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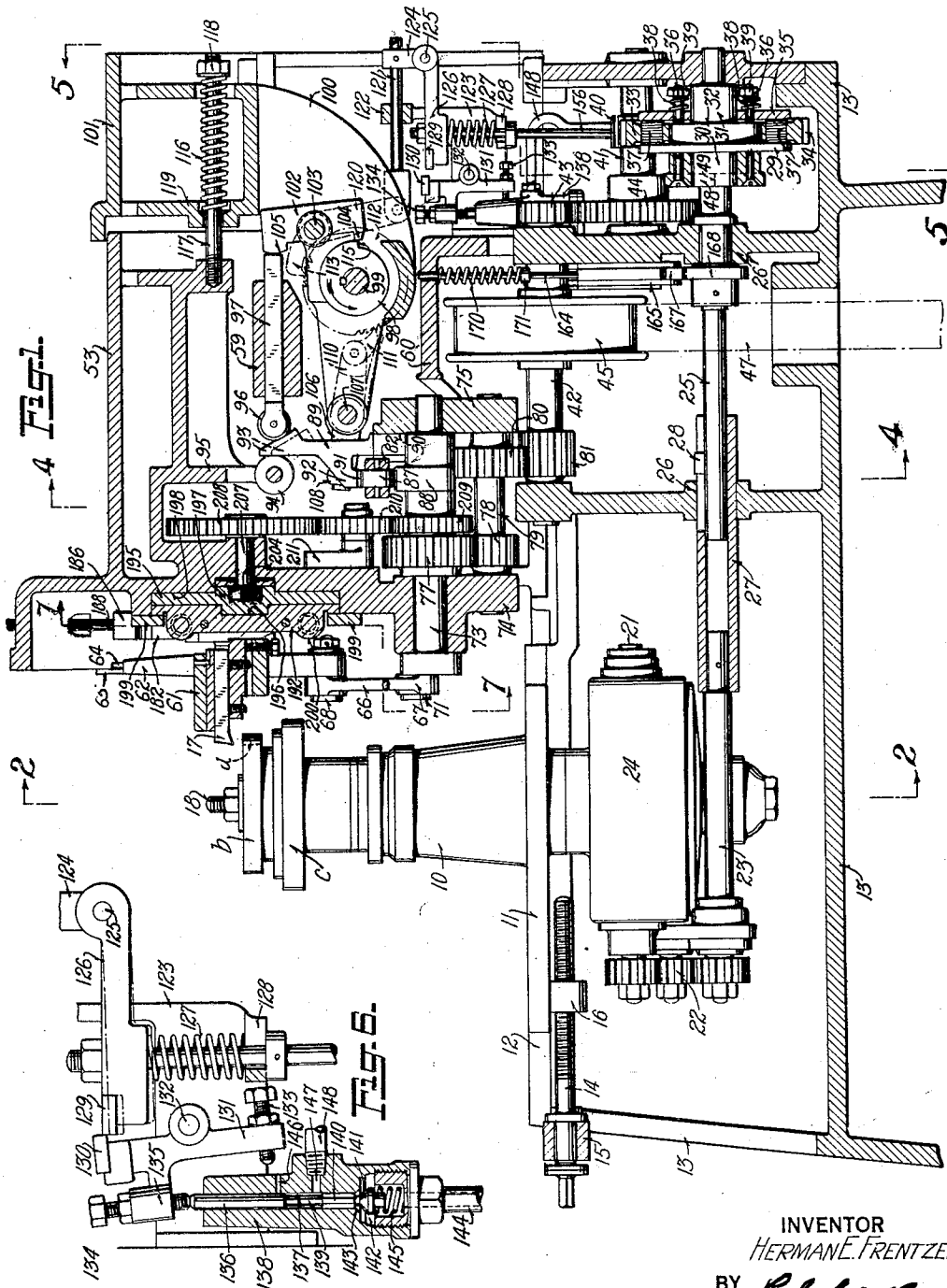
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1,872,270

