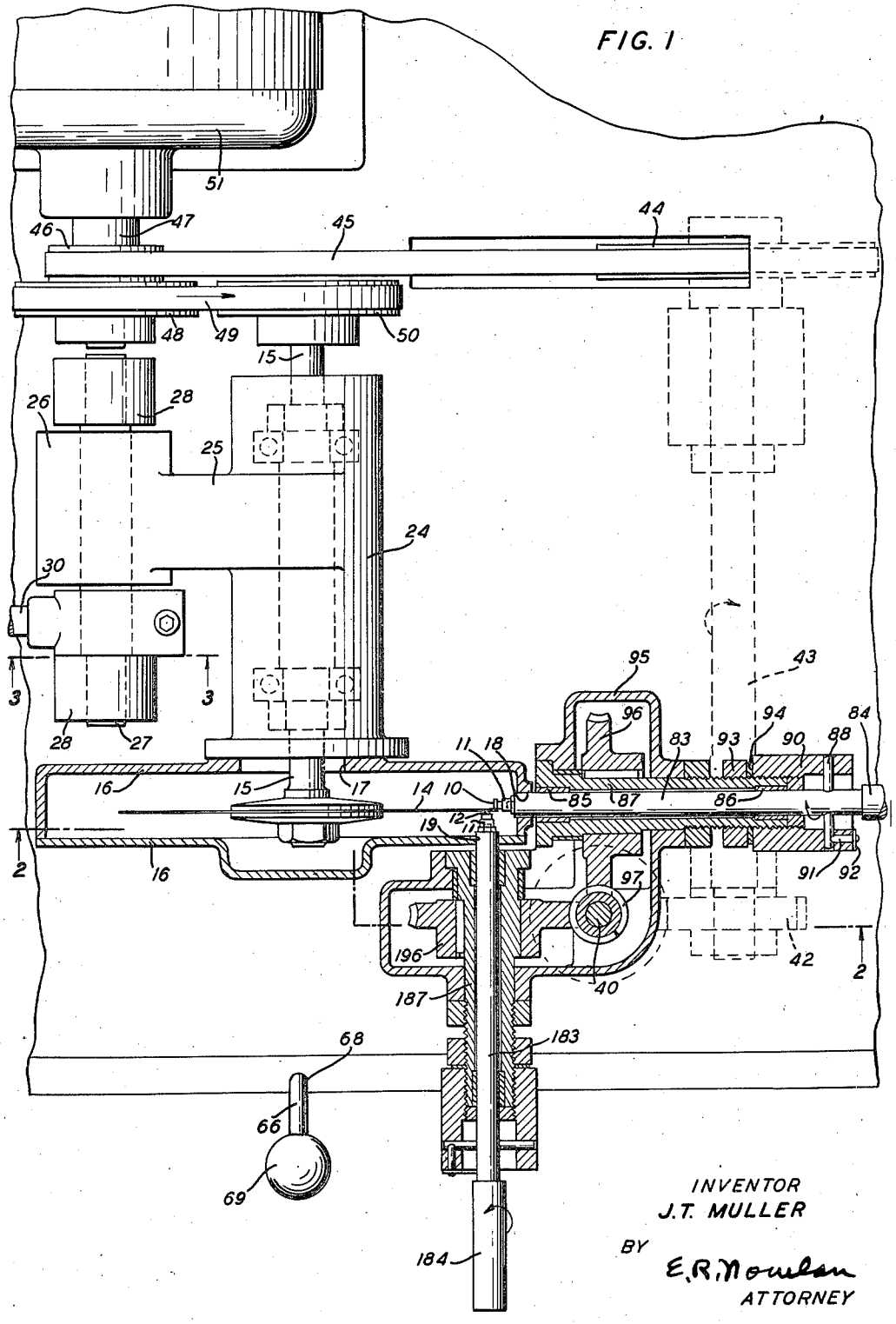
April 16, 1946. J. T. MULLER 2,398,387

MATERIAL FORMING APPARATUS

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FIG. 1



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MATERIAL FORMING APPARATUS

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FIG. 3

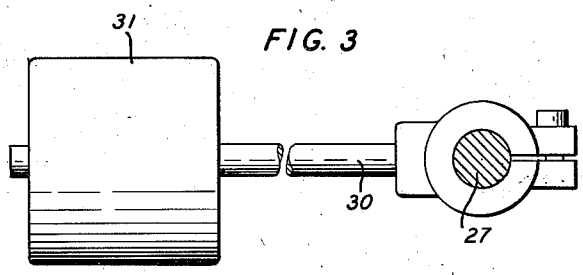


