

[54] **PRESSURE CONTROL FOR LAPPING DEVICE**

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[51] Int. Cl. **B24b 7/04**

[58] Field of Search **51/134, 165.9; 125/11 TP**

[56] **References Cited**

UNITED STATES PATENTS

3,492,762	2/1970	Heinrich.....	51/134
2,282,038	5/1942	Davenport.....	125/11 TP
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FOREIGN PATENTS OR APPLICATIONS

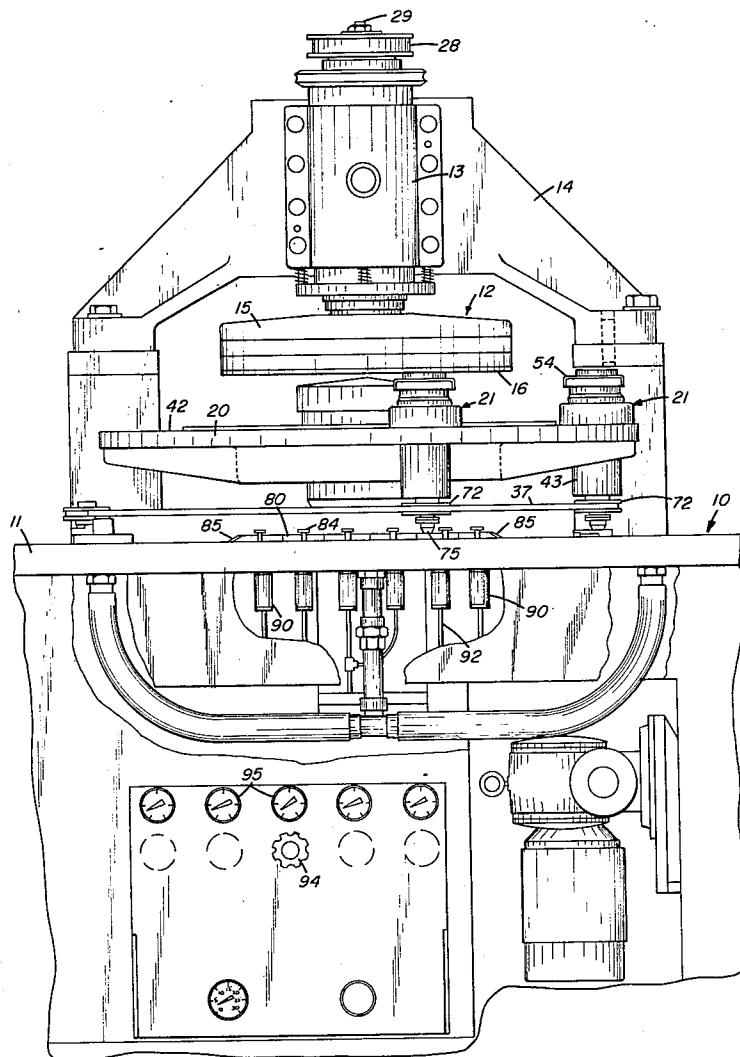
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[57] **ABSTRACT**

A plurality of pivotally mounted members are arranged in a plane parallel to and spaced from a lapping surface and relative to the path of movement of an element so as to move the element axially and to provide a pressure pattern comprising a number of incrementally increasing and/or decreasing pressures with which the element can be maintained in engagement with the lapping surface. Each of the pivotal members is responsive to the force exerted thereagainst by a gas- or liquid-actuated plunger. With a group of such members arranged relative to the path of travel of the element, the pressure with which the element is maintained against the lapping surface can be varied to increase uniformly from one end to the other, to decrease uniformly from one end to the other, or to provide a number of variable pressures throughout the path of travel during the lapping operation. In other words, a pressure pattern can be devised for any one or a combination of material, lapping speed, element hardness, etc.