SLOTTING MACHINE

Filed June 18, 1926

5 Sheets-Sheet 1



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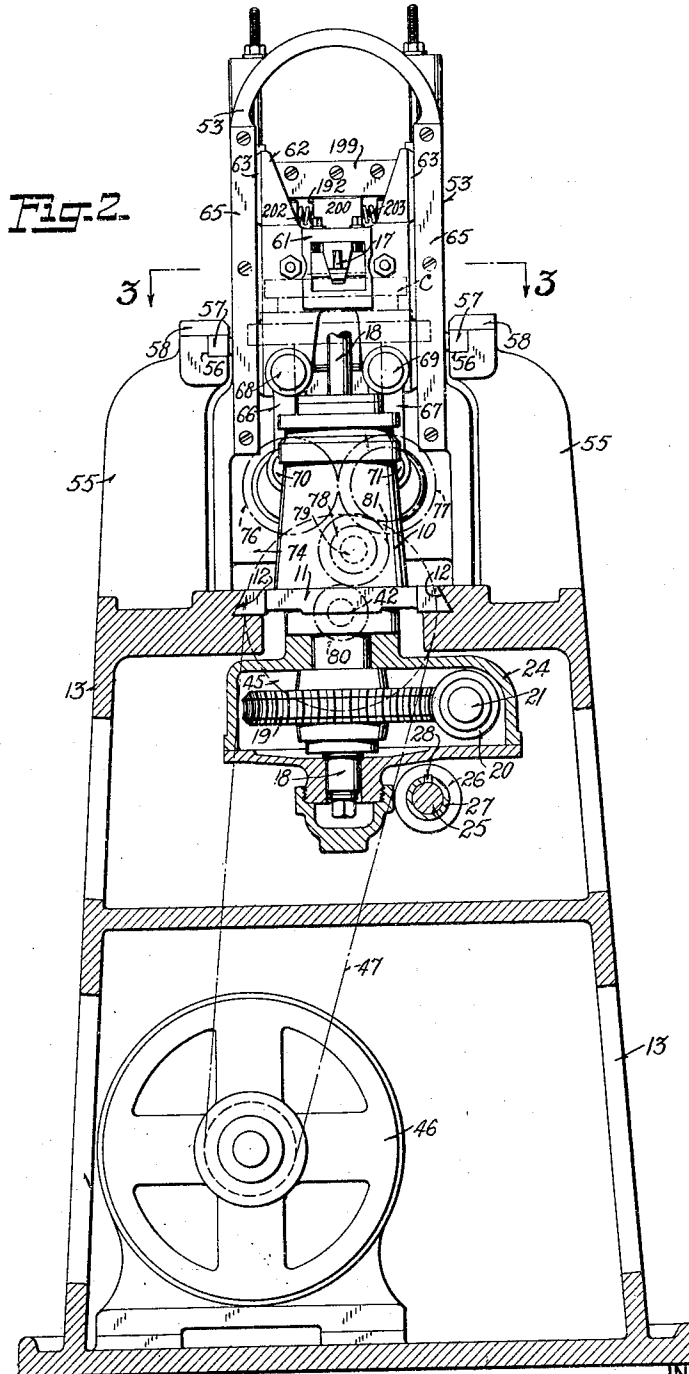
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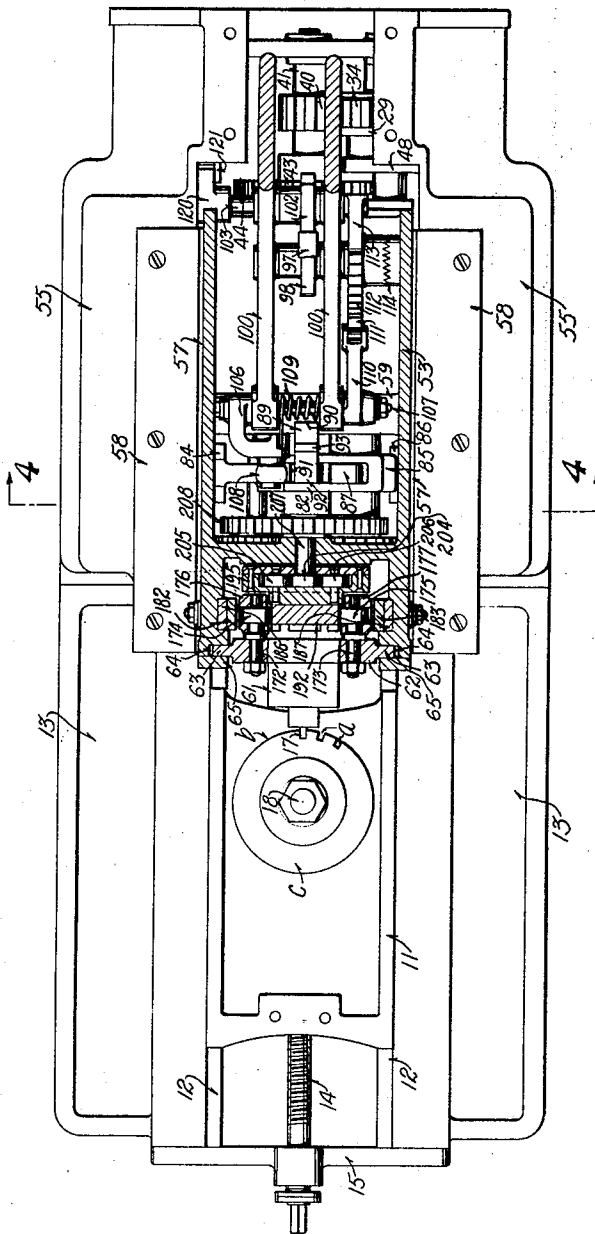
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SLOTTING MACHINE

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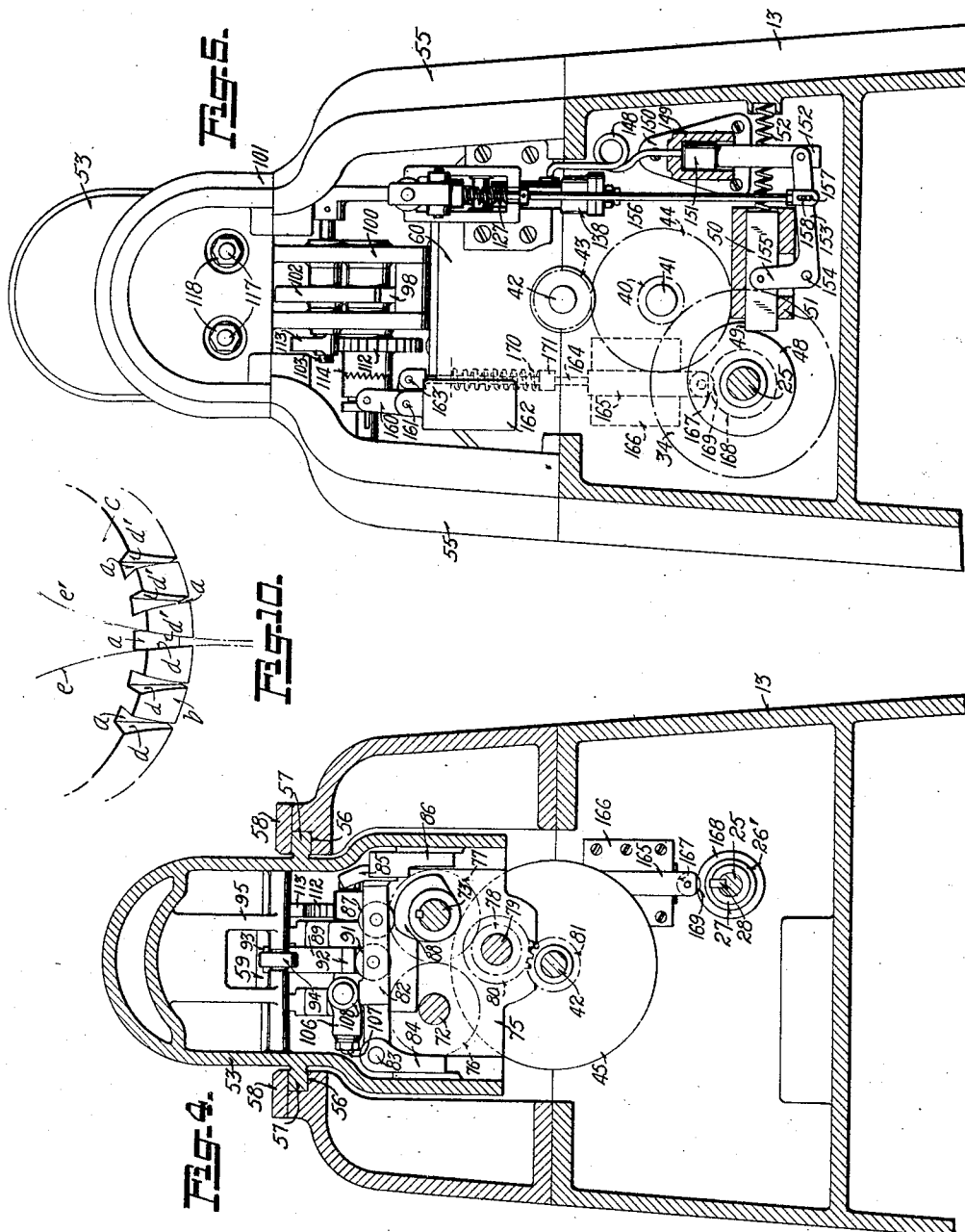
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SLOTING MACHINE