FIG. 2

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MATERIAL FORMING APPARATUS

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FIG. 4

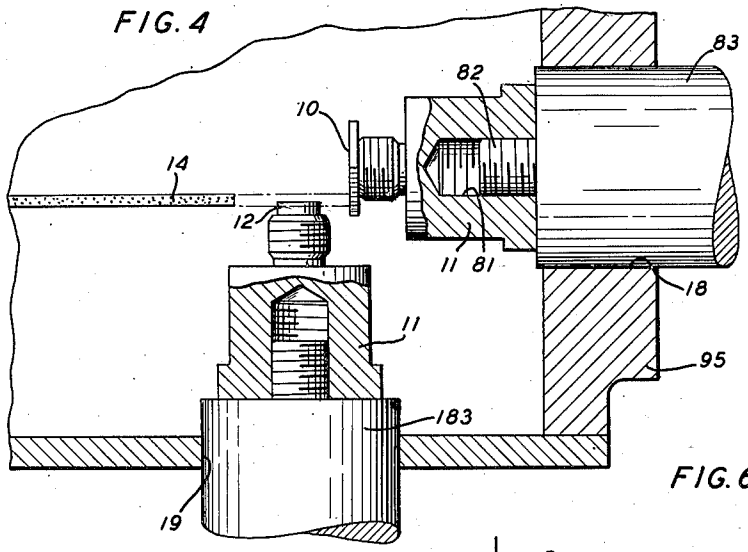


FIG. 5

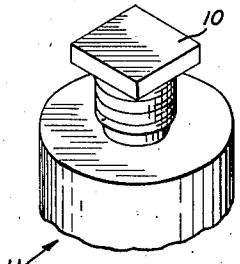


FIG. 6

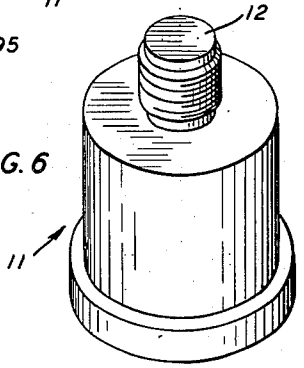
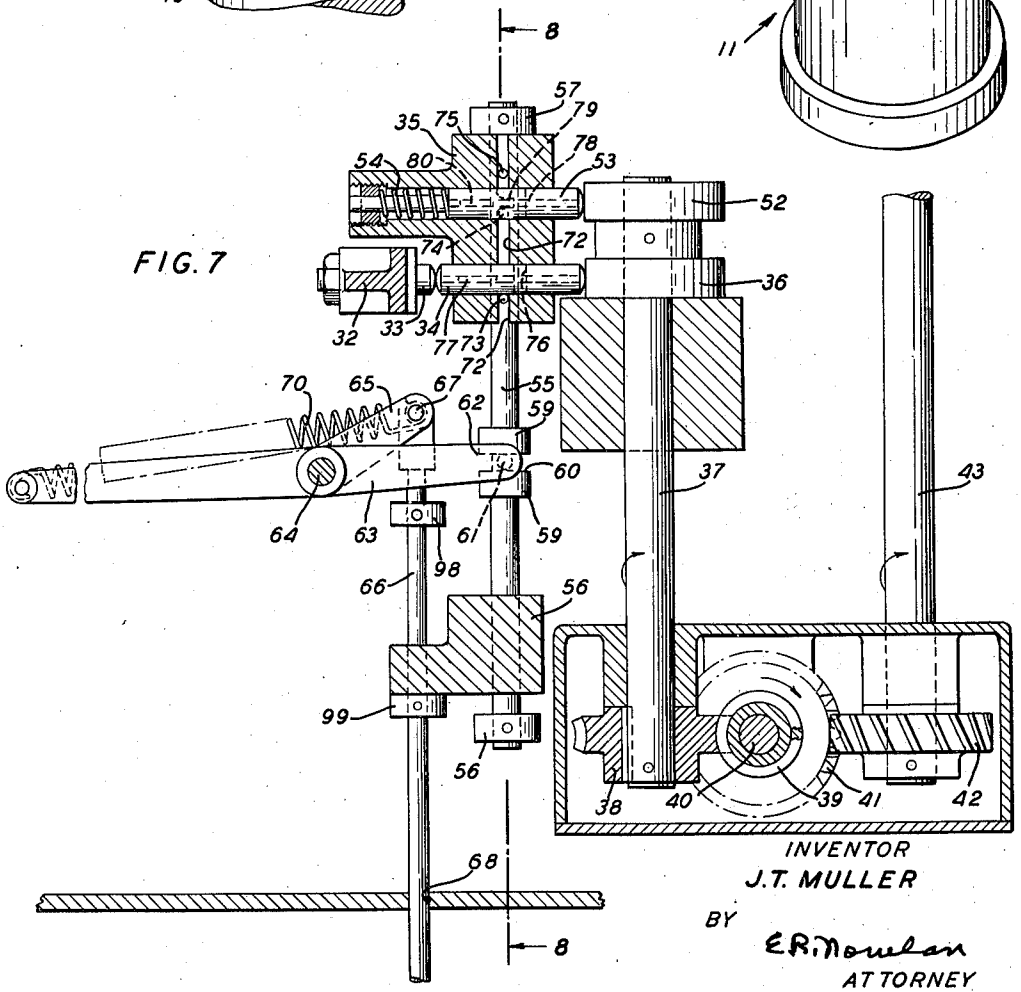


