Dec. 5, 1961 F. H. WALKER ET AL 3,011,374

WAFER COIL MANUFACTURE

Filed Nov. 8, 1955 2 Sheets-Sheet 1

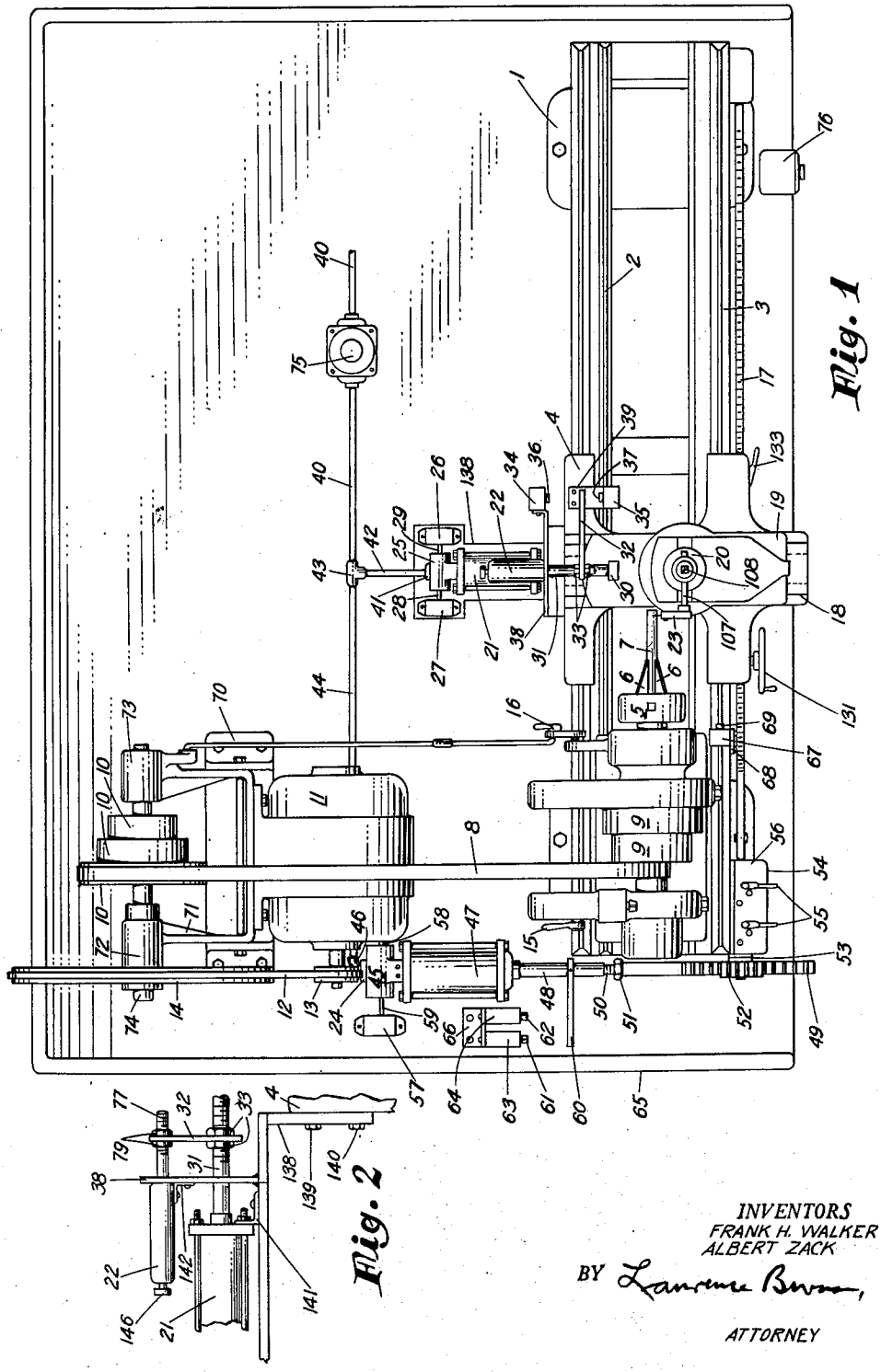


Fig. 1

Fig. 2

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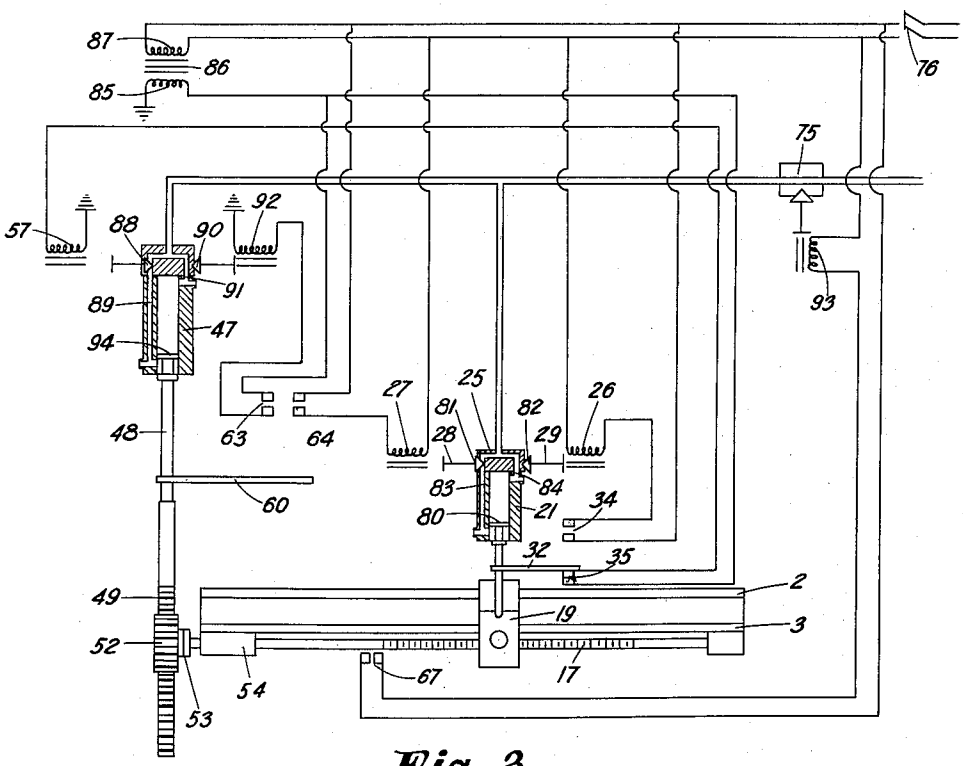


Fig. 3

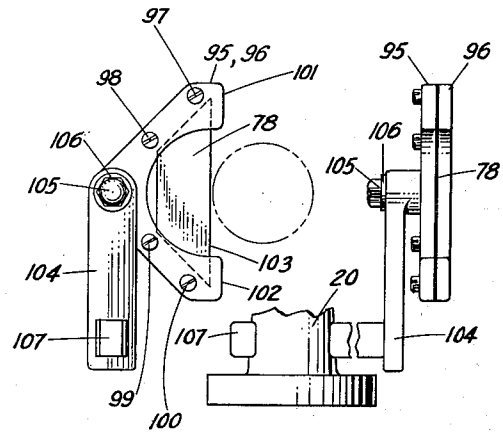


Fig. 4

Fig. 5

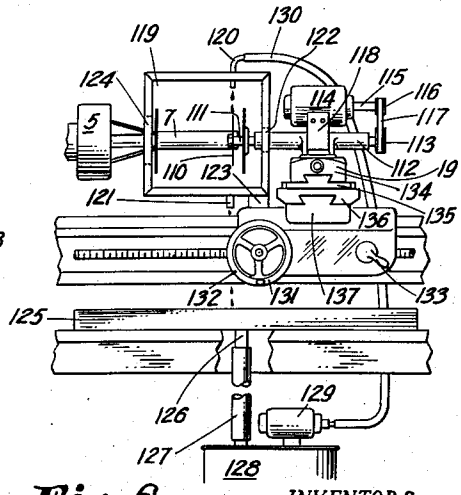


Fig. 6

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WAFER COIL MANUFACTURE

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This invention relates to methods and apparatus for the manufacture of wafer coils, and particularly for the manufacture of such coils by cutting slices from a roll of metallic foil wound with insulation between its turns.