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5 Sheets-Sheet 4



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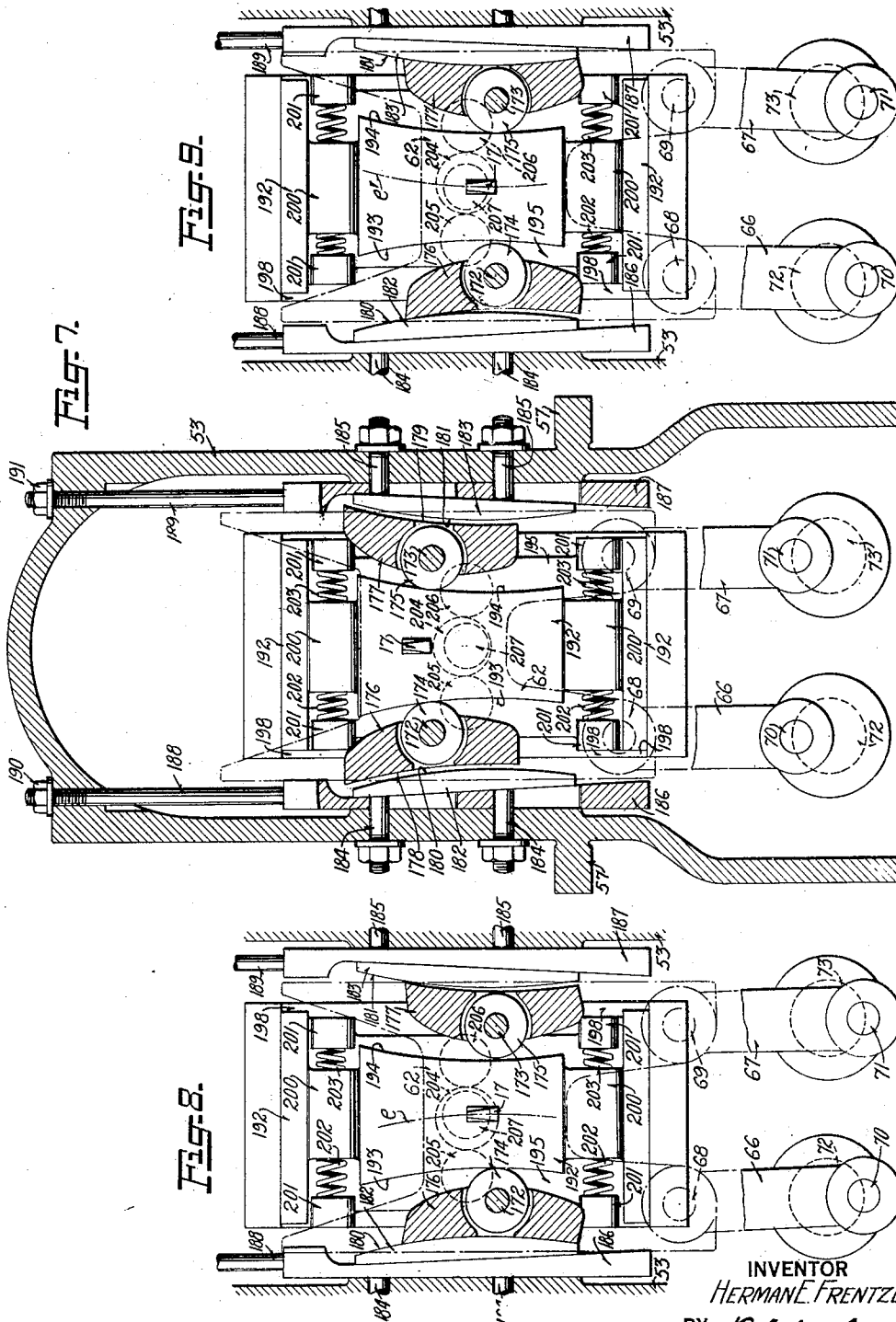
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SLOTTING MACHINE

Filed June 18, 1926

5 Sheets-Sheet 5



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SLOTTING MACHINE

Application filed June 18, 1926. Serial No. 116,784.

This invention relates to slotting machines and more particularly to machines for forming a series of longitudinally flared slots in the periphery of coupling disks and the like.

5 A machine for this general purpose is described in my copending application, Serial No. 91,019, filed February 27, 1926. In that machine two cutters are employed one for forming each longitudinally curved side wall of a slot. The present invention contem-
10 plates the provision of a machine in which both side walls of each slot may be formed by a single cutter.

