positioned about the second tube ends 33. The frame 29 is replaced, with guide apertures 44 about the columns 35 and the underside of the frame resting against stops 39. The knobs 50 are turned to advance the screws 49 which contact and urge slides 28 inwardly against first tube ends 27. The lengths of the tubes 24 are selected to be successively decreasing height, running from the periphery of the bundle of the tubes 24 toward the center so as to form a compact planar array of first tube ends 27 upon being forced together by the advancing slides 28. The slides 28 will be locked in place at the maximum inward positions by the lead springs 52 seated in the slots 54. Screws 49 are then withdrawn to the outward end of the guideways 46.

A compact planar array of beam lead devices 20, bonded to the carrier 23 with wax, cellulose nitrate cement or similar type material, is positioned over the first tube ends 27 with each device 20 being seated on one tube end. The vacuum source 26 is applied by opening the valve 34 to impart a holding force to each device 20. The devices 20 are then released from the carrier 23 by spraying acetone or other appropriate solvent to dissolve the bond between the carrier and the devices. The carrier 23 is removed and the devices 20 are held in place by the vacuum applied to the tubes 24 through the base manifold 25.

In the alternative, the beam leaded devices may be fabricated on a pressure sensitive carrier of silicone rubber in the manner disclosed in copending application to W. P. Wanesky Ser. No. 729,859 filed Apr. 10, 1968. In this instance, the carrier is placed over the tube ends 27 and the devices are vacuum held on the ends of the tubes 24. The silicone rubber carrier is then peeled away from the devices to leave the devices vacuum held on the ends of the tubes.

With the devices 20 firmly held to the first tube ends 27 by the suction of vacuum source 26, the spreader rods 30 are inserted between rows of tubes 24 and release buttons 55 are depressed to release slides 28 for outward movement when a sufficient outward force is applied. The rods 30 are successively drawn upwardly with the center rod first, then an adjacent rod until one half of the first tube ends 27 are separated into rows, then the sequence is repeated for the other half of the first tube ends (see FIG. 9). As the rods 30 are moved up sufficient force is applied through the flexed rods to overcome the frictional drag exerted by leaf springs 52 on the bottom of slides 28, thus the slides are moved outwardly along the guideways 46. The devices 20 move apart in rows (see positions of FIGS. 12 and 13 for the movement of the first tube ends) withdrawing the interleaved beam leads 22 without touching. Upon complete separation of the rows to the expanded position the spreader rods 30 are removed. At this time, the opposed beam leads 22 extending toward separated rows are spaced from each other.

Upon separation of the matrix of the first tube ends into spaced rows, the spreader plate 31 is moved towards the devices vacuum held on first tube ends 27. As the spreader plate 31 travels upwardly, the columns of tubes 24 are flexed to move the first tube ends (see FIG. 14) and the vacuum held devices into the expanded array. Again, as the tubes are flexed, beam leads 22 are moved from the initial interleaved relation without making contact with the beam leads of adjacent devices. Upon completion of the expansion of the array of articles, the spacings between adjacent articles is in the same ratio as existed between adjacent articles in the initial, compact array.

When the spreader plate 31 reaches its maximum travel at the stops 39 (see FIG. 8) the devices 20 on the first tube ends 27 are separated and define a partial spherical or concave-shaped surface. The frame 29 is then removed and the tray 32 is slidably moved upward along the tubes 24. The center device or devices 29 in the expanded array are initially contacted by the tray 32 and these devices are seated in the depressions 43. As the tray 32 moves further upwards concentric square patterns of devices 20 will be sequentially picked up. The sequential pickup of devices 20 breaks the vacuum that is holding the devices 20 in successive increments. This successive breaking of vacuum requires less force and provides a smoother pickup of the devices 20 than is attained if all the devices are removed at the same time. Upon moving past all tube ends 27, the tray 32 contains devices 20 positively positioned in an expanded form. The tray 32 with devices 20 can now be transferred to circuit fabrication points or packaged for shipment or storage.

When a compact array of rows and column of articles or devices without interleaved projections is to be expanded and picked up, the use of spreader rods 30 is no longer required. The spreader plate 31 can be moved up, expanding simultaneously the rows and columns in the array of devices 20. The tray 32 again can be lifted upwards to receive and seat all articles within the tray depressions 43.

