United States Patent [19]

Altshuler

[11] **3,730,410**

[45] **May 1, 1973**

[54] **WAFER BREAKER**

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[22] Filed: **June 16, 1971**

[21] Appl. No.: **153,766**

[52] **U.S. Cl.** **225/96.5,** 29/413, 225/2

[51] **Int. Cl.** **B26f 3/00**

[58] **Field of Search**.....225/2, 96.5, 93, 225/1; 292/174, 175; 52/394, 402; 29/413

[56] **References Cited**

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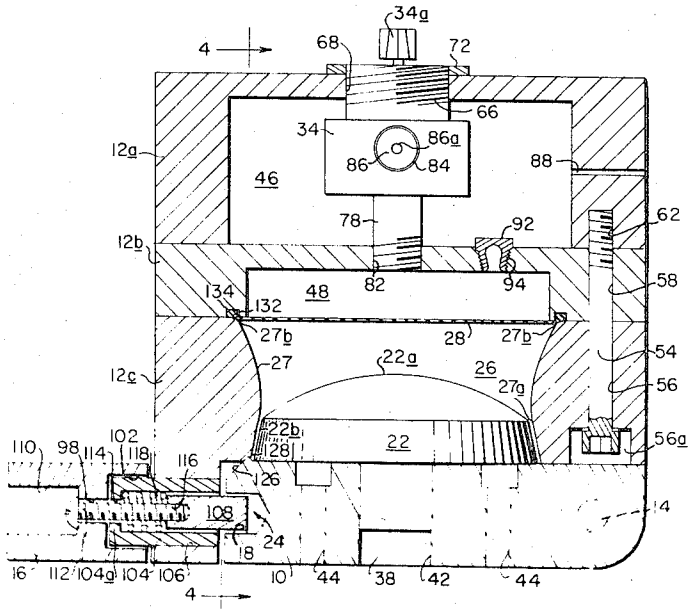
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[57] **ABSTRACT**

A wafer breaker has a housing with upper and lower sections hinged together so that the upper section can swing down on top of the lower section. The lower section carries a removable platen having a rounded top surface on which a flat scribed wafer is placed. The top housing section contains a pressure chamber having a flexible and resilient wall which is positioned directly above the platen when the top section is in its closed position. Adjustment of a valve in the top section to a first operative position causes air under pressure to enter the pressure chamber and push the flexible wall against the flat wafer on the rounded platen thereby fracturing the wafer along the scribed lines. Following this, the valve is turned to a second position which slowly exhausts the air from the pressure chamber so that the wall resumes its unstressed state relatively slowly, thereby minimizing turbulence in the chamber containing the fractured wafer so that the resulting chips are not scattered.