A more specific object is the provision in
15 a machine for the purpose mentioned of mechanism for reciprocating the tool or the like, alternately, along two distinct paths, conforming to the respective contours of the walls of each slot.

20 Another object is the provision of means for effecting the ready adjustment of the tool operating mechanism in order to form slots of various widths.

25 Another object is the provision of novel and improved means for feeding the tool toward and from the work.

Another object is the provision of novel and improved means for feeding the tool and indexing the work in definite sequence.

30 Other objects and advantages will appear from the following description of an illustrative embodiment of the present invention.

In the drawings:—

35 Figure 1 is a vertical longitudinal sectional view of a slotting machine constructed in accordance with the present invention.

Fig. 2 is a sectional view taken substantially along the line 2—2 of Figure 1.

40 Fig. 3 is a horizontal sectional view taken substantially along the line 3—3 of Figure 2.

Fig. 4 is a vertical sectional view taken substantially along the line 4—4 of Figures 1 and 3.

45 Fig. 5 is a vertical sectional view taken substantially along the line 5—5 of Fig. 1.

Fig. 6 is a detail view of the trip mechanism, on a larger scale, shown in Fig. 1.

Fig. 7 is a view taken substantially along the lines 7—7 of Figure 1.

50 Figs. 8 and 9 are diagrammatic views simi-

lar to Fig. 7 illustrating the action of the cutter and cutter operating mechanism.

Fig. 10 is a fragmentary view diagrammatically illustrating the character of the slots produced by this machine.

55 The machine selected for illustration is designed to cut a series of longitudinally flared slots *a* in the periphery *b* of a coupling disk *c*. From an inspection of Fig. 10 it will be noted that the opposite side walls *d* and *d'* of each slot are oppositely curved longitudinally, one wall lying within a curved surface indicated by the line *e* and the other wall lying in a curved surface indicated by the line *e'*. To
60 produce slots of this form, the single cutter of the present machine is caused to reciprocate alternately along paths coincident with these curved surfaces *e* and *e'*.
65

The coupling element or disk *c*, as shown in full lines in Figures 1 and 3 and in dotted lines in Figure 2, is supported upon an upright housing 10, having a base plate 11 mounted for lengthwise adjustment in horizontal ways 12 formed in the upper forward portion of an appropriate base frame 13. A screw 14, journaled in a cross-bar 15 fixed to the base frame, and threaded through an appropriate block 16 fixed to the plate 11, constitutes a convenient means for adjusting the housing 10 toward and from the cutter 17, so
70 as to accommodate the machine to work of various diameters. The work is fixed in a well known manner to a vertical shaft 18 extending upwardly therethrough and through the housing 10. This shaft is actuated and
75 controlled by a worm wheel 19 fixed to the lower end thereof and meshing with a worm 20 carried by a horizontal shaft 21, which in turn is connected through a change speed gear train 22 of a well known type, to a horizontal
80 shaft 23. Shafts 21 and 23 and gears 22 are carried by a housing 24 surrounding the worm 20 and worm wheel 19, and supported by and beneath the base plate 11 of the upright housing 10. The gears 22 are so select-
85 ed, that for each complete rotation of shaft 23, shaft 18 and consequently the work is rotated through an angle corresponding to the desired spacing of the slots in the work. Shaft 23 is rotated intermittently by appro-
90 100

priate mechanism such as will now be described.

A shaft 25, journaled in fixed bearings 26 and 26' in the base frame 13, is connected in driving relation with the shaft 23, through a hollow shaft 27. Shaft 23 is fixed at one end within this hollow shaft 27, and the end of the other shaft 25 is slidably fitted therein and provided with a key and slot connection 28 therewith. This driving relation is thus maintained in all positions of adjustment of the housing 10. A continuously operated friction clutch of appropriate form tends at all times to rotate the shaft 25 in one direction, and an intermittently released locking mechanism operates normally to hold this shaft against rotation under the influence of the clutch.

The clutch shown in Figure 1 comprises a disk 29 having hub portions 30 and 31 fixed to the shaft 25. The hub portion 31 is provided with an enlarged portion 32 adapted to loosely receive a ring 33, having gear teeth 34, formed on the periphery thereof. A second ring 35, surrounding the hub portion 31, is carried by a series of studs 36, projecting from the face of the enlarged portion so as to rotate therewith. The ring 33 carries a series of friction blocks 37, preferably of wood, interposed between the disk 29 and ring 35, and maintained in contact therewith under the pressure of a series of springs 38, each interposed between the ring 35 and a nut 39 on one of the studs 36.

The ring 33 is driven continuously by a pinion 40, meshing with the teeth 34 thereon, and the frictional contact between the blocks 37 with the ring 35 and disk 29 provides a yielding drive for the shaft 25. The pinion 40 is fixed to a shaft 41, journaled in the base frame 13, this shaft being driven from the main drive shaft 42 through a pinion 43 and gear 44. The shaft 42 is journaled in the base frame 13 and is driven by a pulley 45 fixed thereto, the pulley being connected to an electric motor 46 in the bottom of the base frame through a belt 47.

The mechanism shown for releasably locking the shaft 25 against rotation comprises a cam 48 fixed to the hub portion 30 and formed with a shoulder 49 for locking engagement with a detent 50 of appropriate form. (See Fig. 5.) In this instance the detent comprises a bar, mounted for lengthwise reciprocation in a fixed bracket 51. A spring 52 normally maintains the bar 50 in the advanced locking position of Figure 5, but the bar is intermittently withdrawn from engagement with the shoulder 49 of the cam 48 by mechanism to be hereinafter described, and when so withdrawn the cam and shaft 24 are free to rotate through one complete revolution under the influence of the friction clutch hereinabove described.