FIG. 7



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MATERIAL FORMING APPARATUS

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FIG. 8

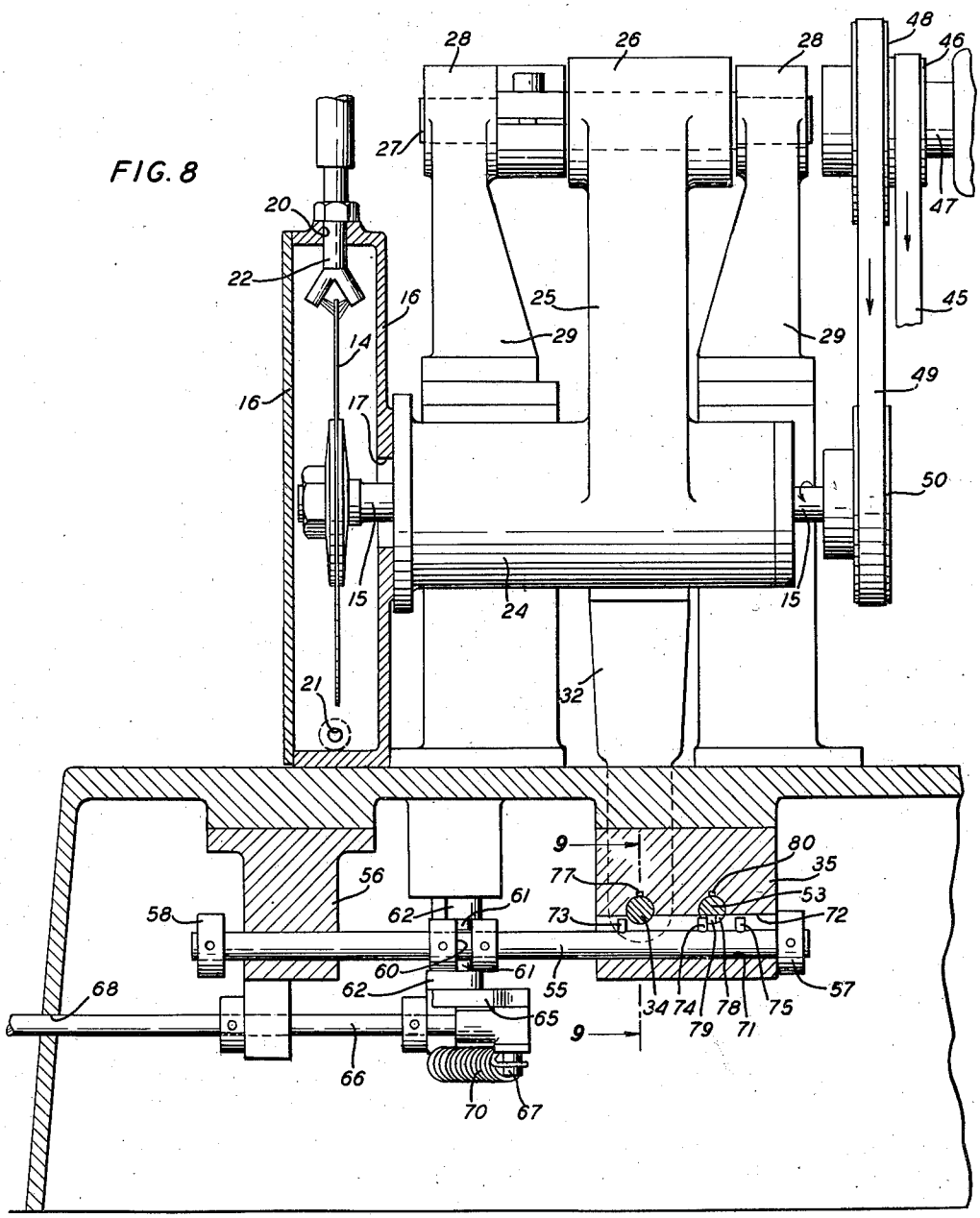
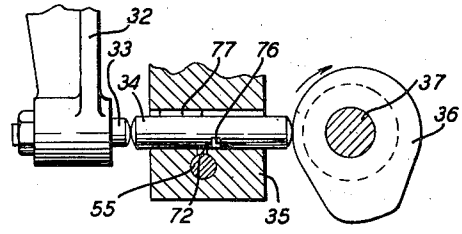