3 Claims, 3 Drawing Figures



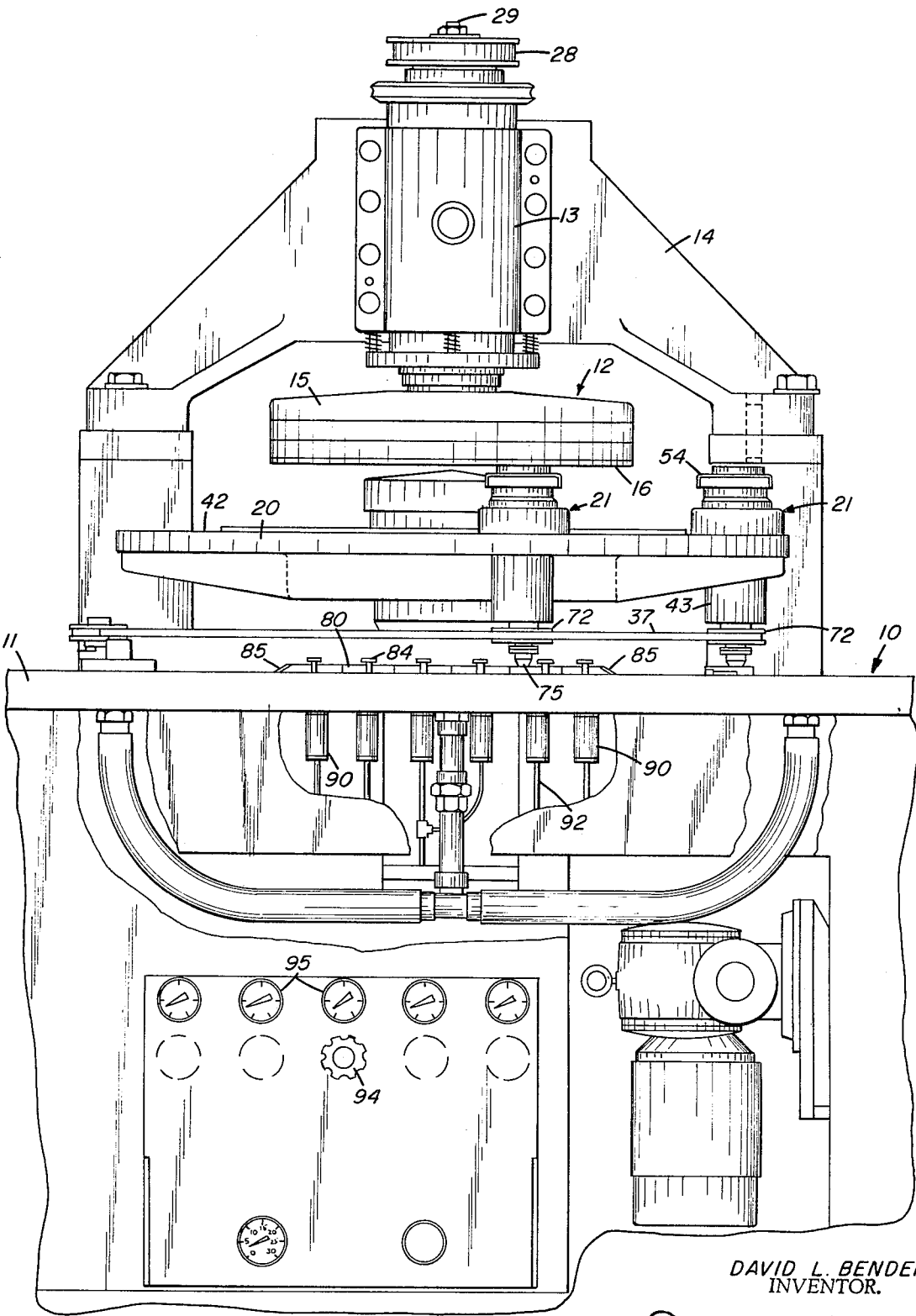


FIG. 1