A tool carriage 53 in the form of a hollow

casting is mounted for lengthwise reciprocation toward and from the work. As indicated in Figures 2, 3 and 4, this carriage is supported by and between a pair of upright side members 55, fixed to the upper rear portion of the base frame 13, and formed with appropriate horizontal guides 56, for receiving the longitudinally extending ribs 57, formed on the sides of the carriage. The guides 56 are covered by appropriate plates 58 by which the ribs 57 are slidably retained therein. The side members 55 are rigidly connected and braced by a transverse bar or bridge piece 59 and a web-like formation 60 formed integral therewith.

The tool or cutter 17 is rigidly clamped in an appropriate tool holder 61 of well known form, fixed in a vertically reciprocating carrier plate 62. The plate 62 is provided at its opposite side edges with laterally projecting tongues 63, slidably engaged in vertical guides 64 formed in the front end of the tool carriage 53. (See Figs. 2 and 3.) Appropriate cover plates 65 retain the tongues in the guides. Although the carrier plate 62 is thus retained in a true vertical plane, it will be noted from an inspection of Figure 3, that sufficient clearance is provided to permit limited lateral movement of this plate within that plane. The carrier plate is reciprocated by a pair of links 66 and 67 pivotally connected at their upper ends 68 and 69 to the lower end of the plate, and connected at their lower ends to crank pins 70 and 71 carried by the forward ends of two crank shafts 72 and 73, respectively. The forward portions of the crank shafts 72 and 73 are journaled in the lower front wall 74 of the tool carriage, and the rear ends thereof are journaled in a transverse rail 75 fixed within the carriage. A gear 76 on shaft 72 meshes with a gear 77 on shaft 73 so that these shafts rotate at the same speed in opposite directions. Gear 77 is driven by a gear 78 fixed to a shaft 79, which in turn is driven from the main drive shaft 42 through gears 80 and 81. It will be noted that the face of gear 81 is of such width as to maintain contact with the gear 80, as the same is advanced and retracted with the lengthwise advance and retraction of the tool carriage toward and from the work.

The crank shafts 72 and 73 are thus operated continuously so that the carrier plate 62 is reciprocated continuously and the tool 17 carried thereby passes back and forth through the work. Each down stroke of the tool is a cutting stroke and each up stroke an idle or return stroke. The tool carriage 53 is given two distinct motions. It is reciprocated toward and from the work in timed relation with the strokes of the tool, so as to effect cutting engagement with the tool and work on each down stroke and to provide clearance between the tool and work during each upward stroke; it is also fed slowly toward the

work as the cut progresses, until a slot of desired depth has been formed, and then quickly returned to the initial feed position. Although this dual movement may be accomplished in various ways an extremely simple compact mechanism for the purpose will now be described.

This mechanism includes a lever 82 extending transversely of and within the tool carriage 53. This lever is mounted at one end upon a horizontal pivot 83, in a bracket 84 fixed to one wall of the housing, the other end thereof carrying a shoe 85 guided within a bracket 86 fixed to the opposite wall of the carriage. A roller 87, journaled in the lever, rests upon a cam 88 fixed to the crank shaft 73. The cam 88 is so shaped as to raise and lower the lever at the beginning and end of each down stroke of the tool 17. A bar 89 is mounted for vertical reciprocation in a guideway 90 formed in the front face of the rail 75 carried by the carriage. A second roller 91 journaled in the lever 82 bears beneath an element 92 projecting laterally from the bar 89, through which the bar is raised and lowered with the lever. A wedge-shaped portion 93 at the upper end of the bar engages between a roller 94 carried by a bracket 95 depending from the top of the tool carriage, and a roller 96 journaled in the forward end of bar 97. The arrangement is such that when the bar 89 and wedge portion 93 thereof have been elevated by the lever 82 into the full line position of Figure 1, roller 94 is forced away from roller 96, causing a corresponding movement of the tool carriage toward the left, and when the bar 89 is lowered so as to lower the wedge portion 93 into the dotted line position of this figure, roller 94 approaches roller 96, with a corresponding movement of the tool carriage toward the right. The tool carriage is thus reciprocated continuously toward and from the work in timed relation with the vertical reciprocation of the tool.

The mechanism for feeding the tool carriage toward the work as the cutting progresses is also actuated by the lever 82. In this instance this mechanism includes a feed cam 98 fixed to a shaft 99 journaled in spaced parallel arms 100, constituting the side members of a frame supported by a casting 101 fixed upon the rear portion of the upright side members 55. An upright lever 102, fixed intermediate its ends upon a rock shaft 103, journaled in the arms 100, is provided at its lower end with a nose 104, which bears against the cam, and at its upper end is provided with a nose 105, which bears against the rear end of the bar 97. The bar 97 is mounted for lengthwise movement in the fixed bar 59, hereinabove mentioned, supported by the upright side member 55. A lever 106, fixed to one end of a rock shaft 107, journaled in the forward ends of the

arms 100, carries a roller 108 which bears upon the lever 82. An appropriate spring 109, surrounding the shaft 107, maintains a downward yielding pressure on the lever 106 so as to maintain the roller 108 against the lever 82. An arm 110 fixed to the other end of the rock shaft 107, carries a pawl 111, which engages appropriate teeth on a ratchet wheel 112. A stop pawl 113, supported loosely on the shaft 103, prevents rotation of the ratchet wheel 112 except in a counter-clockwise direction (Fig. 1). The ratchet wheel 112 is mounted loosely on the shaft 99 and is connected in driving relation therewith through a clutch 114. The arrangement is such that upon each up stroke of the lever 82, the lever 106, shaft 107, and arm 110 are swung clockwise, and the pawl 111 rotates the ratchet wheel 112 through a predetermined angle counter-clockwise and when the clutch 114 is closed, this rotation of the ratchet wheel is transmitted to the cam 98; and upon each down stroke of the lever 82, the arm 110 and pawl 111 perform an idle stroke, the ratchet wheel being held against rotation by pawl 113. When the clutch 114 is closed, the cam 98 is thus slowly driven intermittently in a counter-clockwise direction as indicated by the arrow in Figure 1.