9 Claims, 5 Drawing Figures



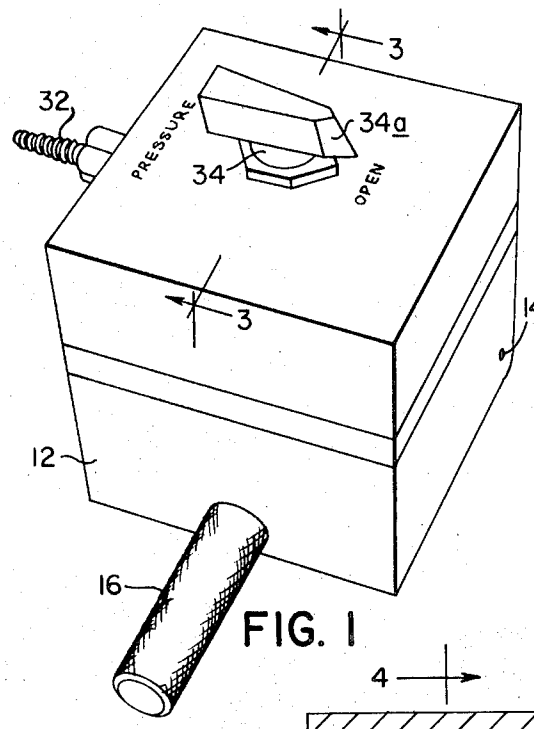


FIG. 1

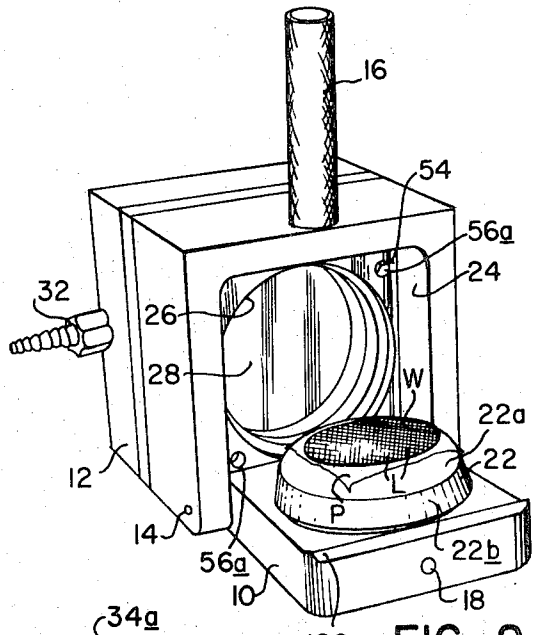


FIG. 2

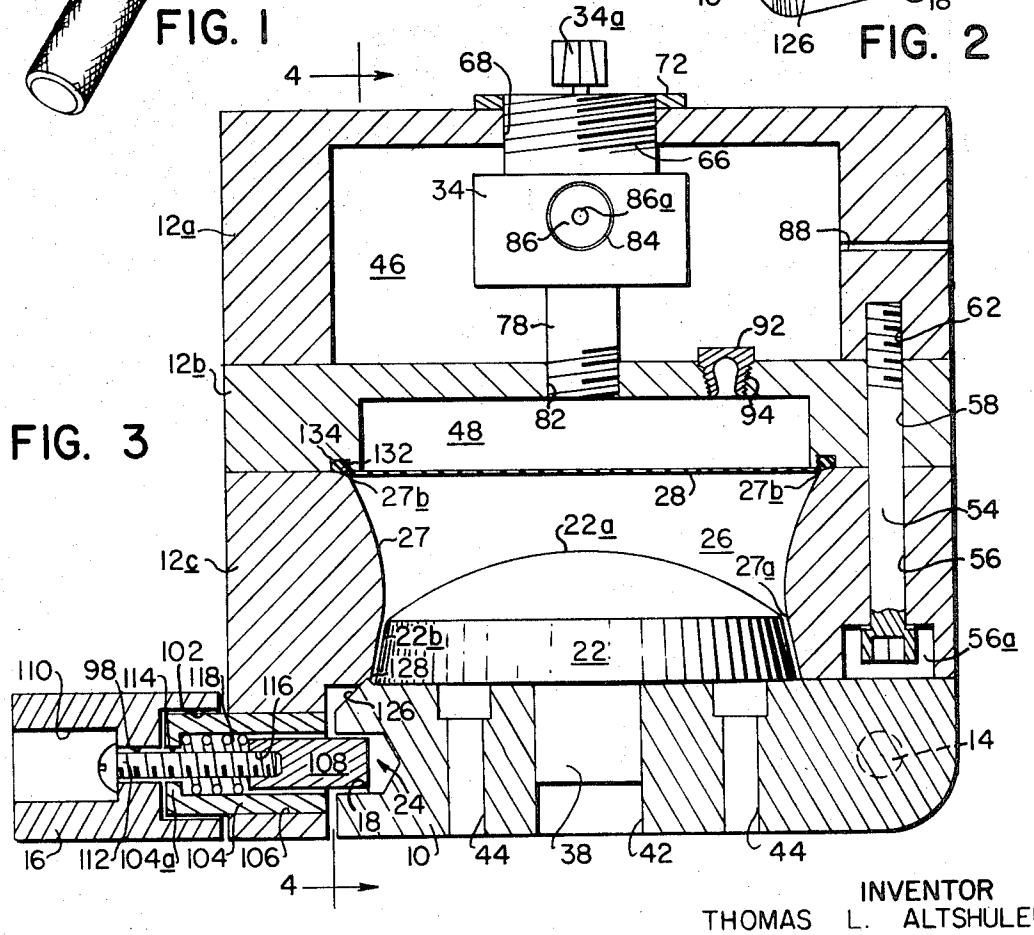


FIG. 3

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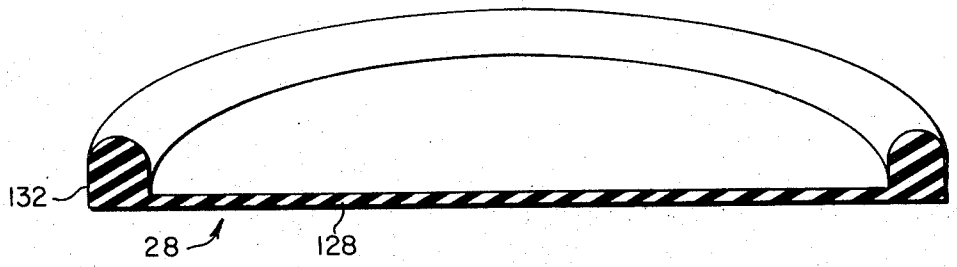


