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D. FELDMAN ET AL
APPARATUS AND METHOD FOR SEPARATING SCRIBED
PLATES OF BRITTLE MATERIAL
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3,615,047

FIG. 1

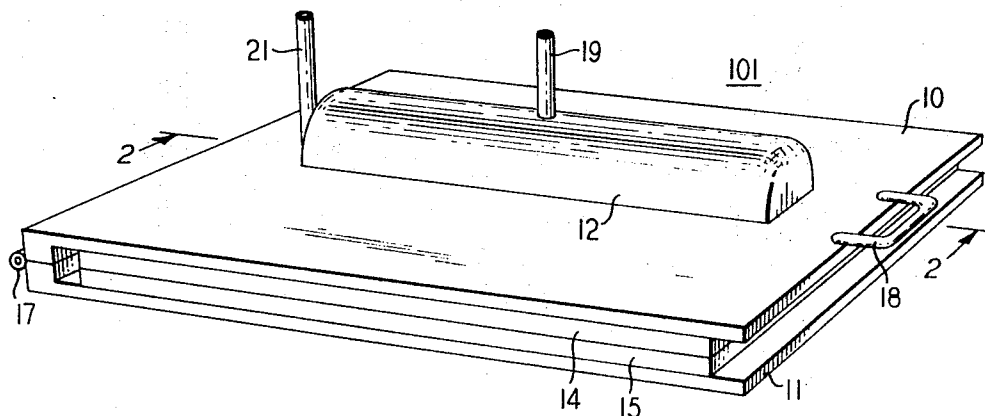


FIG. 2

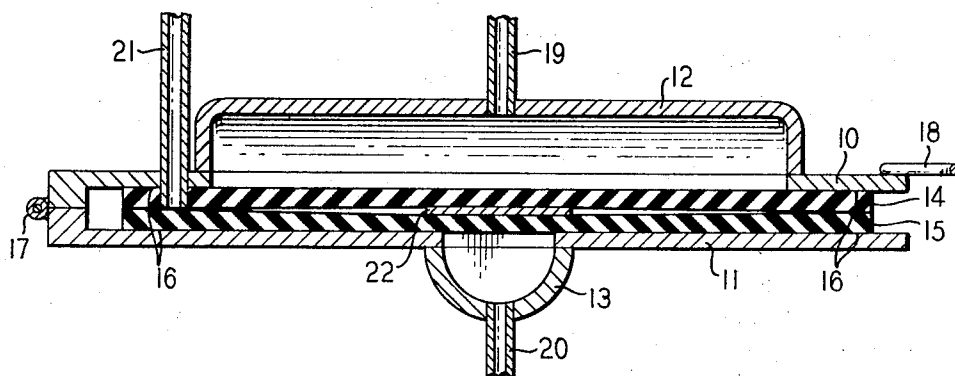
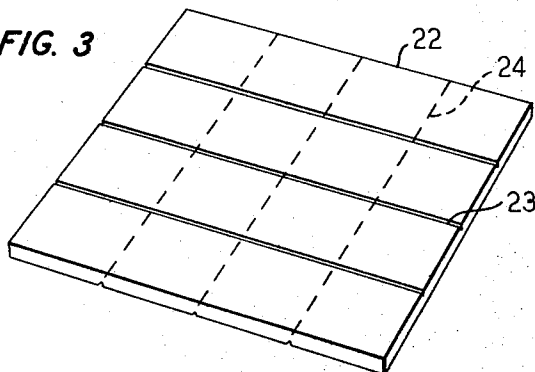


FIG. 3



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APPARATUS AND METHOD FOR SEPARATING SCRIBED PLATES OF BRITTLE MATERIAL

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2 Claims

ABSTRACT OF THE DISCLOSURE

Apparatus for separating a scribed plate of brittle material utilizes two flexible membranes between which the plate is vacuum clamped. A uniform force such as fluid pressure forces the membranes into a die which causes the membranes to transmit uniaxial stresses to the plate to separate it along scribe lines. Separation along a set of scribe lines orthogonal to the first set is achieved by using a die which is orthogonal to the first die.

BACKGROUND OF THE INVENTION

(1) Field of the invention

This invention relates to apparatus for separating into pieces a plate of brittle material and more particularly to apparatus for separating into individual units a scribed, thin film substrate.