The cam 98 is of the snail type having a gradually increasing radius and an abrupt shoulder 115. As the cam rotates the lever 102 is rocked counter-clockwise, and the bar 97 is advanced toward the left. This movement of the bar 97, transmitted through the roller 96, wedge portion 93 and roller 94, causes a corresponding feed movement of the tool carriage toward the work. This movement continues until the nose 104 on the lever 102 passes over the shoulder 115 on the cam, at which time tool carriage is free to return to its initial feed position.

The return movement of the tool carriage toward the right (Fig. 1) is accomplished, in the machine shown, by a pair of springs 116, within the casting 101. Each spring surrounds a tension rod 117, extending rearwardly from the tool carriage into the casting 101, and is interposed between a nut 118 on the rod and a web 119 in the casting.

The indexing mechanism, including shaft 25 and the parts driven thereby, is thrown into operation automatically, to rotate the work through a predetermined angle, after the completion of each slot. In the machine shown the mechanism for this purpose is placed under the control of the upright lever 102. This mechanism includes an arm 120, fixed to the rock shaft 103 so as to swing with lever 102, and connected at its lower end to a horizontal rod 121, mounted for lengthwise movement, through a boss 122 carried by a bracket 123, fixed to the web 60. A block 124, adjustably fixed to the rod 121, carries a pivot pin 125, supporting

one end of a lever 126, so that the lever 126 travels lengthwise with the rod 121. The lever 126 is yieldably supported in the horizontal position shown in full lines in Figures 1 and 6, by a spring 127 resting at its lower end upon a shoulder 128 formed in the bracket 123. In this position of this lever a plate 129, fixed thereon, lies in the same horizontal plane as a cooperating plate 130, fixed to the upper end of a lever 131. Lever 131 is mounted intermediate its ends upon a horizontal pivot pin 132 fixed in the bracket 123, and at its lower end carries a set screw 133 which limits the clockwise swing thereof. A set screw 134, adjustably fixed in a boss 135, carried by the upper end of lever 131, is aligned with a rod 136 fitted for vertical movement within a bore 137 in a valve block 138 carried by the bracket 123. The lower reduced end 139 of the rod 136 abuts the end of a valve stem 140 projecting upwardly from a valve 141, disposed in a chamber 142, and cooperating with a seat 143 at the lower end of the bore 137. The chamber 142 is open to an appropriate fluid pressure source (not shown) through a pipe 144. A spring 145 tends at all times to lift the valve 141 toward its closed position against the seat 143, but permits the valve to be lowered away from the seat under the downward thrust of the rod 136. An exhaust port 146, leading from the bore 137, is covered by the rod 136 when the rod is in the lower position of Figure 6, but when this rod is elevated to close the valve 141, port 146 is uncovered, and bore 137 is then open to the atmosphere. A port 147 maintains communication between the bore 137 and a pipe 148 leading to the upper end of a cylinder 149, supported by a fixed bracket 150. A piston 151, within the cylinder 149, is connected through a rod 152, with one arm 153 of a bell-crank lever, rockably supported upon a fixed pivot 154. The other arm 155 of the lever is operatively connected to the detent bar 50, so that when piston 151 is depressed by fluid pressure applied through pipe 148, the bar 50 is withdrawn from engagement beneath the shoulder 49 on the stop cam 48. A rod 156, supported by the lever 126 and extending downwardly through the spring 127, is provided at its lower end with a slot 157, for receiving a pin 158 carried by the horizontal arm 153 of the bell-crank lever. The arrangement is such that when this arm 153 is depressed by the piston 151, the pin 158 strikes the lower end of slot 157, so as to pull the rod 156 downwardly, and depress the lever 126 into the dotted line position of Figure 6. In this depressed position the plate 129 is lowered below the plane of plate 130.

The control mechanism just described thus operates as follows: As the lever 102 swings counter-clockwise under the action of the cam 98, to feed the tool carriage 53 toward

the work, the arm 120 swings with this lever, so as to force the rod 121 and the lever 126 toward the right (Fig. 1). This movement continues until the nose 104 on lever 102 passes over the shoulder 115 on the cam, at which time the lever 102 and arm 120 swing clockwise and advance the lever 126 toward the lever 131. When so advanced the block 129 strikes the block 130 and tilts the lever 131 into the position of Figure 6. The valve 141 is thus depressed and fluid pressure from chamber 142 is admitted through bore 137, port 147, and pipe 148 to the cylinder 149 to depress the piston 151, and arm 153 of the bell-crank lever and thus withdraw the bar 50 in the manner just described. This action of the bell-crank lever is transmitted through the rod 156 to the lever 126, so that the plate 129 is lowered out of engagement with the plate 130, and the lever 131 is free to rock clockwise permitting the rod 136 to rise and the valve 141 to close. Port 146 is thus opened to port 147 and the fluid in cylinder 149 is free to escape. This permits the bar 50 to be again advanced against the cam 48 under the pressure of the spring 52.

The instant that the bar 50 is withdrawn from engagement with the shoulder 49 on the cam 48, the cam and shaft 25 start rotating under the action of the friction clutch, hereinabove described, and continue to rotate until the shoulder 49 again strikes the bar 50, which has in the meantime been returned into position against the cam in the manner just described. The shaft 25 thus rotates through exactly three hundred and sixty degrees and then comes to rest.

In the machine shown the feed cam 98 remains at rest during each rotation of the shaft 25, and for this purpose the clutch 114 is placed under the control of shaft 25. As shown in Figure 5 the clutch is controlled by the upright forked arm 160 of a bell-crank lever, mounted upon a pivot pin 161, fixed in a bracket 162. The other arm of this lever is connected through a pin 163 with a vertical rod 164, connected at its lower end to a bar 165. Bar 165 is mounted for lengthwise movement in a fixed guide 166 and carries a roller 167 at its lower end. The roller 167 rests upon a cam 168 fixed to the shaft 25. The cam 168 is of circular form except for a recess 169 in the periphery thereof. The rod 164 extends through the web 60, and a spring 170 on the rod, between the web and a collar 171 fixed to the rod, maintains the roller 167 against the cam 168. When the shaft 25 is at rest with the shoulder 49 of cam 48 against the bar 50, the roller 167 is seated in the recess 169 of the cam 168 and the clutch 114 is closed, so that the feed cam 98 rotates with the ratchet wheel 112. As soon as shaft 25 rotates, however, the roller 167 rises out of the recess 169, so that the bar 165 and rod 164 are elevated and the bell-crank is rocked

counter-clockwise (Fig. 5) so as to open the clutch 114 and the feed cam 98 comes to rest. The clutch 114 remains open until the shaft 25 has completed one revolution and returned the recess 169 beneath the roller 167 so as to permit the rod 164 and bar 165 to be again lowered into the position of Figure 5.