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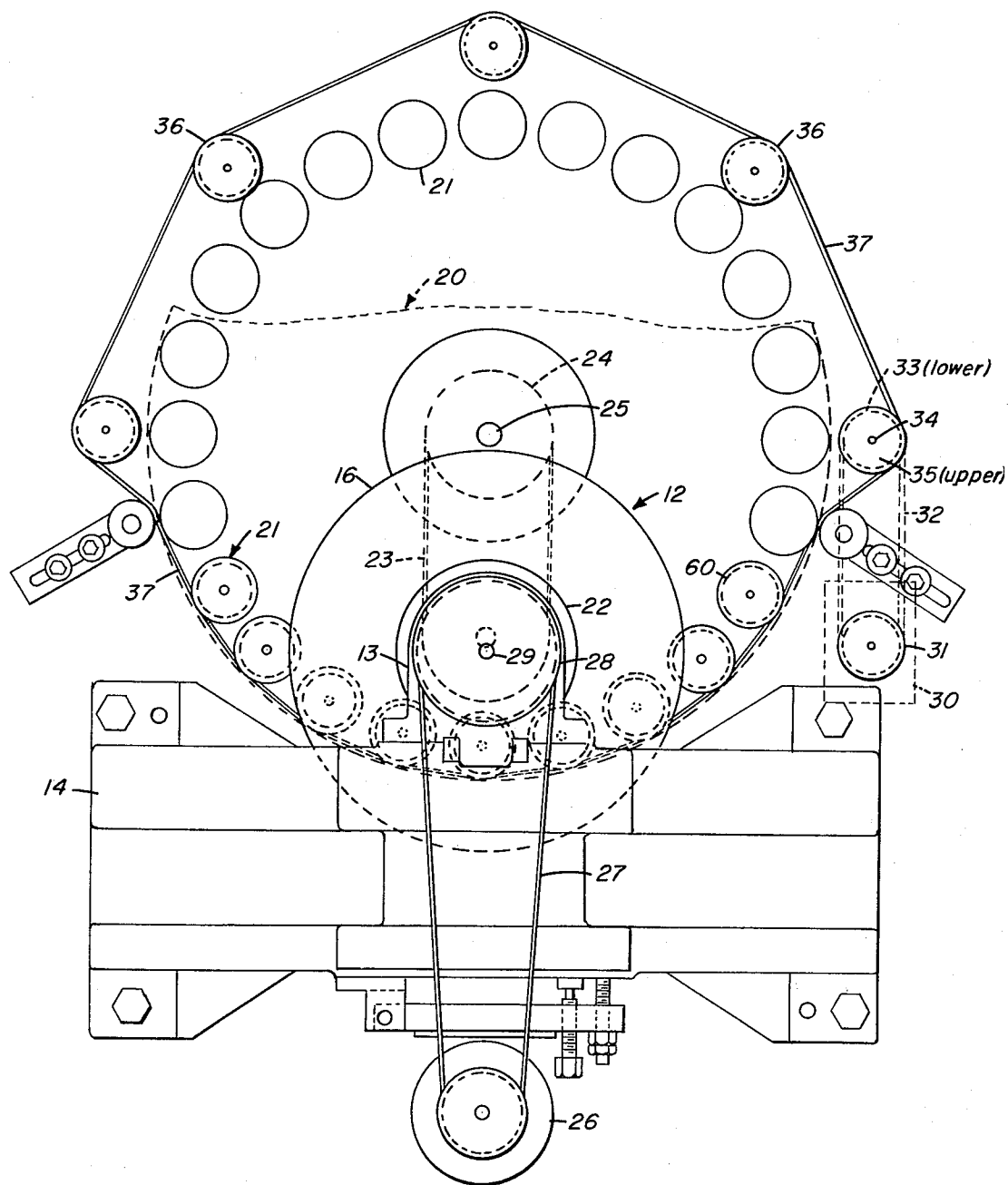