In making such coils, a wide sheet of metallic foil and a wide sheet of insulating material are generally wound on a core. Several sheets of foil, or several sheets of insulating material, or several sheets of each, may be wound together. Instead of using a sheet of insulating material, an insulating coating may be placed directly on the foil, if desired, and the insulated foil then wound directly on itself. But whatever the method of winding the roll, the result will be a winding of foil, with solid insulating material between the turns of the winding. The winding will generally be impregnated with a suitable insulating material such as wax or a plastic.

Thin wafer coils are then cut from the wide roll of wound foil. The cutting can be done with a knife if the roll is impregnated with a sufficiently soft material such as wax, or with a rotating cutter wheel if the impregnating material is a hard resin.

An object of the present invention is to facilitate the cutting of said coils from the roll. A further object is to provide automatic means for performing the cutting.

When the cutting is done by a rotating wheel, the material in the coil is sawed out and lost for a distance equal to the thickness of the wheel. Since the thickness of the coil to be cut is in many cases very small, the thickness of the material cut out between coils by the wheel can be a considerable portion of the thickness of the coil. There could thus be a large loss of material, unless the wheel is extremely thin compared to the thickness of the wafer coil to be cut from the roll. Making the wheel thin reduces its heat conductivity, but we find that excessive heating can be prevented by using a cooling fluid, for example, water, on the wheel and the coil.

When a knife is used, there is no material lost in the cutting. The knife blade must be extremely thin, however, and we find that to maintain its shape during the cut, the blade should be very rigidly held so that it cannot bend. In general, this can be achieved by fixing the blade between two rigid support members, each of which is secured to the blade along a non-cutting edge thereof. In the embodiment described, the blade is held at the apex of a comparatively heavy V-shaped or U-shaped member, the legs of which spread out sufficiently to clear the coil.

According to our invention, the wound roll is rotated while the cutter is reciprocated transversely against the coil, the cutter being moved along the axis of the roll between cuts a distance about equal to the desired thickness of the wafer coil. We find that the speed with which the cutter is moved in cutting the coil is quite important, too high a speed ripping the layers of foil and paper, and too low a speed smearing the foil over the face of the coil. A speed such that the cutter moves into the roll during each revolution thereof a distance about equal to the distance between turns of the foil is preferable, and the speed should not ordinarily be more than about twice that speed nor less than about half of it.

Since the speed is important, it should also be uniform while the cutter is in contact with the roll. The cutter will come to zero speed at each end of the path in which

it reciprocates, and will then build up again to its maximum speed in the reverse direction. For that reason, the path of the cutter should extend beyond the roll for a considerable distance in each direction, so that the slowing down and building up of speed will not occur while the cutter is in contact with the roll. Starting from zero speed at the beginning of its stroke, the cutter should build up to a maximum constant speed before it contacts the roll and should then maintain that speed until the roll is cut through, after which the cutter can drop to zero speed and reverse.

In the embodiment herein described, a hydraulic check valve is used to keep the motion of the cutter uniform as it passes through the roll.

After the cutter has cut a wafer coil from the roll and has then withdrawn to its starting position, the cutter is moved in the direction of the longitudinal axis of the roll a distance equal to the desired thickness of the coil to be cut off, proper allowance being made for the thickness of the cutter. This motion can be achieved by turning a threaded rod which passes through a correspondingly threaded portion in the cutter support, the rod being set in a direction parallel to the longitudinal axis of the roll. The end of the rod is fixed to a pinion gear which is turned by a reciprocating rack. The pinion is fixed to the rod by a slip-clutch, so that the pinion will turn the rod during the forward motion of the rack, but not during its backward motion, or vice-versa, depending on whether the rod bears right-hand or left-hand threads, and whether the rack is placed above or below the pinion.