As hereinabove mentioned the tool 17 is reciprocated along two distinct paths alternately, when following one path it forms one wall of the slot, in the work and when following the other path it forms the other wall of the slot. Mechanism for producing this peculiar motion is shown in Figures 1, 2, 3 and 7 to 9. The tool carrier plate 62 carries two spaced studs 172 and 173 fixed therein and extending rearwardly therefrom. These studs carry rollers 174 and 175 and shoes 176 and 177, respectively. Each shoe 176—177 has a curved surface 178—179 adapted to bear against a correspondingly shaped surface 180—181, on a cam block 182—183. Blocks 182 and 183 are supported on studs 184 and 185, extending through the opposite side walls of the tool carriage 53. Vertically adjustable wedges 186 and 187 are interposed between the blocks 182 and 183 and are supported by rods 188 and 189, extending upwardly through the top of the carriage 53, and carrying nuts 190 and 191 on the upper ends thereof. By turning the nuts 190 and 191 the wedges 186 and 187 may be raised or lowered to thereby adjust the cam blocks 182 and 183 toward or from the shoes 176 and 177.

A cam block 192, interposed between the rollers 174 and 175, is provided at opposite sides with curved surfaces 193 and 194, which extend substantially parallel with the curved surfaces 180 and 181, respectively. The block 192 is mounted upon the front face of a horizontal slide plate 195, and is formed with a horizontal groove 196 for receiving a horizontal guide rib 197 on the slide plate. The front wall 74 of the tool carriage 53 is cut away as at 198 to form a horizontal guideway for the block 192 and plate 195, the block and plate being retained therein by appropriate plates 199. Both the plate and block are movable horizontally within the guideway 198 and the block is movable horizontally across the face of the plate. Bosses 200 at the upper and lower ends of the block 192 are interposed between spaced bosses 201 formed at the upper and lower ends of the plate 195, and compression springs 202 and 203 between these bosses serve to yieldably retain the block centrally disposed on the face of the plate.

The plate 195 is reciprocated horizontally by a cam 204 disposed between rollers 205 and 206 journaled within the plate. The cam 204 is fixed to a horizontal shaft 207 driven by a gear 208 fixed thereto. The gear 208 is driven from a gear 209 on the crank

shaft 73, through a gear 210, supported by a bracket 211 fixed to the front wall 74 of the tool carriage. Gear 208 is twice the diameter of gear 209 so that crank shaft 73 rotates twice during each rotation of shaft 207.

The operation of the cutter 17 will now be described, reference being made to Figures 7, 8, and 9. In Figure 7 the carrier plate 62, and consequently the cutter, are at the upper end of their stroke and the cam 204 is in its upper dead center position, so that the horizontal slide plate 195 and cam block 192 are in central position. In this position the rollers 174 and 175 contact with the surfaces 193 and 194 on the cam block and both shoes 176 and 177 are withdrawn from the surfaces 180 and 181 on the cam blocks 182 and 183. As the cam 204 rotates counter-clockwise from this position the plate 195 is shifted toward the left, and the springs 203 force the cam block 192 toward the left, so that the shoe 176 is forced against and held in contact with the surface 180. This lateral movement of the shoe 176 is transmitted through the stud 172 to the carrier plate 62 so that the tool 17 is shifted toward the left. At the same time the carrier plate 62 and tool are traveling down under the action of the crank shafts 72 and 73 and links 66 and 67, so that the shoe 176 follows the surface 180, and causes the tool to follow a path such as indicated by the line *e* in Figure 8. This down stroke continues until the parts arrive at the position shown in this figure, the cam 204 having arrived at its left ninety degree position and the crank shafts 72 and 73 having turned through one hundred and eighty degrees in lower dead center position. On the upward return stroke of the carrier plate 62 and tool the cam 204 maintains the shoe in contact with surface 180 until the tool approaches the upper limit of its stroke, and the cam 204 approaches its lower dead center position.

On the next downward stroke the cam 204 continues to rotate counter-clockwise, shifting the slide plate 195 toward the right and causing the springs 202 to shift the cam block 192 toward the right, to thereby shift the shoe 177 into contact with surface 181. The carrier plate 62 and tool 17 are thus shifted toward the right, and the shoe 177 in following the surface 181 causes the tool to follow along the path *e'* of Figure 9. Figure 9 illustrates the positions of the parts at the lower end of the second down stroke of the tool. It is noted that the cam 204 has reached its right extreme position and that the crank shafts are again in lower dead center position. Upon the following up stroke the shoe 177 continues to follow the surface 181 until the cam 204 approaches its upper dead center position.

The cam block 182 thus determines the

path of travel of the tool during one reciprocation and the cam block 183 determines the path of travel of the tool during the next reciprocation. By raising or lowering the wedges 186 and 187 these blocks may be adjusted toward and from each other to thereby vary the width of the slot cut by the tools.

Various changes may be made in the embodiment of the invention hereinabove described without departing from or sacrificing any of the advantages of the invention as defined in the appended claims.

I claim:—

1. In a slotting machine the combination of a tool holder, tool reciprocating means, tool shifting means reciprocating in timed relation with said reciprocating means to cause the tool to follow two different cutting paths alternately during alternate reciprocations thereof, and means for effecting a relative feed movement between the tool and work.