FIG. 9



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Patented Apr. 16, 1946 2,398,387

UNITED STATES PATENT OFFICE

2,398,387

MATERIAL FORMING APPARATUS

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Application May 11, 1944, Serial No. 535,173

16 Claims. (Cl. 51—3)

This invention relates to material forming apparatus and more particularly to apparatus for simultaneously edge trimming one laminar article while facing off a broad surface of another similar article, the apparatus being also particularly adapted to perform these two operations consecutively on any one article.

In recent developments of various electrical arts, numerous applications have been found for slabs, slices, "chequers" or "wafers" of various crystalline materials, e. g. quartz, silicon, and the like. Where "wafers" (i. e. laminar circular disks) of such material are in question, these may be made by cutting from a body of the material "chequers" (i. e. square laminar slices) and then edge trimming such square chequers into circular wafers. It is frequently further desirable that the two broad faces of such a wafer be accurately parallel.

An object of the present invention is to provide simple, rugged and reliable apparatus for converting square chequers of hard material which may have inaccurately parallel broad faces into circular wafers with accurately parallel broad faces.

With the above and other objects in view, the invention may be embodied in an apparatus for simultaneously edge trimming one laminar article and facing another and comprising a saw operative in a fixed plane, means to support a work holding member to present a laminar article held thereon to the saw to be edge trimmed thereby, and means to support the work holding member alternatively to present the laminar article thereon to the saw to be faced thereby.

Other objects and features of the invention will appear from the following detailed description of an embodiment thereof, taken in connection with the accompanying drawings, in which the same reference numerals are applied to identical parts in the several figures and in which:

Fig. 1 is a plan view partly in horizontal section of an apparatus constructed in accordance with the invention;

Fig. 2 is a vertical section on the line 2—2 of Fig. 1;

Fig. 3 is a vertical section on the line 3—3 of Fig. 1;

Fig. 4 is an enlarged detail of a portion of the showing of Fig. 1;

Fig. 5 is a broken detached central perspective of a wafer to be edged and faced, mounted on a holder base;

Fig. 6 is a detached central perspective of the complete holder base with a finished wafer thereon;

Fig. 7 is a section on the line 7—7 of Fig. 2;

Fig. 8 is a section on the line 8—8 of Fig. 2, and

Fig. 9 is a section on the line 9—9 of Fig. 8.

The apparatus herein disclosed as an illustrative embodiment of the invention is specifically constructed to edge and face off square chequers 10 of micro-crystalline silicon mounted on a holder base 11, to convert the chequers into accurately parallel faced circular wafers 12. The tool which simultaneously edges a chequer and faces a wafer is a diamond studded circular saw 14 mounted on and driven by a shaft 15 extending into a casing 16 entirely enclosing the saw except for a slot 17 where the shaft 15 enters the casing, and except for apertures 18 and 19 to be hereinafter described, and except for apertures 20 and 21 which receive and are closed by, respectively, a jet 22 and a drain 23 for cooling fluid for the saw.