FIG. 5

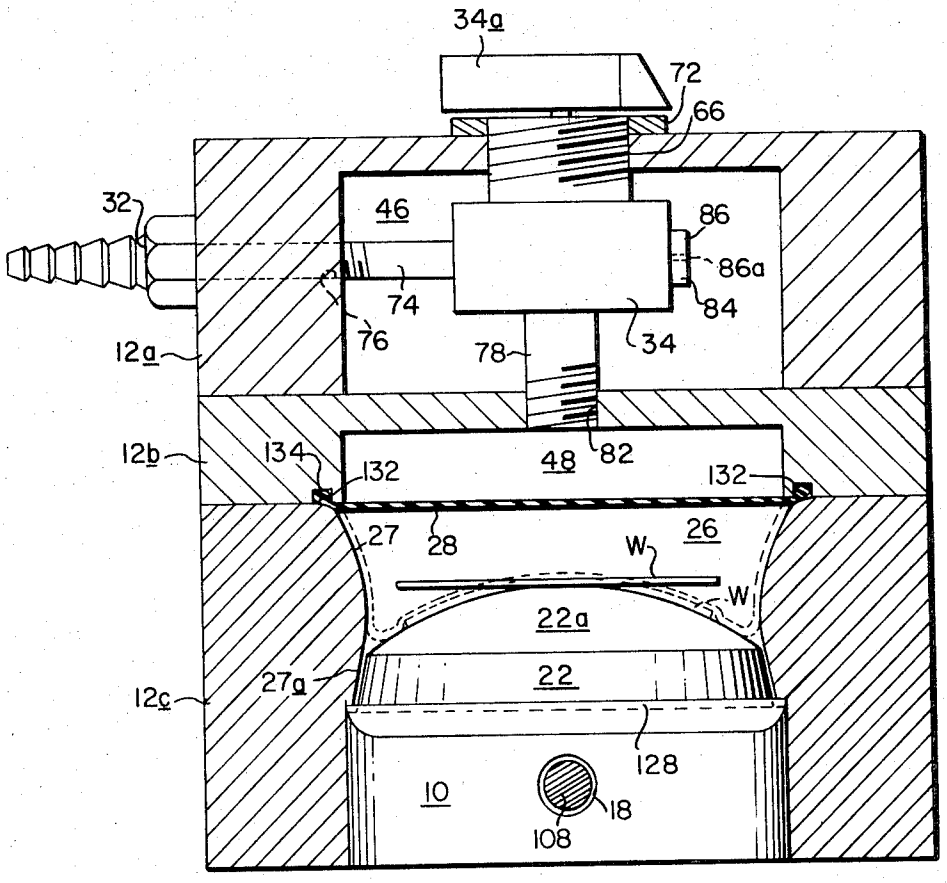


FIG. 4

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WAFER BREAKER

BACKGROUND OF THE INVENTION

This invention relates to a device for fracturing thin slices of relatively brittle material along lines scribed in the material. It has particular application in connection with breaking semiconductor wafers.

A semiconductor such as a diode contains a thin, chip of semiconductive material like germanium or silicon. These chips are cut from flat wafers which are, in turn, sliced from a long, generally cylindrical single crystal. Each wafer is scribed with two orthagonal sets of parallel lines and the wafer is then fractured along the scribed lines to divide the wafer into chips.

As a practical matter, it is necessary for the wafer to be fractured very carefully to insure that the wafer breaks cleanly along the scribed lines to maximize the yield. U. S. Pat. No. 3,493,155 describes a wafer breaker which was designed to accomplish this and, to some extent, it has been successful in doing so.