We find the proper control of the various movements described above to be quite important.

In the embodiment described, the cutter is reciprocated by a piston operating in a cylinder with air inlets at each end. When the cutter is at each end of its stroke, it actuates mechanism which shifts the air input to the proper inlet to move the piston in the reverse direction. At the return end of its stroke, the cutter actuates mechanism which moves the cutter longitudinally by the amount of the desired thickness of coil to be cut, and the ending of that movement actuates mechanism which starts the cutter on its cutting stroke. After the cutter has moved a longitudinal distance corresponding to the cutting of a predetermined number of coils, it engages a switch which shuts off all further motion of the cutter.

The cutter itself need not actuate the various mechanisms described above; the mechanism can be actuated by the cutter support or by anything which moves with the cutter.

Although the preferred embodiment described below uses resilient switches, air cylinders and solenoid-operated air valves to control the motion of the cutter, other devices can be used.

A particular embodiment of the invention is described in detail below and shown in the drawings, in which:

FIGURE 1 is a plan view of apparatus embodying the invention;

FIGURE 2 is a side elevation of the air cylinder and check valve used in the apparatus;

FIGURE 3 is a schematic drawing of the apparatus in conjunction with the electrical circuit;

FIGURE 4 is a side view of a cutter according to the invention; and

FIGURE 5 is a front view of the same cutter.

FIGURE 6 is a view of another cutter.

In FIGURE 1, the foundation for the device is a standard commercial lathe bed **1**, having the longitudinal ways **2**, **3** along which the lathe cross-feed carriage **4** slides. The chuck **5**, with its jaws **6**, rotates on an axis parallel to the axis of the ways, and the wound roll **7** of foil and insulation is held in the chuck **5** by said jaws **6**. The chuck is rotated by the belt **8**. The belt **8**,

driven from one of the pulleys 10, drives one of the pulleys 9 which transmits motion to the chuck 5. The pulley 10 is driven from an electric motor 11 through another belt 12 and pulleys 13, 14. The gear ratios by which the pulley 9 drives the chuck 5 can be changed in the usual manner by gear shift lever 15, and the pulley ratio by belt shift lever 16.

The carriage 4 has the usual threaded portion in engagement with the screw-threaded rod or lead-screw 17, so that turning of the latter will move the carriage longitudinally along the ways 2. The carriage 4 contains a way 18 raised therefrom, which engage a cross-slide 19 in a sliding fit, so that said cross-slide can move back-and-forth transversely to the longitudinal axis of the chuck 5. The tool holder 20 extends upwardly from the cross-slide 19, and holds the cutting tool.

Thus far, except for the roll 7, and the cutting tool 23, the description has been of an ordinary commercial lathe. In what follows, the additions made to the lathe, and which act in combination with certain parts of the lathe to cut wafer coils from the roll are described.

In an ordinary lathe, the cross-slide 19 is operated by hand, through a crank which turns a screw to which the slide is threaded. In our invention, however, the screw is removed, and an air cylinder 21 which can be of a regular commercial type, arranged to reciprocate the cross-slide 19 and connected thereto by the connecting rod 31. A hydraulic check valve 22 is also connected to said connecting rod 31 to make the motion of the slide uniform as the slide carries the cutting tool 23 through the wound roll 7 to sever a wafer coil therefrom.

The air cylinder 21 has a double solenoid valve 25 at the end thereof opposite to that from which connecting rod 31 extends.