FIG. 2

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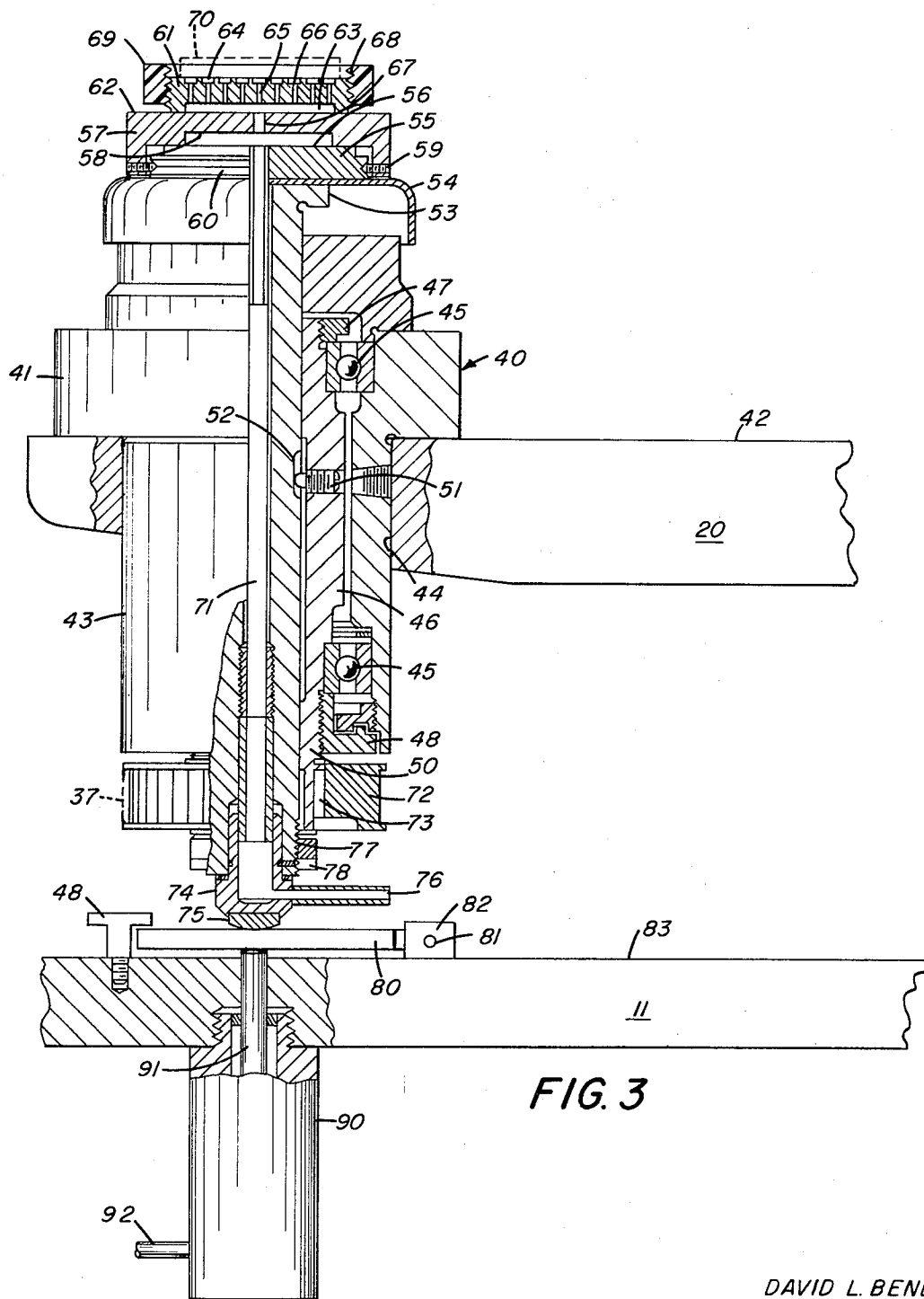


FIG. 3

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PRESSURE CONTROL FOR LAPPING DEVICE

FIELD OF THE INVENTION

The invention relates to a lapping device and more particularly to an arrangement for controlling the pressure and for providing a pressure pattern with which the surface of an element that is to be lapped is maintained against the surface of a lapping wheel.