However, that prior wafer breaker has some disadvantages which limit its wider application. More particularly, it is cumbersome and relatively difficult for unskilled personnel to operate properly on a consistent basis. Also, it requires a substantial amount of maintenance due to failure of the flexible wall or diaphragm which is an essential part of these devices. Still further, the prior breaker can be opened accidently while under pressure with subsequent hazard to personnel. Also, the chips are subjected to air turbulence which tend to scatter them within the breaker. This generates more dust and debris and, in extreme cases, scratches the chips.

Accordingly, it is the aim of the present invention to provide an improved wafer breaker which fractures the wafer cleanly and thus maximizes yield.

Another object of the invention is to provide a wafer breaker which is easy to operate even by relatively unskilled personnel.

Another object of the invention is to provide a wafer breaker which generates a minimum amount of dust and debris during the fracturing process.

Still another object of the invention is to provide a wafer breaker which has a long, useful life and requires a minimum amount of maintenance.

A further object of the invention is to provide a wafer breaker of this type which is safe to use.

Another object of the invention is to provide a wafer breaker which is easily modified to make chips of different sizes.

Other objects will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises the features of construction, combination of elements and arrangements of parts which will be exemplified in the construction hereinafter set forth, and the scope of the invention will be indicated in the claims.

Briefly, my wafer breaker comprises a housing having hinged together upper and lower sections which can be swung together and locked. The lower section carries a platen having a rounded top surface on which a wafer to be fractured is placed. The top housing section contains a pressure chamber having a flexible and resilient wall in the form of a special diaphragm to be described in more detail later. When the housing is locked in its closed position, the diaphragm is situated directly above the platen. Also a fitting is included in the upper section for introducing air under pressure into the pressure chamber therein.

A valve mounted on the upper section controls the pressurizing and depressurizing of the chamber. More particularly, in one position of the valve, air under pressure is introduced into the chamber. This pushes the diaphragm down against a wafer positioned on the platen. Since the wafer is flat while the underlying platen is rounded the diaphragm bends the wafer causing the wafer to fracture along the lines scribed on its exposed surface, i.e. that side away from the platen.

When the valve is moved to a second position, the chamber is vented to the atmosphere by way of a small orifice which exhausts the air at a rate that will cause the diaphragm to resume its unstressed condition relatively slowly so that the air flow into the chamber containing the fractured wafer is relatively gentle. This minimizes turbulence in that chamber so that the chips are not scattered about. When the air has been fully exhausted from the pressure chamber, the top housing section can be unlocked and lifted up to expose the individual chips which are resting on the platen.

The subject wafer breaker is a single unit having a single control which can be manipulated by an operator to both pressurize and depressurize the breaker. Also, the locking arrangement is specially designed to allow the housing to be opened and closed very easily when the unit is depressurized, but for safety reasons, to prevent the housing from being opened when the unit is pressurized. All of these factors make the subject wafer breaker a particularly useful tool in semiconductor manufacture where safety and simplicity of operation are important factors to be considered.

BRIEF DESCRIPTION OF THE DRAWINGS

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawings, in which:

FIG. 1 is an isometric view of a wafer breaker made in accordance with this invention with the unit illustrated in the closed position;

FIG. 2 is a similar view from the opposite side showing the wafer breaker in its open position;

FIG. 3 is a sectional view along lines 3—3 of FIG. 1;

FIG. 4 is a similar view along lines 4—4 of FIG. 3; and

FIG. 5 is a perspective view in section of a diaphragm forming an important part of the FIG. 1 wafer breaker.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Turning now to FIGS. 1 and 2 of the drawing, the wafer breaker has a housing made of a strong material such as Al alloys. The housing includes a generally rectangular lower section 10 and a box-like upper section 12 whose lower rear corners are hinged at 14 to the rear edge of lower section 10.

Using a generally cylindrical handle 16 projecting out from the front of section 12, that section can be swung between an open position shown in FIG. 2 to a closed position shown in FIG. 1 wherein it overhangs the lower section 10. Handle 16 forms part of a locking arrangement which engages in a hole 18 in the front of

lower section 10 to lock the two sections together in the closed position as will be described in more detail later.

Still referring to FIG. 2, a platen 22 made of stainless steel or comparable material is positioned in lower housing section 10. Platen 22 has a curved, herein spherical, top surface 22*a* and a slightly conical side wall 22*b*. The underside of upper housing section 12 is recessed at 24 and has a cylindrical recessed chamber 26 to acommodate lower housing section 10 and platen 22 respectively when the wafer breaker is closed as shown in FIG. 1.