Further, other expedients may be utilized to hold the articles on the ends of rods 24. For example, if the articles to be separated are paramagnetic, then the rod ends 27 may be magnetized to hold the articles in the compact whereafter the separation may be accomplished in the manner heretofore explained with the vacuum holding expedients.

In certain situations it may be desirable to use the present invention to compact an expanded array of articles. In which case, the tray 32 is used to position the articles on the first rod ends 27 and then moved downward to sit on spreader plate 31 which is further moved downward along tubes 24 to rest about the first tube ends 33. The frame 29 is placed about the first tube ends 27 resting on stops 39. The slides 28 are moved inwardly along the guideways 46 to compact the array of first rod ends 27 with the article located thereon. Finally, an adhesive is applied to the articles and the carrier 23 presses against the compacted array of articles whereafter the vacuum is released and the carrier removed with the compact array of articles. Again, it will be noted that upon completion of the compacting of the array of articles, the openings between adjacent articles are in the same ratio as existed between adjacent articles in the initial, expanded array. It is to be understood that the above-described embodiment and construction of elemental parts are merely illustrative of an application of the principles of the invention and that many modifications and changes may be made without departing from the invention.

What I claim is:

1. An apparatus for imparting relative movement to articles arranged in an array, which comprises:
   - an array of moveably mounted rods having ends which are arranged in a first array corresponding to the array of articles for supporting the articles thereon; and
   - means for moving said rod ends into a second array which is spatially proportional to said first array.

2. An apparatus for spatially altering a compact array of articles, which comprises:
   - a plurality of spaced rods having moveable first ends and fixed second ends;
   - means for moving said first ends into a compact array, corresponding to the array of articles, to individually support said array of articles on said first ends; and
   - means for moving said first tube ends to spatially alter the compact array of articles.

3. An apparatus as defined in claim 2, wherein said rods are hollow tubes, which further comprises means for applying vacuum through said tubes to hold the articles on said first ends.

4. An apparatus for separating a compact, planar array of articles into a separated array, comprising:
   - a plurality of spaced rods having fixed first ends and movable second ends;
   - means for moving said second ends of said rods together to individually support the articles on said second ends;

a spreader plate normally positioned adjacent said first ends having apertures corresponding to the separated array for receiving said spaced rods; and

means for guiding said spreader plate for movement toward said second ends of said rods to separate the compact array of articles.

5. An apparatus for expanding a compact array of articles and removing the articles in the expanded array, comprising:

a plurality of rods having moveable first ends and fixed second ends;

means for moving said first ends of said rods into a compact array corresponding to the array of articles to individually support the articles on said first ends;

means for holding said supported articles on said first ends;

means, moveable along said rods, for separating said first rod ends to expand the compact array of held articles; and

means advanced by said separating means for removing the expanded array of articles from said first rod ends.

6. An apparatus for expanding a compact planar array of articles and removing the articles in the expanded array, comprising:

a plurality of spaced tubes having moveable ends thereof terminating in a concave surface;

means for moving said moveable ends of said tubes together to position said moveable ends in a plane to support the articles on said moveable ends;

means for applying a vacuum through said tubes to hold the articles on said moveable tube ends;

a spreader plate having apertures corresponding to the expanded array, for receiving said spaced tubes;

means guiding said spreader plate for movement towards said moveable ends of said tubes to spread said moveable ends to separate the compact array of articles; and

a tray seated on said spreader plate and having shallow depressions located about apertures corresponding to the apertures of said spreader plate, said tray being removable from said spreader plate to pick up said articles in said shallow depressions.

7. An apparatus for separating a compact row of articles, into a separated configuration, comprising:

a plurality of spaced tubes having moveable first ends terminating in a single row;

a manifold for mounting the second ends of said spaced apart tubes;

means for moving said first ends of said tubes into a compacted row, corresponding to the compact row of articles, to support the articles on said compacted row of first ends;

means for applying a vacuum through said manifold to the second ends of the spaced tubes to hold the articles on said first ends;

a spreader plate having a multitude of apertures, corresponding to the separated configuration, through which extend the second ends of said spaced tubes; and

means guiding said spreader plate for movement toward said first ends of said tubes to spread said first ends to separate the compact array of articles into the separated configuration.