The saw shaft 15 is journalled in a sleeve 24 whose forward end makes a tight sliding contact with the casing 16 around the slot 17. The sleeve 24 is carried by an arm 25 having a body 26 rigidly rotatably supported on a shaft 27 journalled in bearings 28, 28 on pedestals 29, 29. A lever 30 is clamped rigidly on the shaft 27 and carries a counterpoise 31, the gravity of whose mass tends to swing the arm 25 and therewith the shaft 15 and saw 14 counterclockwise (Fig. 2) about the axis of the shaft 27. A depending lever arm 32 is secured on the sleeve 24 and carries a rigidly mounted abutment pin 33 horizontally in the lower end thereof to be abutted and actuated by a cylindrical slide bar 34 mounted slidably in a bracket 35 of the machine frame. The slide 34 makes contact with and is actuated by a cam 36 rigid on a horizontal shaft 37 to move the lever 32 and therewith the shaft 15 and saw 14 clockwise about the axis of the shaft 27 against the urge of the counterpoise 31.

The shaft 37 is driven by a worm gear 38, keyed thereon, from a worm 39 near the bottom of a vertical shaft 40 which in turn is driven by a gear 41 below the worm 39 and meshing with a gear 42 driven by a shaft 43 having a pulley 44 driven by a belt 45 from a pulley 46 on a shaft 47 which also through a pulley 48, a belt 49 and a pulley 50, drives the shaft 15. The shaft 47 is positioned to be coaxial with the shaft 27 and is driven by any suitable power means, e. g. a motor 51.

On the shaft 37 to the rear of the cam 36 is secured a second cam 52 of the same contour as the cam 36, acting on a second slide bar 53 in the bracket 35 and parallel to the slide 34, and which is resiliently held against the cam 52 by a spring 54. A slide rod 55, horizontal and at right angles to the slides 34 and 53 and immediately under these, is slidably supported in the bracket 35 and in a second forward bracket 56, and is shown in Fig. 7 in its extreme forward position in which it is stopped by a collar 57 while a collar 58 limits its backward travel. About midway of the slide rod 55 are fixed collars 59, 59 defining

a circumferential slot 60 entered by pins 61, 61 mounted in the arm of a yoke 62 formed integral with the end of one arm of a lever 63 pivoted at 64 on the frame of the machine. A second lever 65 is pivoted on the same stub 64 independently of the lever 63. A pull-rod 66 is pivotally secured at 67 on the outer end of the lever 65, and is supported in the bracket 56 and in an aperture 68 of the machine frame, these supports being made triflingly loose to allow the rod to follow the small lateral component of the short arcuate motion of the pivot 67. At its outer end the rod 66 is furnished with a knob 69. A tension spring 70 is connected between the outer end of the lever 63 and the pivot 67.

Opening from the top of the bore 71 in the bracket 35 in which the slide rod 55 is housed, there is a vertical longitudinal slot 72 through the bracket along the top of the rod. Vertical pins 73, 74 and 75 are mounted in the rod 55 to slide in and be guided by the walls of the slot 72. The slide 34 is formed on its under side with a cross slot 76 to allow the pin 73 to enter therein and pass through when the slot 76 registers with the slot 72. The slide 34 is therefore slidably keyed in the bracket 35 at 77. The slide 53 is formed on its under side with a relatively wide slot 78 for the pin 74, but having a stop tongue 79 formed to allow the pin 74 to enter but not pass through the slot in one position of the slide, and to enter and pass through the slot in another position of the slide. The slide 53 is also keyed slidably in the bracket 35 at 80 to prevent rotation of the slide in the bracket.

The apparatus thus far described constitutes the saw and its drive and control mechanism, whose operation will be described hereinafter. There remains to be described now the work holding and feeding arrangements with their drive and control mechanism.

As above noted, the work comes to the present apparatus as a square chequer 10 mounted on a work holder 11, shown complete in Fig. 6. The chequer 10 is to be edge trimmed to produce a wafer 12 and is to have its exposed flat surface faced off as a plane perpendicular to the axis of the holder 11. To this end, the holder 11 has an axial bore 81 threaded to receive a threaded axial tang 82 formed on one end of a relatively long, cylindrical carrier rod 83 formed at its other end with an enlarged cylindrical handle 84. The bar 83 is axially insertible into and removable from accurately fitting supporting bearings 85 and 86 mounted in a hollow shaft 87 and the bar is removably locked in place in the shaft by a cross pin 88 in the bar entering a bayonet joint slot 89 in a hollow head 90 mounted on the shaft and yieldably retained therein by a pin 91 and spring 92. The head 90 is threaded on the outer end of the shaft 87 and secured by a nut 93 and lock washer 94.