The platen is arranged to support a scribed wafer W of semiconductor material. Preferably the wafer W is placed between the leaves of a single fold of lens paper P.

Housing section 12 contains a pressure chamber 48 (FIG. 3) having a flexible and resilient wall in the form of a diaphragm 28 separating it from chamber 26. A hose fitting 32 mounted in the side of housing section 12 near the top thereof communicates with the pressure chamber inside this section. Fitting 32 is arranged to be connected to a source of air under pressure. A three-way valve 34 having a handle 34*a* is mounted in the top wall of housing section 12. When the valve is in one operative position (PRESSURE), air from the source connected to fitting 32 flows into the pressure chamber and pushes outward on diaphragm 28.

When the housing section 12 is closed down on section 10 as shown in FIG. 1, the diaphragm 28 is directly above platen surface 22*a*. Accordingly, when the air pressure is exerted against it, the diaphragm is pushed down against the flat wafer W, whereupon the wafer is bent down against the rounded platen surface 22*a*. This causes the wafer to fracture along the scribed lines L thus separating the wafer into a number of individual chips. The lens paper P tends to retain these chips in place.

Following this, the valve 34 is turned to its other operative position (OPEN) which gradually vents the pressure chamber so that the diaphragm 28 returns to its normal unstressed condition. The housing section 12 may be unlocked and opened to the FIG. 2 position to expose the platen 22 and the individual chips thereon.

Turning now to FIGS. 3 and 4, platen 22 has a generally cylindrical depending stem 38. This stem is received in a cylindrical passage 42 in the middle of housing section 10. Thus, the platen is properly positioned. Still, if necessary, the platen can be removed easily and replaced with another platen having a different radius of curvature on its top surface 22*a* to handle chips of different area.

The side wall 27 of chamber 26 is constricted at 27*a* so that its diameter at the taper is slightly less than the largest diameter of platen 22. This permits the chamber 26 to receive the platen, yet it prevents the platen from dropping onto diaphragm 28 in the event that the closed wafer breaker is inverted in handling.

Housing section 10 also contains a plurality of passages 44 distributed around passage 42 which can accommodate bolts to anchor the wafer breaker to an underlying base. The upper ends of passages 44 are counterbored so that the bolt heads will be recessed so as not to interfere with the proper seating of platen 22 on housing section 10.

Housing section 12 is actually composed of three separate parts, to wit: an upper cup-like component 12*a* having a cavity 46 which houses the valve 34, a smaller, cup-like middle component 12*b* which, together with diaphragm 28, forms the pressure chamber 48 and a lower component 12*c* which is hinged to housing section 10 and carries handle 16. Component 12*c* and diaphragm 28 define the cavity 26 which receives platen 22 when the wafer breaker is closed.

The three upper housing components 12*a*, 12*b* and 12*c* are secured together by means of bolts located at their four corners. These bolts extend up through passages 56 in component 12*c*, passages 58 in component 12*b* and are screwed into threaded passages 62 in component 12*a*. Passages 56 are countersunk at 56a so that the heads are recessed as shown in FIG. 3.

Referring to FIGS. 3 and 4, valve 34 has a threaded neck 66 which is screwed into a correspondingly threaded opening 68 in the top of housing component 12*a*. A nut 72 is then screwed down onto neck 66 which slides in an opening in the top of the housing. Valve 34 has three ports. A threaded port 74 (FIG. 4) accepts a threaded tube 74 which fits through passage 76 in the side of the housing component 12*a*, and it connects with the hose fitting 32 which is threaded into the other end of the same passage. A threaded valve outlet port 78 extends down into a correspondingly threaded passage 82 in the top wall of housing component 12*b*. Also, valve 34 has a second outlet port 84 which opens into cavity 46. In the PRESSURE position of valve handle 34*a*, air entering fitting 32 is directed through port 78 into the pressure chamber 48. When valve handle 34*a* is in its OPEN position, air in the pressure chamber 48 is conducted through ports 78 and 84 into cavity 46. A plug 86 having a restricted orifice 86*a* is fixed in port 84 so that the air exhausts from chamber 48 relatively slowly. A small vent passage 88 (FIG. 3) is provided in the rear wall of housing component 12a to relieve any air pressure buildup in cavity 46.