DESCRIPTION OF THE PRIOR ART

It is well known in the lapping art to provide apparatus that is capable of imparting a smooth surface to a planar surface or to a peripheral surface of an element. It is customary to mount a number of elements, particularly if in the form of a glass disc or a lens, on a carrier by means of pitch or other suitable adhesive materials. The carrier is usually rotated with respect to a polishing or lapping member that is also rotated, or rotated and oscillated. However, when lapping a material such as glass, a chip from a disc or a lens that is being lapped can be carried under the polishing member and cause damage to the other discs or lenses that are mounted on the same carrier.

When lapping thin crystal wafers of a material, such as germanium, silicon or a similar material, that are used in the field of electronics as the basic element for a transistor, the general principles for lapping or polishing glass are usually followed for polishing the planar surfaces of the crystal material to a thickness and parallelism of very small tolerance. The number of wafers that might be scratched or made unusable due to cracking or chipping during the lapping operation can result in a relatively high cost having to be applied to those wafers that are successfully lapped without damage. One of the primary causes for cracking or chipping wafers during the lapping operation is the pressure with which the wafer is maintained against the surface of the lapping wheel.

In U.S. Pat. No. 3,492,762, issued on Feb. 3, 1970 to Robert G. Heinrich, a lapping device is disclosed in which individual crystal wafers or elements are maintained in engagement with a lapping surface by means of an arcuate, planar cam which moves each discrete holder of a crystal toward the lapping surface as it is moved into proximity thereto and holds the wafer in engagement with the lapping surface throughout its movement in that portion of its designated path which intersects the lapping surface. It has been found that best results can be obtained, not only as to smoothness of the surface being lapped but also with respect to damage to the wafer, when the pressure with which the wafer is maintained against the lapping surface can be varied to provide a pattern of pressure throughout the portion of its path through which it is moved during the lapping operation, such a pressure pattern taking into account the type of material, the lapping speed, the required smoothness tolerance, etc.

SUMMARY OF THE INVENTION

The primary object of the invention is to provide a suitable control for maintaining a surface of an element to be lapped in engagement with a lapping surface with a preset or designated pressure pattern throughout its movement along a path and relative to the lapping surface.

Another object of the invention is to provide a suitable control whereby an element can be maintained against a lapping surface with an incrementally variable pressure throughout its path of travel.

Still another object of the invention is to provide a control comprising a plurality of independently adjustable pressure members for maintaining an element against a lapping surface with a preset or designated pressure pattern throughout its path of travel relative to the lapping surface.

The above objects and advantages of the invention are attained by positioning an element to be lapped on a supporting member mounted on a rotatable carrier that moves each element across and relative to a planar lapping surface. The element is retained on a holder that can be rotated as well as moved axially toward and away from the lapping surface independent of the rotation of the carrier. A plurality of pivotally mounted members are arranged in a plane parallel to and spaced from the lapping surface and relative to the path of movement of the element so as to move the element axially and to provide a pressure pattern comprising a number of incrementally increasing and/or decreasing pressures with which the element can be maintained in engagement with the lapping surface. Each of the pivotal members is responsive to the force exerted thereagainst by a gas- or liquid-actuated plunger. With a group of such members arranged relative to the path of travel of the element, the pressure with which the element is maintained against the lapping surface can be varied to increase uniformly from one end to the other, to decrease uniformly from one end to the other, or to provide a number of variable pressures throughout the path of travel during the lapping operation. In other words, a pressure pattern can be devised for any one or a combination of material, lapping speed, element hardness, etc.

With such a pressure control arrangement, the movement of the element to be lapped toward the lapping surface is accomplished and maintained by each respective pivotal member. The means by which each element is returned to a position in which it is displaced from the lapping surface is accomplished by air pressure or resilient means associated with each respective supporting member on the carrier. Inasmuch as the working pressures can be adjusted in increments throughout the path of travel, various materials can be easily accommodated to the same lapping surface or the lapping characteristics of the surface and which might be dependent on the lapping pressure.