The double solenoid valve 25 can be of an ordinary commercial type, its structure being shown substantially in FIGURE 3. A piston 80 in the air cylinder is connected to a post 30 on the cross-slide 19, by the connecting rod 31. The solenoids 26 and 27, one on each side of valve 25, actuate the valve, through connecting links 28, 29, to direct air into the cylinder 21 at one end thereof or the other, depending on the direction in which the air cylinder is to move the cross-slide 19. The connecting rod 31 carries an extending arm 32, held thereto by the nuts 33. In line with the path in which said arm will be carried by movement of the piston, and at each end of said path, are the switches 34, 35, actuated by the depressing of push buttons 36, 37 respectively. The switches 34, 35 are fixed to brackets 38, 39, attached to the cutting platform 4.

The solenoid valve 25 is supplied with compressed air through pipe 40, connected to the inlet 41 through the conduit 42 and one arm on the T-connection 43. The other arm of the T, through pipe 44, supplies the inlet 24 of another solenoid valve 45 through the elbow 46. The solenoid valve 45 actuates the air cylinder 47, allowing air to enter at one side or the other of a piston 94 therein to move a connecting rod 48, extending from said piston. The latter is not shown in FIGURE 1, since it is inside the air cylinder 47, but it is shown schematically in FIGURE 2. The rod 48 is connected at its end to the rack 49, movable therewith. The connecting rod 48 and the rack 49 are joined by a threaded rod 50, the position of the rack being adjustable by turning said threaded rod in an internally-threaded hole in the end of rack 49. The lock-nut 51 secures the rod 50 in position after adjustment.

The pinion 52 is in engagement with rack 49 and above the latter, being rotatable by movement thereof. Said pinion is attached to the threaded longitudinal rod 17, generally called a lead-screw, through the slip clutch 53 and the adjustable gear train 54, the latter controlling the angular speed ratio between pinion 52 and lead screw 17. The slip-clutch can be of a suitable type, well-known in the art, to transmit power only in one direction of rotation. The levers 55, in the gear train box 56, shift the gears and change the ratio when moved.

The direction of air flow in air cylinder 47 and hence the direction of motion of the connecting rod 48 is controlled by the solenoid 57 and another solenoid on the other side of valve 45, and not appearing in FIGURE 1, because said solenoid lies under the position of motor 11. The solenoids are connected to the valve 45 in the usual manner, by the connecting links 58, 59.

The connecting rod 48 carries the laterally-extending arm 60, which at the end of the retracting stroke of the connecting rod 48, depresses the push-buttons 61, 62 in switches 63, 64 supported from the base plate 65 by the bracket 66. The switches 63, 64 are so located that the arm 60 will depress the push buttons at the end of its retracting stroke.

Switch 67 is attached to the bed plate 1 of the lathe by bracket 68, which holds the switch in position such that its actuating push-buton 69 is depressed by the cutter platform 4, at the end of the latter's longitudinal motion along the ways 2 toward the chuck 5.

The motor 11 is attached to the base plate 65 by a suitable bracket 70, from which extends a U-shaped bracket 71, whose ends carry the bearings 72, 73, in which the shaft 74, carrying the pulleys 10, turns.

The air supply to valves 25, 45 is turned on and off by operation of the solenoid valve 75. The electrical circuit to the apparatus is turned on and off by switch 76.

In FIGURE 2, the connecting rod 31, projecting from air cylinder 21, is connected to the connecting rod 77 extending from the hydraulic check valve 22, by the connecting arm 32 which is held to the respective connecting rods by nuts 79, 79, 33, 33, screwed to threaded portions of the rods 31 and 77.

A bracket 138 is attached to the lathe carriage 4 by the screws 139, 140. A small angle piece 141 connects the air cylinder 21 to the bracket 138. The plate 38 extends upward from bracket 4, to which it is attached, the connecting rods 31 and 77 passing through holes in plate 38, the holes being large enough to permit easy motion of said connecting rods therethrough. A small angle piece 142 attaches check valve 22 to plate 38.

The check valve 22 has the adjusting screen 146.