The shaft 87 is journalled to stand parallel to the plane of the saw 14 in a housing 95 mounted on the machine frame, and is driven by a gear 96 from a worm 97 on the upper end of the shaft 40. When the carrier rod 83 is locked home in the shaft 87, the rod enters the saw housing 16 through the closely but not tightly fitting aperture 18 and brings the chequer 10 carried by the rod 83 into the path of the saw 14 to be edge trimmed thereby to form a wafer 12.

Located in the same horizontal plane as the shaft 87, with similar associated parts and similarly arranged and supported in the housing 95, is a second shaft 187 identically like the shaft 87 and positioned at right angles to the shaft 87 and to the plane of the saw 14, and driven by a gear 196 from the same worm 97 that drives the gear 96 on the shaft 87. When the bar 183 with a wafer 12 is locked in place in the shaft 187, the bar enters the saw housing 16 through the aperture 19 and brings the wafer 12 into the path of the saw 14 to have the broad outer surface of the wafer faced off by the saw.

As illustrated in the drawings the several parts of the machine are shown in their respective positions at the end of an edging cut on the chequer 10 and of a simultaneous facing cut on the wafer 12. The slides 34 and 53 are in their extreme right positions on the low dwells of the cams 36 and 52. The continued rotation of the shaft 37 then brings these slides rapidly up on the high dwells of the two cams forcing the slides rapidly to the left, an idle motion of the slide 53 with the rod 55 in the position shown, but causing the slide 34 to drive the arm 32 and therewith the sleeve 24 and the saw 14 to the left until the saw is clear of both pieces of work. The high dwell of the cam 34 holds the saw, still running, out of the way long enough to permit an attendant to remove the carrier bar 183 with its edged and faced wafer 12 entirely from the machine, to remove the bar 83 with its edged but unfaced wafer from the shaft 87 and insert and lock it into the shaft 187, and to insert and lock a third carrier bar with chequer 10 thereon to be edged and faced, into the shaft 87.

The slide 34 then moves slowly and regularly toward the right as the cam diminishes from its high dwell toward its low dwell, allowing the counterpoise 31 to drive the saw slowly and steadily through the operative portion of its cycle to edge the one work piece mounted on the shaft 83 while simultaneously facing the other piece mounted on the shaft 183.

If, for any reason, it be desired to hold the saw in its inoperative position without stopping the drive of the machine, the knob 69 is used to draw the pull-rod 66 forward until stopped by contact of the collar 98 with the bracket 56. This action swings the lever 65 (Fig. 7) forward past the lever 63 and the spring 70 then tends to turn the lever 63 counterclockwise (Fig. 7) and thus to force the rod 55 rearwardly. This rod, however, cannot move unless the slot 76 of the slide 34 and the right hand side of the slot 78 of the slide 53 be aligned with the slot 72 of the bracket 35. The parts are so proportioned and arranged that this takes place only when the two slides are driven to the extreme left by the high dwells of the cams 36 and 52, i. e. when the saw is in its leftmost and inoperative position. Then the pin 73 enters the slot 76 and the pin 74 enters the slot 78 until the collar 58 stopping against the bracket 56 halts the progress of the rod 55 toward the rear. The pin 74 is now in the upper end of the slot 78 above the tongue 79; and so long as it is there the slide 53 is driven idly to and fro by the cam 52. The pin 73 is in the upper end of the slot 76; and so long as it stands there it holds the slide 34 and thereby the saw in their respective left-most positions; and the cam 36 does not touch the slide 34 except inoperatively as the high dwell of the cam passes the end of the slide. The spring 70 now tends to turn the lever 63 counter-clockwise and the lever 65 clockwise, thus maintaining all the parts under the control of the spring in the positions described.

When it is desired to render the saw again

operative, the knob 69 is used to push the rod 66 rearwardly until stopped, as shown, by the collar 99 against the bracket 56, thus swinging the lever 65 rearwardly past the lever 63. The spring 70 then tends to turn the lever 63 clockwise and thus to draw the rod 55 forward. However, unless the slide 53 is in its leftmost position, the tongue 79 prevents the pin 74 (now in back of the tongue) and thereby the rod 55 from moving forward until the cam 52 has driven the slide 53 to its leftmost position, i. e. until the cam 36 is holding the saw in its leftmost position by contact of the high dwell of the cam 36 with the slide 34. At this moment the paths are clear for both pins 73 and 74 to snap forward with the rod 55 into the position shown; and the machine then resumes its normal cycle of operation.