(2) Description of the prior art

Multiple thin film and semiconductor circuits are usually formed on large substrates. After formation of the circuits it becomes necessary to separate the substrates into individual circuit units commonly called dice. Normally, the substrate is scribed or scored prior to separation to insure separation in the desired locations. The scoring is done with a diamond scribe or by a laser. Scribing in orthogonal directions with a diamond scribe is normally done on opposite sides of the substrate because the scribe line intersections are not well defined if both sets of scribe lines are on the same side of the substrate. Scribing in orthogonal directions may be done satisfactorily on one side of the substrate if a laser is used.

Various types of apparatus and various methods are used for separating the scribed substrates. The substrates are often manually separated into chips. This procedure is very inefficient and damage to the chips frequently results from the handling.

The scribed substrate may also be separated by moving a roller over the substrate which has been placed on a resilient surface. The units are usually kept in position by an adhesive tape during the separation. This apparatus and method for separating the substrate is unsatisfactory because damage to the individual units often results from the high local forces produced by the roller. Additionally, the use of tape makes the operation very slow.

Another type of apparatus for separating scribed plates of brittle materials is disclosed in U.S. Pat. 3,167,228, issued Jan. 26, 1965 to E. R. Moran and G. R. Jefferies. This patent teaches the application of a bending movement to the scribed plate by compressing the plate between a convex and a concave surface, one of which surfaces is resilient. For plates having sets of orthogonal scribe lines, spherical-shaped convex and concave surfaces are used. Thus, the plate is separated in orthogonal directions in a single operation.

U.S. Pat. 3,182,873, issued May 11, 1965 to B. F. Kalvelage and A. W. Coe, similarly teaches apparatus which separates a semiconductor substrate along or-

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thogonal directions simultaneously. Such simultaneous separation of a substrate along orthogonal scribe lines is satisfactory for most semiconductor substrates. Semiconductor substrates are usually quite thin and approach pure crystals in structure. Thus, these substrates readily break in preferred directions which coincide with the scribe lines.

However, thin film substrates are usually much thicker than semiconductor substrates. Thin film substrates are usually made from glass or ceramic which has no preferred direction of separation. An attempt to simultaneously separate such substrates in orthogonal directions usually results in a separation along a direction at 45 degrees to the desired directions. Thus, separation of thin film substrates of glass and ceramic along orthogonal directions must be done in two operations and the apparatus disclosed in the two referenced patents is not satisfactory for this procedure.

Accordingly, it is an object of this invention to improve the apparatus for separating plates of brittle material into smaller units without damage to such units.

A more specific object is to enhance the ability of such apparatus to separate along orthogonal directions plates of material having no preferred direction of separation.

SUMMARY OF THE INVENTION

The foregoing objects and others are achieved in accordance with the principles of the invention by apparatus which utilizes two flexible membranes to transmit the proper stresses to the scribed substrate. The scribed substrate is vacuum clamped between the interior surfaces of two cover plates, each of which contains an appropriate die. A pressurized fluid such as air is introduced against the exterior surface of one membrane forcing the two membranes into the die of one cover plate. The membranes are forced to assume a small radius of curvature in one direction only through a stretching and bending action. Thereby, uniaxial stresses are introduced into the substrate causing it to cleanly separate along the scribe lines in a particular direction. Separation along a set of orthogonal scribe lines is achieved by introducing the pressurized fluid against the exterior surface of the second membrane. The membranes are then forced into the die in the second cover plate. This die is orthogonal to the first die and thus separation along the set of orthogonal lines is obtained.

The vacuum clamp holds the individual units in position during the entire operation. The sequence of steps in the operation can be automated to achieve a high production rate.

BRIEF DESCRIPTION OF THE DRAWINGS

The objects and features of the invention may be more fully comprehended from the following detailed description and accompanying drawing, in which:

FIG. 1 is a perspective view of the apparatus of this invention in a closed position in readiness to separate a substrate;

FIG. 2 is a sectional view along direction 2—2 of FIG. 1 showing the substrate between the membranes; and

FIG. 3 shows a scribed substrate which is ready to be placed into the apparatus for separation.

DETAILED DESCRIPTION

FIG. 1 shows the substrate separating apparatus 101 in a loaded and closed position ready to initiate the substrate separating procedure. The apparatus 101 comprises two cover plates 10 and 11. As shown more fully in FIG. 2, each cover plate 10 and 11 also contains a die 12 and 13, respectively. The dies 12 and 13 are substantially identical in the illustrative embodiment and are arranged at right

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angles to one another. This particular arrangement is optimum for separating a single substrate having two sets of orthogonal scribe lines.