The electrical and mechanical circuit is shown schematically in FIGURE 3. The solenoid valve 25 is at the end of air cylinder 21, in which the main piston 80 can reciprocate. The valve pistons 81 and 82 are fixed together mechanically so that they move as a unit. Valve piston 81 is shown in closed position, cutting off air flow through the passage 83. Valve piston 82 is shown open, allowing air flow through passage 84 to one side of the piston.

The main piston is shown at the end of its return stroke, with arm 32 closing switch 35. The latter is in a series circuit with the solenoid 57 and the secondary 85 of transformer 86, the primary 87 of said transformer being connected to a suitable power line through the double pole switch 76. The solenoid 57 operates the valve piston 88, the latter opening the passage 89 to air flow when the solenoid 57 is energized. The opposite valve piston 90 is fixed mechanically to valve piston 88 and moves therewith, so that when one valve is open the other closes.

The valve piston 90 can be brought to open position, that is, a position opening passage 91 to air flow, by the passage of current through solenoid 92, which actuates it. One end each of solenoid 57, solenoid 92, and secondary 85 is shown connected to ground, which means that there is a common connection joining one end of each of them. The switch 63 is in the series circuit connecting solenoid 92 to transformer secondary 85.

Switch 64 is in series with solenoid 27 and the power line, and switch 34 is similarly in series with solenoid 26 and the power line, that is the power line which supplies the primary 87 of the transformer 86. Switch 67, at the end of the longitudinal travel of cross slide 19, is in

series with solenoid 93, which closes valve 76 when the switch 67 is closed.

The piston 94, reciprocable in air cylinder 47, is attached to the connecting rod 48, which moves rack 49.

In operating the apparatus, the carriage 4 is moved to a position suitable for making the first cut, by turning the crank 13 which rotates the lead screw 17. The slip-clutch 53 on pinion 49 will permit backward motion of the lead-screw without motion of said pinion. The carriage 4 will then be in its starting position, as shown in FIGURE 2. Switch 76 is then closed, and since switch 35 is held closed by arm 32, the relay 57 will be energized, pulling aside the valve piston 88 and allowing air to flow through passage 89 to one side of air cylinder piston 94, thus driving it forward. For convenience, motion toward the top of the drawing in FIGS. 1 and 2 is considered as being in the forward direction.

Rack 49 moves with piston 94, turning pinion 52 and hence turning lead-screw 17 to move carriage 4 the distance of the desired thickness for the wafer to be cut. At the end of the forward stroke, arm 60 closes switches 63 and 64. The closing of switch 63 actuates solenoid 92, thereby pulling valve piston 90 aside to open the passage 91, allowing air to flow therethrough to the other side of piston 94 forcing it backward. On the backward stroke the motion of this piston will move the rack 49, which will rotate the pinion 52; but the rotation of said pinion will not rotate the lead-screw 17, because slip-clutch 53 permits motion only in the other direction.

Meanwhile, the closing of switch 64 at the end of the forward stroke, actuates solenoid 27, which retracts valve piston 81, allowing air to flow to the rear of piston 80, thereby driving the latter forward. The cross-slide 19, being attached to the piston 80 by connecting rod 31, also moves forward. This is the cutting stroke, because the cross-slide carries the cutting tool with it.

At the end of the cutting stroke, the arm 32 closes switch 34, thereby actuating solenoid 26 and opening the passage 84 allowing air to pass therethrough and force the piston back to its original position at the other end of its stroke. The switch 35 is then closed by arm 32, and the process repeats itself, cutting another wafer.

The cutting of wafers proceeds in the above-described manner, until near the end of the useful portion of roll 7, the cross-slide engages switch 67, closing the same and thereby energizing solenoid 93, which actuates valve 75 and shuts off the air supply, leaving the cross-slide stationary until the machine is restarted with another roll 7.

The cutting tool 23 of FIGURE 1 is shown in more detail in FIGURES 4 and 5. The thin knife blade 78, of the razor blade type, is clamped firmly between the flat-sided U-shaped yolks 95, 96 by the screws 97–100, inclusive. The open ends 101, 102 of the yolks 95, 96, extend slightly beyond the cutting edge 103 of the blade 78, shown just ahead of the roll 7, which appears in phantom.