Other objects and advantages of the invention will be apparent to those skilled in the art by the description which follows.

DESCRIPTION OF THE DRAWINGS

Reference is now made to the accompanying drawings wherein like reference numerals designate like parts and wherein:

FIG. 1 is a front elevational view of a lapping device embodying the invention;

FIG. 2 is a plan view showing particularly the drive means for moving the lapping wheel and the carrier as well as the drive means for each individual element holder; and

FIG. 3 is a vertical sectional view through a supporting member showing one of several pressure control members by which the element is maintained in engagement with the lapping surface.

DESCRIPTION OF THE PREFERRED EMBODIMENT OF THE INVENTION

With reference particularly to FIGS. 1 and 2, a support means 10 comprises a bedplate 11 which is mounted on a suitable framework (not shown) so that the bedplate is positioned at a workable height for an operator. A lapping member 12 including its associated spindle or shaft is rotatably mounted in a bracket 13 that is fixed to a support bracket 14 which, in turn, is mounted on the bedplate.

The lapping member 12 comprises a cast disc 15 having a lapping wheel 16 secured thereto in any well known manner. The lapping member 12 overlies a carrier 20 on which a plurality of supporting members designated by the numeral 21 are rotatably mounted. The carrier 20 is rotated by means of a motor 22 that is connected by a belt 23 to a pulley 24 on a shaft 25 to which the carrier is fixed. The carrier 20 moves the supporting elements 21 in an arcuate path across a portion of the lapping wheel 16 as seen in FIG. 2. The lapping member 12 is rotated by a motor 26 by means of a belt 27 which engages a pulley 28 on the associated spindle or shaft 29 of member 12 that is rotatably mounted in bracket 13, as seen in FIGS. 1 and 2 and as shown and described in the above-mentioned U.S. Pat. No. 3,492,762.

The drive means for rotating the supporting members 21 comprises a motor 30 which drives a pulley 31 connected by a belt 32 to a pulley 33 (lower) on a shaft 34; the latter also carrying another pulley 35 (upper) arranged above pulley 33. A plurality of pulleys 36 are arranged around the periphery of carrier 20, in a pattern as shown in FIG. 2, and are connected by a belt 37 to the one pulley 35 that is on the same shaft as pulley 33. The pulleys 36 are arranged in the same plane as pulley 72 (see FIG. 3) on each of the supporting members 21 which will be described in more detail hereinafter. It will be noted from FIG. 2 that the belt 37 engages only those pulleys 36 on the supporting members 21 that are immediately near and directly under the lapping member 12. By this arrangement, the drive means for supporting members 21 is coupled only to those supporting members moved into positions immediately ahead of, aligned with and immediately beyond the lapping member 12.

From the description thus far, it is evident that the lapping member 12 is continuously rotated and the carrier 20 is rotated to move the supporting members 21 in a circular path, a portion of which intersects the surface of the lapping member 12. Also, as the supporting members 21 are moved in this path, rotation of those members leaving and approaching the lapping member 12 is started and ended with engagement and disengagement with belt 37. As pointed out in the above patent, the purpose for rotating the supporting members 21 while in engagement with the lapping member 12 is to produce a smoother surface finish with only single pass under the lapping member 12.