What is claimed is:

1. Apparatus for simultaneously edge trimming one laminar article and facing another and comprising a rotary cutting disk operative in a fixed plane, means to support an elongated work holding member in a position parallel to the plane of the disk to present a laminar article held thereon to the disk to be edge trimmed thereby, and means to support the work holding member alternatively in a position perpendicular to the plane of the disk to present the laminar article thereon to the disk to be faced thereby.

2. Apparatus for simultaneously edge trimming one laminar article and facing another and comprising a rotary cutting disk operative in a fixed plane, means to support an elongated work holding member in a position parallel to the plane of the disk to present a laminar article held thereon to the disk to be edge trimmed thereby, and means to support the work holding member alternatively in a position perpendicular to the plane of the disk to present the laminar article thereon to the disk to be faced thereby in combination with a work holding member fittable into either of the two said supporting means to be held thereby in operative relation to the disk.

3. Apparatus for simultaneously edge trimming one laminar article and facing another and comprising a rotary cutting disk operative in a fixed plane, means to support an elongated work holding member in a position parallel to the plane of the disk to present a laminar article held thereon to the disk to be edge trimmed thereby, means to rotate the member about the axis of the member while in the supporting means, means to support the work holding member alternatively in a position perpendicular to the plane of the disk to present the laminar article thereon to the disk to be faced thereby, and means to rotate the member about the axis of the member while in the second named supporting means.

4. Apparatus for simultaneously edge trimming one laminar article and facing another and comprising a rotary cutting disk operative in a fixed plane, means to support an elongated work holding member in a position parallel to the plane of the disk to present a laminar article held thereon to the disk to be edge trimmed thereby, means to rotate the member about the axis of the member while in the supporting means, means to support the work holding member alternatively in a position perpendicular to the plane of the disk to present the laminar article thereon to the disk to be faced thereby, and means to rotate the member about the axis of the member while in the second named supporting means in combination with an elongated work holding member fittable into either of the two said supporting means to be held thereby in operative relation to the disk.

5. Apparatus for simultaneously edge trimming one laminar article and facing another and comprising a rotary cutting disk operative in a fixed plane, means to shift the disk in the said plane from an operative position thereof to an inoperative position and back, means to support a work holding member to present a laminar article held thereon to the disk when in the operative position thereof to be edge trimmed thereby, and means to support the work holding member alternatively to present the laminar article thereon to the disk when in the operative position thereof to be faced thereby.

6. Apparatus for simultaneously edge trimming one laminar article and facing another and comprising a rotary cutting disk operative in a fixed plane, means to shift the disk in the said plane from an operative position thereof to an inoperative position and back, means to support a work holding member to present a laminar article held thereon to the disk when in the operative position thereof to be edge trimmed thereby, and means to support the work holding member alternatively to present the laminar article thereon to the disk when in the operative position thereof to be faced thereby in combination with a work holding member fittable into either of the two said supporting means to be held thereby in operative relation to the disk.

7. Apparatus for simultaneously edge trimming one laminar article and facing another and comprising a circular cutting disk operative in a fixed plane, means to drive the disk in rotation, means to shift the disk cyclically without affecting the rotation thereof in the said plane from an operative position thereof to an inoperative position and back, means to support a work holding member to present a laminar article held thereon to the disk when in the operative position thereof to be edge trimmed thereby, and means to support the work holding member alternatively to present the laminar article thereon to the disk when in the operative position thereof to be faced thereby.

8. Apparatus for simultaneously edge trimming one laminar article and facing another and comprising a circular cutting disk operative in a fixed plane, means to drive the disk in rotation, means to shift the disk cyclically without affecting the rotation thereof in the said plane from an operative position thereof to an inoperative position and back, means to support a work holding member to present a laminar article held thereon to the disk when in the operative position thereof to be edge trimmed thereby, and means to support the work holding member alternatively to present the laminar article thereon to the disk when in the operative position thereof to be faced thereby in combination with a work holding member fittable into either of the two said supporting means to be held thereby in operative relation to the disk.

9. Apparatus for simultaneously edge trimming one laminar article and facing another and comprising a circular cutting disk operative in a fixed plane, means to drive the disk in rotation, means to shift the disk cyclically without affecting the rotation thereof in the said plane from an operative position thereof to an inoperative position and back, means to support an elongated work holding member in a position perpendicular to the plane of the disk to present the laminar article

thereon to the disk to be faced thereby, means to rotate the member about the axis of the member while in the supporting means, means to support the work holding member alternatively in a position parallel to the plane of the disk to present the laminar article thereon to the disk to be edge trimmed thereby, and means to rotate the member about the axis of the member while in the second named supporting means.