The blade is thus held firmly against bending, so that it will retain its shape when in contact with the roll. The middle of the yolk is held firmly to the metal post 104 by the screw 105 and the lock-washer 106. The arm 107 extends from post 104 in a direction out of the paper, and is wider near post 104 than it is at its free end. The arm 107 passes through an opening in latter holder 20, and is held in the usual manner by a screw whose square head is shown at 108.

In FIGURE 6, a thin rotating wheel 110 is used as a cutter. The wheel is fixed at its center to a shaft 111, which is held in the elongated bearing 112, in which it turns and which holds it in position. The bearing is fixed to the latter cross-slide 19. The shaft 112 carries a pulley 113 which is driven from the electric motor 114 through the latter's shaft 115, the pulley 116 thereon, and the belt 117 which transmits motion from one pulley to the other. The motor 114 is held to the cross-slide 19 by the bracket 118.

The transparent plastic enclosure 119 fixed to the carriage 4 by the bracket 123, extends around the wheel 110 and the roll 7, to collect water which drops onto the wheel 110 from the nozzle 120, which enters the enclosure 119. An outlet 121 is provided at the bottom of the enclosure 119, so that the water will run out of said enclosure, thereby avoiding accumulation of water therein.

At one end of the enclosure 119, there is an opening 124 (shown dotted) through which the front of the roll-holding chuck 5 extends. At the other end, there is an opening 122 through which bearing 112 and shaft 111 extend. This opening 122 must be great enough transversely to the axis of roll 7 to permit the necessary transverse motion of the bearing 112 which moves with the cross-slide 19.

The water leaving enclosure 119 through outlet 121 drips through the open space between the ways of the lathe 1, into the drip pan 125, from which it is carried by outlet 126 and hose 127 to the reservoir 128, from which it is pumped out by the pump 129 and reaches the nozzle 120 through rubber hose 130.

The wheel 132, with the crank 131 forming part of it, can be used to move the lathe carriage along the ways 2, 3 in the manner customary with lathes. The lever 133 locks the carriage in position, also in a manner well-known for lathes.

The cross-slide 19, as used herein, includes the number 134 slidable in slide 135 and the piece 136 slidable in the slide 137. Members 134, 135 and 136 all move together along the main slide 137, and can be considered as a single piece in the present invention, although they could be used separately in ordinary lathe practice.

The cutting wheel 110 is preferably hollow ground.

What we claim is:

A machine for cutting wafer coils from a wound roll, said machine comprising: means for holding said roll along a predetermined axis; a cutting tool; means comprising a solenoid-actuated air cylinder for advancing said cutting tool transversely against said roll for a predetermined distance to cut the same; means comprising an electrical switch, actuated by the arrival of the cutting tool at the end of its forward stroke, for actuating a solenoid to reverse the direction in which the air cylinder moves the cutting tool to retract the same; and means including an electrical switch actuated by arrival of the cutting tool at the end of its retracting stroke for shifting said tool a predetermined distance in a direction parallel to said predetermined axis, the direction in which this switch must be moved for actuation being opposite to the direction in which said first-mentioned switch must be moved.

References Cited in the file of this patent

UNITED STATES PATENTS

1,504,703	Nicholas	Aug. 12, 1924
1,654,021	Thener	Dec. 27, 1927
2,086,374	Wikle	July 6, 1937
2,122,204	Gora	June 8, 1938
2,279,046	Kearney	Apr. 7, 1942
2,369,617	Somerville	Feb. 13, 1945
2,410,355	Nesbitt	Oct. 29, 1946
2,521,004	Gitter	Sept. 5, 1950
2,557,308	Nippert	June 19, 1951
2,596,062	Abbey	May 6, 1952
2,609,876	Bauer et al.	Sept. 9, 1952
2,674,310	Thornley	Apr. 6, 1954