8. An apparatus for expanding the pattern of a compact array of workpieces into an expanded pattern and at the same time maintaining the original relative orientation, which comprises:

a plurality of hollow tubes of different lengths;

a base for securing second ends of said tubes and positioning moveable first ends of said tubes with the longer tubes being positioned about the shorter tubes;

means for applying a vacuum to said second ends of said tubes;

a plurality of columns projecting from the base;

a frame supported by said plurality of column and located about said first ends of said tubes;

a plurality of slides moveably mounted with said frame for holding said first ends of said tubes in a compact planar array to support the workpieces on said first ends; and

a spreader plate slidably mounted on said columns, said spreader plate having apertures corresponding to the expanded pattern for receiving said tubes, for spreading said first ends of said tubes and workpieces apart.

9. An apparatus for expanding the pattern of a compact array of articles, comprising:

a plurality of tubes;

a frame mounted about said tubes, said tubes having moveable ends which protrude through said frame;

a plurality of guideways located on said frame extending from said tubes;

a plurality of moveable slides, located in said guideways, for compacting said moveable tube ends to support the articles;

a plurality of means to frictionally bear on and oppose sliding motion of said slides; and

means for spreading said moveable ends of said tubes apart to force said moveable slides outward against the action of said friction means to expand the array of articles.

10. An apparatus for separating a compact planar array of articles, comprising:

a plurality of spaced tubes having moveable ends thereof forming a concave surface;

a frame, located about the moveable ends of said tubes, with a plurality of radial guideways;

a plurality of slides moveable within the radial guideways of said frame;

plurality of springs secured to said frame within the radial guideways and bearing against the slides for applying a frictional drag;

means for moving the slides within the radial guideways towards the moveable ends of said tubes to compact said moveable tube ends in a planar array to support said articles; and

means for spreading said moveable ends of said tubes against the effect of said frictional drag to separate the articles.

11. An apparatus for expanding a compact planar array of articles and removing the articles in the expanded array, which comprises:

a frame;

a plurality of radial guideways within said frame;

a base;

a spreader plate with a multitude of apertures;

a plurality of columns projecting from said base for supporting said frame and extending through certain said apertures in said spreader plate;

a plurality of tubes mounted in said base in spaced array and running parallel to said columns, with movable ends protruding through the apertures in said spreader plate;

a plurality of slides moveably mounted within said radial guideways to move said moveable tube ends into a compact array for receiving said articles; and

a tray having a multitude of apertures to receive said tubes and seated on said spreader plate for movement with said spreader plate towards said articles to pick up the expanded array of articles as said spreader plate is moved to said moveable ends of said tubes.

12. A method of imparting relative movement to articles arranged in spaced array, which comprises:

supporting said articles on ends of an array of flexible rods; and

flexing the rods to move the articles into a second array with the spacing between articles being maintained in the same ratio.

13. A method of manipulating a bundle of flexible tubes to spatially alter a pattern of articles, which comprises:

arranging the ends of the bundle of tubes to correspond to the pattern of articles;

positioning the pattern of articles over first ends of the tubes;

applying vacuum through the tubes to hold the articles on said first ends; and

flexing said tubes to spatially alter the pattern of articles.

14. A method of manipulating a bundle of flexible tubes to spatially alter a pattern of articles as defined in claim 13 where the articles are arranged in rows and columns, which comprises:

flexing rows and columns of said tubes to maintain the ratio of spacing between articles in the initial position with respect to the spacing of the articles in the spatially altered pattern.

15. A method of spatially altering a compact array of articles that are bonded to a carrier while maintaining the relative orientation of the articles, comprising:

positioning the compact array of articles over a compact array of first ends of tubes to seat the articles over said first ends of said tubes;

applying a vacuum to the second ends of said tubes to hold said articles on said first tube ends;

removing said carrier to leave the articles on said first tube ends; and

moving said tubes to form a spatially altered matrix of said articles.

16. A method of expanding a compact array of articles while maintaining the relative orientation of the articles, comprising:

compacting first ends of a plurality of spaced tubes into an array conforming to the array of articles;

positioning the compact array of articles over the individual compacted ends of the tubes;

applying a vacuum to the tubes to hold said articles on said first tube ends;

inserting a plurality of rods between adjacent rows of said spaced second tube ends;

sequentially moving said rods towards said first tube ends to force said compacted first tube ends to expand into a plurality of spaced rows; and

sliding a spreader plate with a multitude of apertures for receiving said spaced second tube ends, towards said first tube ends to expand said first tube ends and the attached articles.