10. Apparatus for simultaneously edge trimming one laminar article and facing another and comprising a circular cutting disk operative in a fixed plane, means to drive the disk in rotation, means to shift the disk cyclically without affecting the rotation thereof in the said plane from an operative position thereof to an inoperative position and back, means to support an elongated work holding member in a position perpendicular to the plane of the disk to present the laminar article thereon to the disk to be faced thereby, means to rotate the member about the axis of the member while in the supporting means, means to support the work holding member alternatively in a position parallel to the plane of the disk to present the laminar article thereon to the disk to be edge trimmed thereby, and means to rotate the member about the axis of the member while in the second named supporting means in combination with an elongated work holding member fittable into either of the two said supporting means to be held thereby in operative relation to the disk.

11. Apparatus for simultaneously edge trimming one laminar article and facing another and comprising a circular cutting disk operative in a fixed plane, means to drive the disk in rotation, means to shift the disk cyclically without affecting the rotation thereof in the said plane from an operative position thereof to an inoperative position and back, means to support a work holding member to present a laminar article held thereon to the disk when in the operative position thereof to be edge trimmed thereby, means to support the work holding member alternatively to present the laminar article thereon to the disk when in the operative position thereof to be faced thereby, and means to retain the disk at will in the inoperative position thereof without stopping the rotation thereof.

12. Apparatus for simultaneously edge trimming one laminar article and facing another and comprising a circular cutting disk operative in a fixed plane, means to drive the disk in rotation, means to shift the disk cyclically without affecting the rotation thereof in the said plane from an operative position thereof to an inoperative position and back, means to support a work holding member to present a laminar article held thereon to the disk when in the operative position thereof to be edge trimmed thereby, means to support the work holding member alternatively to present the laminar article thereon to the disk when in the operative position thereof to be faced thereby, and means to retain the disk at will in the inoperative position thereof without stopping the rotation thereof in combination with a work holding member fittable into either of the two said supporting means to be held thereby in operative relation to the disk.

13. Apparatus for simultaneously edge trimming one laminar article and facing another and comprising a circular cutting disk operative in a fixed plane, means to drive the disk in rotation, means to shift the disk cyclically without affecting the rotation thereof in the said plane from an operative position thereof to an inoperative position and back, means to support an elongated work holding member in a position perpendicular to the plane of the disk to present the laminar article thereon to the disk to be faced thereby, means to rotate the member about the axis of the member while in the supporting means, means to support the work holding member alternatively in a position parallel to the plane of the disk to present the laminar article thereon to the disk to be edge trimmed thereby, means to rotate the member about the axis of the member while in the second named supporting means, and means to retain the disk at will in the inoperative position thereof without stopping the rotation thereof.

14. Apparatus for simultaneously edge trimming one laminar article and facing another and comprising a circular cutting disk operative in a fixed plane, means to drive the disk in rotation, means to shift the disk cyclically without affecting the rotation thereof in the said plane from an operative position thereof to an inoperative position and back, means to support an elongated work holding member in a position perpendicular to the plane of the disk to present the laminar article thereon to the disk to be faced thereby, means to rotate the member about the axis of the member while in the supporting means, means to support the work holding member alternatively in a position parallel to the plane of the disk to present the laminar article thereon to the disk to be edge trimmed thereby, means to rotate the member about the axis of the member while in the second named supporting means, and means to retain the disk at will in the inoperative position thereof without stopping the rotation thereof in combination with an elongated work holding member fittable into either of the two said supporting means to be held thereby in operative relation to the disk.

15. Apparatus for simultaneously shaping two articles and comprising a thin rotary cutting disk operative in a fixed plane, means to support one work holding member to apply an article held thereby to one face of the disk, and means to simultaneously support another work holding member to apply a second article held thereby to the other face of the disk at a position substantially opposite to the position of application of the first named article so that each article supports the disk against deflection by the other article.

16. Apparatus for simultaneously shaping two articles and comprising a thin rotary cutting disk operative in a fixed plane, means to support one work holding member to apply an article held thereby to one face of the disk, and means to simultaneously support another work holding member to apply a second article held thereby to the outer face of the disk at a position approximately opposite to the position of application of the first named article so that each article supports the disk against deflection by the other article in combination with a pair of work holding members each fittable into either of the two said supporting means to be held thereby in operative relation to the disk.

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