As a safety measure to prevent the buildup of excessive pressure in pressure chamber 48, a pressure release valve or plug 92 is threaded into a passage 94 in the top wall of housing component 12b. Plug 92 is set to release when the pressure in chamber 48 exceeds a predetermined safe value.

As best seen in FIG. 3, handle 16 forms part of a locking mechanism which locks the wafer breaker in its closed position shown in FIG. 1. More particularly, the handle has an axial passage 98 extending all the way through it. The end of the passage adjacent housing 12 has a relatively large diameter counterbore 102 which is arranged to slidably receive a tubular sleeve 104 which is suaged into a passage 106 in the front of housing component 12*c*. The end of sleeve 104 projects out from the housing and has a closed end 104*a*. A generally cylindrical pin 108 is slidably received in sleeve 104. The end of this pin is arranged to project into opening 18 in housing section 10 when the wafer breaker is closed.

Handle 16 also has a relatively long, smaller diameter counterbore 110 extending in from the opposite end of the handle for receiving the head of a screw 112 which extends through passage 98 and through a hole 114 in the sleeve end 104*a* and into a threaded passage 116 in

the end of pin 108. A compression spring 118 positioned between the sleeve end 104*a* and the pin biases the pin toward the opening 18.

Normally, with the wafer breaker unpressurized, handle 16 can be pulled away from the housing with very little effort, thereby retracting pin 108 from opening 18. Actually, so little force is required that when a bevel 126 is provided at the front edge of housing section 12, the weight of the housing section pushes the end of pin 108 down against the bevel with enough force to create a force component parallel to the axis of the handle 16 sufficient to retract the handle, allowing pin 108 to spring into opening 18, thereby locking the breaker in the closed position.

On the other hand, when the wafer breaker is pressurized in use, normally, at about 100 psi, the upper section 12 is forced away from lower section 10 to some extent so that the top surface of pin 108 is firmly pressed against the upper edge of opening 18. As a result, it requires about 200 lbs. of force to retract the handle 16, making it practically impossible for the operator to open the wafer breaker inadvertantly after it is pressurized.

Turning now to FIGS. 4 and 5, diaphragm 28 is made of high quality resilient material such as 40 durometer rubber material. Also it is specially molded with a thin, circular central membrane 128 having an integral bead 132 extending all around its periphery. Before the various parts of upper housing section 12 are assembled, the diaphragm bead 132 is seated in a circular groove 134 formed in the underside of housing component 12b just radially outward from pressure chamber 48. When housing section 12 is assembled, the diaphragm 28 is firmly anchored in place in a taut condition as shown in solid lines in FIG. 4.

In use, a scribed wafer W is folded into lens paper P and placed on platen 22 as shown in FIG. 2. Preferably, the platen is moistened with alcohol to help retain the paper. Then the housing section 12 is swung down and locked as shown in FIGS. 3 and 4. Next valve handle 34*a* is turned so that it points to PRESSURE, thus introducing compressed air into pressure chamber 48. This forces diaphragm 28 downward so that it gradually assumes the dotted line position shown in FIG. 4.

The side wall of cavity 26 is rounded at its upper edge 27b so that no sharp or irregular edges are presented to the diaphragm as it is pushed downwards. As it moves toward the platen, the diaphragm 28 or at least the central membrane 128 thereof stretches and generally conforms to the side wall of cavity 26. Upon encountering the wafer W, it tends to bend the wafer downwardly against the rounded platen surface 22*a*. The diaphragm 28 presses gently but firmly against the wafer only to the extent of causing the wafer to break just along the scribe lines. Thus there is a maximum number of usable chips produced from each wafer. Moreover, the cleavages along the scribe lines are relatively clean so that a minimum amount of dust and debris results.

Referring to FIG. 3, as the diaphragm 28 membrane is forced downwardly air is forced out of the cavity 26 containing the platen. To assure adequate venting of this chamber, a very small transverse ridge 128 is formed at the top of bevel 126. When housing section 12 is closed down on section 10, this ridge engages the top wall of recess 24 in housing section 12 preventing that wall from closing flush against the top surfaces of section 10. Thus, very small wedge-shaped gaps (not shown) are created at each side of the wafer breaker which permit air to flow into and out of cavity 26. Also, as noted. above, at this point pin 108 is pressed firmly against the top edge of opening 18 so that there is very little danger of an operator being able to exert sufficient retracting force on handle 16 to open the wafer breaker and suffer possible injury.