The dies 12 and 13 shown in FIG. 1 and FIG. 2 are enclosed depressions in the cover plates 10 and 11, respectively. The dies 12 and 13 may be no more than cutouts in these cover plates for a particular design of the separating apparatus.

Fastened between the cover plates 10 and 11 are two flexible membranes 14 and 15. Membranes 14 and 15 may be bonded to plates 10 and 11, respectively, by suitable adhesive bonds around the periphery of the membranes of which bond 16 is typical. When the separating apparatus is in the closed position, the membranes contact each other around their peripheries as shown in FIG. 2 to form an airtight seal.

Cover plates 10 and 11 are joined by a hinge 17 which permits the apparatus to be opened and closed by a handle 18. Handle 18 may have a suitable locking mechanism to lock the apparatus in the closed position during the separating procedure.

The operation of the separating apparatus 101 is controlled by fluid pressure. A pressurized fluid such as air is introduced against the exterior surfaces of membranes 14 and 15 through inlets 19 and 20, respectively. Inlets 19 and 20 are connected to a suitable pressurized source through appropriate regulators and valves which are not shown. The space between the membranes 14 and 15 is evacuated through outlet 21 which is connected to a suitable vacuum pump. The vacuum thereby introduced between the membranes causes the membranes to clamp together and hold the substrate in a fixed position during the separation procedure.

DESCRIPTION OF OPERATION

After formation of the circuits thereon, the substrate 22 shown in FIG. 3 is normally scribed with two sets of scribe lines 23 and 24 which are orthogonal. These scribe lines divide the substrate into individual units. Normally, the two sets of lines are on opposite sides of the substrate. Thus, breakage or separation by bending in two directions is desirable. Substrate 22 is then placed in the opened separating apparatus 101 with scribe lines 24 adjacent membrane 15 and with the lines 24 parallel to the long axis of die 13.

After the apparatus is closed, the space between the membranes 14 and 15 is evacuated through outlet 21. Pressurized fluid is then introduced through inlet 19. The fluid pressure forces the membranes 14 and 15 and the enclosed substrate 22 into die 13. This action forces the membranes 14 and 15 to assume a small radius of curvature in one direction only. Thus, uniaxial stresses are introduced into substrate 22 which separate the substrate along scribe lines 24.

The fluid pressure in inlet 19 is removed and pressurized fluid is introduced into inlet 20. The fluid pressure now forces the membranes into die 12 which causes the substrate 22 to separate along scribe lines 23. The pressure from inlet 20 and the vacuum from outlet 21 are now removed and the apparatus may be opened and the individual units of the separated substrate 22 removed.

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As an aid in removal of the individual units of the substrate 22 after separation, the substrate may be laid on a small sheet of flexible material which is placed into the apparatus with the substrate. After separation, the sheet containing the individual units may be lifted from the apparatus.

Various changes to the apparatus could be made to automate the procedure and increase output. For example, the closing of handle 18 could be used to trigger a unit which controls the valves in inlets 19 and 20 and outlet 21. This control unit could then rapidly cycle the apparatus through its operating sequence to separate the substrates. Additionally, the dies 12 and 13 could be designed to handle a plurality of substrates simultaneously or a plurality of dies could be provided on each cover plate 10 and 11.

Therefore, it is to be understood that the embodiment disclosed herein is merely illustrative of the principles of the invention. Various modifications thereto may be made by those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. Apparatus for separating a plate of brittle material having a first set of score lines on a first major surface and a second orthogonal set of score lines on a second major surface thereof into a plurality of smaller units defined by said score lines comprising, in combination, first and second membranes between which said plate is positioned, means for moving said first and second membranes in a first direction to cause said plate to separate along said first set of score lines, and means for moving said first and second membranes in a second direction to cause said plate to separate along said second set of score lines.

2. A method of separating a plate of brittle material having a first set of score lines on a first major surface and a second orthogonal set of score lines on a second major surface thereof into a plurality of smaller units defined by said score lines, said method comprising placing said plate between first and second elastic members, moving said first and second elastic members in a first direction causing said plate to separate along said first set of score lines, and moving said first and second membranes in a second direction causing said plate to separate along said second set of score lines.

References Cited

UNITED STATES PATENTS

3,182,873	5/1965	Kalvelage et al.	225—2
3,448,510	6/1969	Bippus et al.	225—2 X
3,461,537	8/1969	Lotz	225—2 X
3,493,155	2/1970	Litant et al.	225—2
3,507,426	4/1970	Bielen et al.	225—2

FRANK T. YOST, Primary Examiner

U.S. Cl. X.R.

225—2, 93, 96.5