2. In a slotting machine the combination of a tool holder, tool reciprocating means, tool shifting means reciprocating in timed relation with said reciprocating means to cause the tool to follow two different cutting paths alternately during alternate reciprocation thereof, means for determining the shape of said paths, and means for effecting a relative feed movement between the tool and work.

3. In a slotting machine the combination of a tool holder, tool reciprocating means, means reciprocating in timed relation with said reciprocating means to cause the tool to follow two different cutting paths alternately during alternate reciprocations thereof, means for determining the shape of said paths, means for adjusting said last named means to vary said paths, and means for effecting a relative feed motion between the tool and work.

4. In a machine for forming slots with non-parallel walls the combination of a tool, means for reciprocating said tool along two reversely curved paths alternately during alternate reciprocations thereof to form the opposite walls of a slot, and means for adjusting said means to modify the paths of travel of said tool to thereby modify the slot.

5. In a slotting machine the combination of a tool carrier, means for reciprocating said carrier, means providing two guide surfaces, and means automatically operable to shift said carrier into coacting relation with said surfaces, alternately, to thereby cause said carrier to reciprocate along either of two paths.

6. In a slotting machine the combination of a tool carrier, means for reciprocating said carrier, means providing two guide surfaces, means on said carrier for engaging said surfaces, and means for shifting said carrier to effect and maintain contact of said

engaging means with either of said surfaces, selectively.

7. In a machine tool or the like the combination of a frame, a tool carriage movable thereon toward and from the work, tool reciprocating means on said carriage, feed mechanism supported by said frame for feeding said carriage toward and from the work, and mechanism on said carriage coacting with said feed mechanism to effect reciprocation of said carriage toward and from the work in timed relation with said tool reciprocating means.

8. In a machine tool or the like the combination of a frame, a tool carriage movable thereon toward and from the work, tool reciprocating means on said carriage, a feed cam supported by said frame, and operating connections between said cam and carriage for feeding said carriage toward and from the work, said connections including an element movable in timed relation with said tool reciprocating means for reciprocating said carriage toward and from the work.

9. In a machine tool or the like the combination of a tool carriage, tool reciprocating means on said carriage, feed mechanism for advancing said carriage intermittently toward the work in timed relation with said tool reciprocating means, and means for reciprocating said carriage toward and from the work in timed relation with said tool reciprocating means.

10. In a machine tool or the like the combination of a tool carriage, tool reciprocating means thereon, feed mechanism for advancing said carriage toward the work at a predetermined rate, mechanism for reciprocating said carriage toward and from the work, and an element driven by said tool reciprocating means for actuating both of said mechanisms.

11. In a machine tool or the like the combination of a tool carriage, tool reciprocating means on said carriage, and means for intermittently advancing said carriage toward the work in timed relation with said tool reciprocating means, said advancing means including a reciprocating wedge carried by said carriage and operable to effect retraction of said carriage before each return stroke of said tool reciprocating means.

12. In a machine tool or the like the combination of a work support, indexing mechanism, a tool carriage, a tool reciprocating means on said carriage, mechanism for feeding said carriage toward and from the work, means for reciprocating said carriage toward and from the work in timed relation with said tool reciprocating means, and means controlled by said feed mechanism for controlling said indexing mechanism.

13. In a machine tool or the like the combination of a work support, indexing mechanism, a tool carriage, tool reciprocating

means on said carriage, mechanism for feeding said carriage toward and from the work, trip mechanism coacting with said feed mechanism and operable during the return feed of said carriage to render said indexing mechanism active, and means for reciprocating said carriage toward and from the work in timed relation with said tool reciprocating means.

14. In a machine tool or the like the combination of a tool carrier, means for reciprocating said carrier, means providing two guide surfaces, means on said carrier for coaction with said surfaces to guide said carrier, and means automatically operable to shift said carrier into coacting relation with said surfaces alternately to thereby vary the path of travel of the tool for alternate reciprocations thereof.

15. In a machine tool or the like the combination of a reciprocating tool carrier, means providing two guide surfaces, two shoes carried by said carrier for coaction with said surfaces respectively, and means automatically operable to shift said shoes into coacting relation with their respective guide surfaces alternately to thereby vary the path of travel of the tool for alternate reciprocations thereof.

16. In a machine tool or the like the combination of a reciprocating tool carrier, means providing two curved guide surfaces, a shoe rockably connected with said carrier for coaction with each surface to determine the path of travel of the tool, and means for automatically shifting said shoes into coacting relation with their respective guide surfaces alternately to thereby vary the path of travel of the tool for alternate reciprocations thereof.

17. In a machine tool or the like the combination of a reciprocating tool carrier, means providing two curved guide surfaces, a shoe on said carrier for coaction with each surface, and resilient means for automatically shifting and maintaining said shoes in coacting relation with their respective guide surfaces alternately to thereby vary the path of travel of said carrier and tool for alternate reciprocations thereof.

18. In a machine tool or the like the combination of a reciprocating tool carrier, a pair of members each providing a guide surface for said carrier, means on said carrier for coaction with said surfaces selectively, means for automatically shifting said carrier to effect a coacting relation between said means and each of said guide surfaces alternately to thereby effect operation of the tool along different paths for alternate reciprocations thereof, and means for effecting a relative adjustment between said members to thereby vary the relation between the paths.

19. In a slot forming machine the combination of a tool holder, means for reciprocating said holder to effect alternate cutting and idle

return strokes, means for shifting said holder between successive cutting strokes, and separate non-parallel guides for said holder cooperating with said shifting means and alternately effective to determine the course of travel of said tool holder during successive cutting strokes.

20. In a slotting machine the combination of a tool holder, means for reciprocating said holder to effect alternate cutting and idle return strokes, means for shifting said holder between successive cutting strokes, and separate non-parallel curved guides for said holder cooperating with said shifting means and alternately effective to determine the course of travel of said tool holder during successive cutting strokes.

In witness whereof, I hereunto subscribe my name this 9th day of June, 1926.

HERMAN E. FRENTZEL.