As shown in FIG. 2, the carrier 20 supports a plurality of supporting members 21, all of which are identical

and the following description is, therefore, applicable to each of the members 21. A mounting member 40, see FIG. 3, comprises a flange portion 41 which rests on the upper surface 42 of the carrier 20 and a sleeve portion 43 which extends through an opening 44 in member 20 and toward bedplate 11. The flange 41 is fixed to carrier 20 by suitable fastening means, such as bolts which are not shown, so as to hold the member 40 in a fixed relation to carrier 20. A pair of bearings, each of which is designated by numeral 45, is mounted in member 20 and with respect to an inner sleeve 46. The upper bearing 45 is retained in position by a lock ring 47 and the lower bearing 45 is retained by a threaded ring 48. The inner sleeve 46 serves as a bearing for a tubular member 50, which rotates with sleeve 46 as a unit but is held against rotation relative to sleeve 46 by the set screw 51 but which can be moved axially for a purpose to be described hereinafter and limited in its axial movement by the slot 52 which is engaged by the end of set screw 51. The tubular member 50 is provided with a flange 53 at its upper end which supports a cup-shaped shield 54.

The shield 54 is retained or clamped in position by a holder 55 which overlies shield 54 and is fixed or secured to flange 53 by suitable screws, not shown. The external face 56 of holder 55 supports a replaceable collar 57 which is provided with a circular recess 58 and is retained in position by set screws 59 which engage the peripheral groove 60 in the holder 55. A wafer supporting member 61 is fixed to surface 62 of collar 57 and is provided with a circular recess 63 which is interconnected to surface 64 thereof by a plurality of holes 65 and a patterned recess of grooves or enlarged holes 66 and to recess 58 by a hole or holes 67. The external thread 68 is threadably engaged by a plastic retained ring 69 which prevents any sidewise motion of wafer or element 70 positioned thereon and retained by a suitable vacuum.

The retained ring 68 is, preferably, removed from each of the supporting members 61 in order to establish a common plane of the same height for each of surfaces 64. This is attained by moving the supporting members 21 successively into contact with the lapping member 12 to establish such plane. Once the common plane or height has been established for surfaces 64, a ring 69 is returned to each of respective members 61.

The inner sleeve 46 carries a pulley 72 which is fixed to the sleeve at its lower end by a key 73. The tubular member 50 also carries at its lower end a follower 74 having an insert 75 which is joined by a connector 76 to a source for producing a vacuum or a source of pressurized air. The vacuum is used to retain the elements 70 on their respective member 61 during movement from a loading station, through the abrading station and to an unloading station. In the latter station, air is applied to remove the element. The vacuum or air is directed from connector 76 through a central bore 71, recess 58, holes 67, recess 63, and holes 65 into the pattern of holes 66 beneath the element 70. The tubular member 50 is provided with a threaded end 77 which is engaged by a nut 78 that is adjustable along the threaded portion 79 to control and limit the axial movement of sleeve 50 and, hence, the element 70 in an axial direction toward surface 16 of the lapping member 12.

The pulley 72 is engaged by the belt 37 as the supporting member 21 with its respective holder 55 and element 70 approaches the lapping member 12. Before the supporting member 21 is actually moved under the lapping surface 16, the inner sleeve 46 and member 50 start to rotate upon engagement of belt 37 by pulley 72, such rotation being imparted to tubular member 50 and the element 70 carried or supported thereby through the set screw 51 and slot 52. At this point, the tubular member 50 is at its lowest point with respect to the inner sleeve 46 and the insert 75 is merely spaced from the facing surface of bedplate 11 with sufficient clearance for normal movement in its path.

In the portion of the arcuate path through which the supporting members 21 are moved when under the lapping member 12, there is arranged a plurality of members that are in spaced relation to the carrier 20 and provide means for moving the supporting member with its respective element toward the abrading or lapping surface 16 and for maintaining the surface of the element 70 to be lapped in engagement with the lapping surface. Such means is shown in FIG. 3 and is only one of several arranged in this portion of the path. Specifically, the pressure control means comprises a plate 80 that is pivotally mounted at 81 in a block 82 fixed to the surface 83 of bedplate 11. At the end of plate 80 opposite its pivot, a shoulder screw 84 is arranged to provide a maximum limit of movement for the plate 80. Beneath each of plates 80, a cylinder 90 is mounted with respect to plate 11 and is provided with a plunger 91 which extends through plate 11 and engages the under side of plate 80 as shown in FIG. 3. Each of cylinders 90 is connected by a line 92 to a source (not shown) of either a gas or a liquid medium for varying the pressure exerted by plunger 91 on plate 80.