A few seconds after the device is pressurized, the operator can turn valve handle 34*a* to the OPEN position shown in FIG. 1. This allows the air in pressure chamber 48 to vent through the restricted orifice 86*a* in valve 34 and thence to the atmosphere. The venting of the air in this fashion occurs relatively slowly so that diaphragm 28 withdraws from the platen equally slowly. Thus there is minimum air turbulence produced in chamber 26 that might tend to scatter chips.

At this point, the operator can easily retract handle 16, disengaging pin 108 from opening 18 and allowing the housing section 12 to be opened as shown in FIG. 2. This exposes the chips which are still retained in the lens paper P on platen 22 so that the operator can easily remove the chips and substitute another wafer to be broken.

Thus, the cycle time of the present breaker is quite short, especially because the operator can manipulate the housing and valve with a minimum amount of effort. Accordingly, a large number of wafers can be broken in a given period of time. Moreover, since there is a minimum amount of wastage, the yield per day from the present unit is much higher than is obtained using prior device of this type.

Furthermore, the present wafer breaker is designed so that there is little likelihood of injury either to the device itself or to the operator. Essentially, the only critical moving part is the diaphragm 28 and, as noted previously, this has been designed along with the housing component 12*c* so that the diaphragm is able to withstand many deflections without failure. As a result of all of these features, the present unit is a particularly useful and versatile tool and greatly aids in the manufacture of semiconductor chips.

As a further safety feature, it is possible to have an electrically operated solenoid valve in series with valve 34. This solenoid valve would be normally closed. When pin 108 is engaged into hole 24, the solenoid valve would open admitting pressurized gas to valve 34. A means of doing this is to have sleeve 104 made of an insulating material. An electrically conducting wire connected to the solenoid would pass through sleeve 104 and be connected to pin 108. Another electrically conducting wire would connect the solenoid to housing 12*a*. Thus, it would be impossible to pressurize the wafer breaker unless it were fully closed.

Thus, it will be seen that the objects set forth above, among those made apparent from the preceding description, are efficiently attained and, since certain changes may be made in the above construction without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

I claim:

1. A wafer breaker comprising

A. a pair of hinged together housing sections arranged to swing between a closed position wherein the two sections are adjacent one another to an open position wherein the two sections are oriented at an angle relative to one another,

B. means for locking the sections in the closed position,

C. a platen positioned on one of the sections, said platen having a curved surface which faces the other section when the two sections are in the closed position,

D. a pressure chamber in the other housing section, said chamber having a flexible, resilient wall which is disposed opposite the platen surface when the two sections are in the closed position,

E. means for introducing air under pressure into the pressure chamber when the two sections are locked in the closed position, thereby pushing the flexible wall toward the platen, and

F. a valve having

1. a first operative position which controls the flow of air into the pressure chamber, and

2. a second operative position which controls the flow of air out of the pressure chamber.

2. The wafer breaker defined in claim **1** wherein the locking means comprise

A. retaining means formed in the one housing section,

B. a slidable member mounted in the other housing section so that when the two sections are in the closed position, the member engages the retaining means, the member being prevented from disengaging from the retaining means when the pressure chamber is pressurized by the force of the flexible wall against the platen which tends to move the housing sections to the open position.

3. The wafer breaker defined in claim **2** and further including means for biasing the member into engagement with the retaining means.

4. The wafer breaker defined in claim **1** and further including means restricting the flow of air out of the pressure chamber so that the flexible, resilient chamber wall returns to its unstressed condition at a controlled rate so as to minimize air turbulence in the vicinity of platen.

5. The wafer breaker defined in claim **1** wherein the flexible resilient chamber wall comprises a generally circular diaphragm having an integral bead around its edge which seats in a circular groove in the other housing section so as to firmly hold the diaphragm in a taut condition.

6. The wafer breaker defined in claim **5** wherein the diaphragm and bead are molded of rubber material.

7. The wafer breaker defined in claim **1** wherein the one housing section has an opening and the platen has a depending stem which fits in said opening so as to hold the platen in place in the one section.

8. The wafer breaker defined in claim **7** wherein the platen has a conically tapered side wall and further including means in the upper housing section for engaging the tapered platen side wall so as to prevent the platen from dropping toward and striking the flexible wall, said taper also minimizing the flexible wall deformation, thereby increasing its life.

9. The wafer breaker defined in claim **1** and further including means for relieving the pressure in the pressure chamber when it exceeds a predetermined safe value.

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