As shown in FIG. 1, a plurality of plates 80 are arranged on bedplate 11 and each of the plates is connected through a suitable control valve 94 to the source of either a gas or a liquid medium. Also, each of cylinders 90 is associated with a meter or gauge 95 which indicates the pressure being applied to its respective cylinder.

Depending on the type of material that is to be lapped, the pressure applied to each respective cylinder can be the same to provide a constant pressure as the element 70 is moved through the portion of its path with respect to the lapping member 12, can be varied such that the pressure will increase from the entry side of the path to the exit side, or can be varied as an independent increment by each respective cylinder 90. In this way, complete control of the pressure with which the element 70 is urged against the lapping surface 16 can be obtained and a predetermined pressure pattern can be established in accordance with the material, the lapping speed, the required tolerances, etc., as described above.

As shown in the drawings and described above, the pivotally mounted plates 80 are arranged on the bedplate 11 in an arcuate pattern which corresponds to the portion of the path of movement of the elements under the lapping surface 16. As the carrier 20 moves a supporting member 21 toward the lapping member 12, the insert 75 engages a ramp surface 85 on the leading plate 80 and is moved upward and with such movement the tubular member 50 and the element 70 are moved

therewith. The pressure with which the element 70 will be maintained against the lapping surface 16 will be dependent on the preset pressure with respect to each of the cylinders 90. The force exerted on the plate 80 by the plunger 91 minus the combined weights of plate 80 and member 50 with its associated parts will determine the pressure with which the element 70 is maintained against the surface 16. The maximum axial travel of the tubular member 50 and element 70 toward the lapping surface 16 is determined by the preset position of the nut 78 along the threaded end 77 of the tubular member.

As each of the supporting members 21 is moved relative to the lapping surface 16, the pressure exerted on the tubular member 50 can be varied in increments, the number of increments being dependent on the number of plates 80 forming the path through which the element 70 is moved. Inasmuch as each of plates 80 can be individually adjusted to provide a different pressure, the pattern of pressures across the group of plates 80 can assume any pattern that is desirable for the particular material that is being lapped. It should be readily apparent to one skilled in the art that such a pressure pattern that lends itself to being readily adjusted for various types of materials is one which also will permit a maximum surface smoothness to be obtained with a particular type of cutting surface; for example, a very fine or very coarse abrading surface.

As described in the above-mentioned patents, the element 70 is retained on the member 61 by means of a vacuum which is connected to the tubular member 50 via connector 76. When the supporting member 21 reaches the point in its path where it is no longer under the lapping wheel 16, the insert 75 rides off of the last plate 80 via a ramp 85 and moves toward the surface 83 of bedplate 21 by gravity. In this lower position, the set screw 51 will then abut the upper end of the slot 52.

The invention has been described in detail with particular reference to preferred embodiments thereof, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention.

I claim:

1. In a device for abrading a surface of an element retained on a holder that is arranged relative to the abrading surface of a rotatable member and movable axially toward and away from said abrading surface and in a path at least a portion of which intersects said abrading surface; the improvement comprising:

a plurality of independently adjustable members forming a track arranged in generally spaced, parallel relation to said portion of said path for engagement by said holder;

each member being pivotally mounted along an edge thereof and operatively engaging means for establishing an independent operating pressure with which the surface of said element is maintained against said abrading surface as said holder is moved thereover; and

each of said members moving said holder axially toward said abrading surface and maintaining the surface of said element against said abrading surface with a pressure independent of that of each of the other members.

2. The abrading device in accordance with claim 1 wherein said pressure means comprises a pneumatically operable plunger in engagement with said member adjacent the other edge thereof.

3. The abrading device in accordance with claim 1 including means operatively connected to each of said pressure means for establishing an independent operating pressure.

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