Nov. 21, 1939. L. E. POOLE 2,180,771

COMMUTATOR SEPARATOR UNDERCUTTING MACHINE

Filed April 12, 1937 10 Sheets-Sheet 1

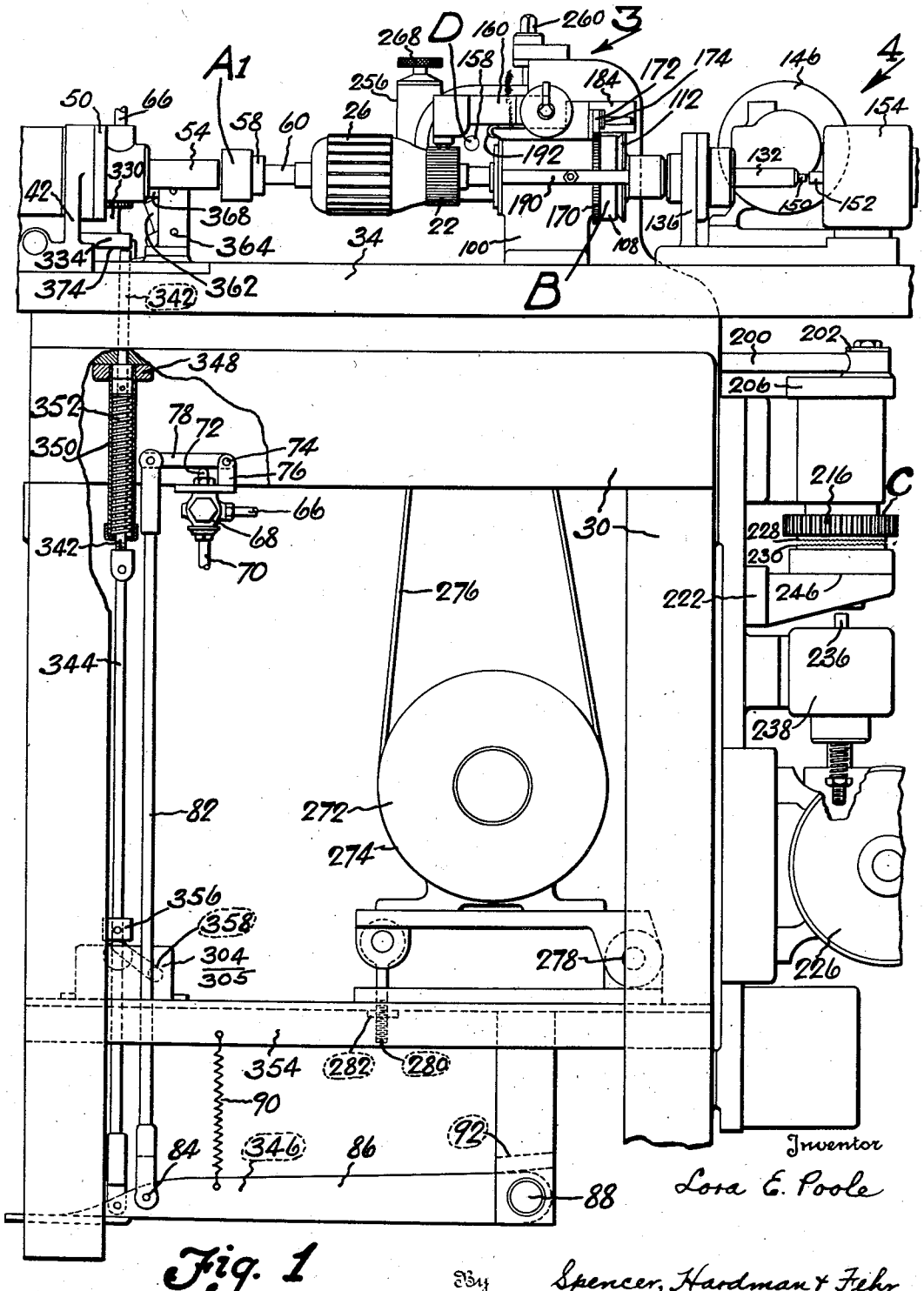


Fig. 1

Inventor
Lora E. Poole

By Spencer, Hardman & Fehr
his Attorneys

Nov. 21, 1939. L. E. POOLE 2,180,771

COMMUTATOR SEPARATOR UNDERCUTTING MACHINE

Filed April 12, 1937 10 Sheets-Sheet 2

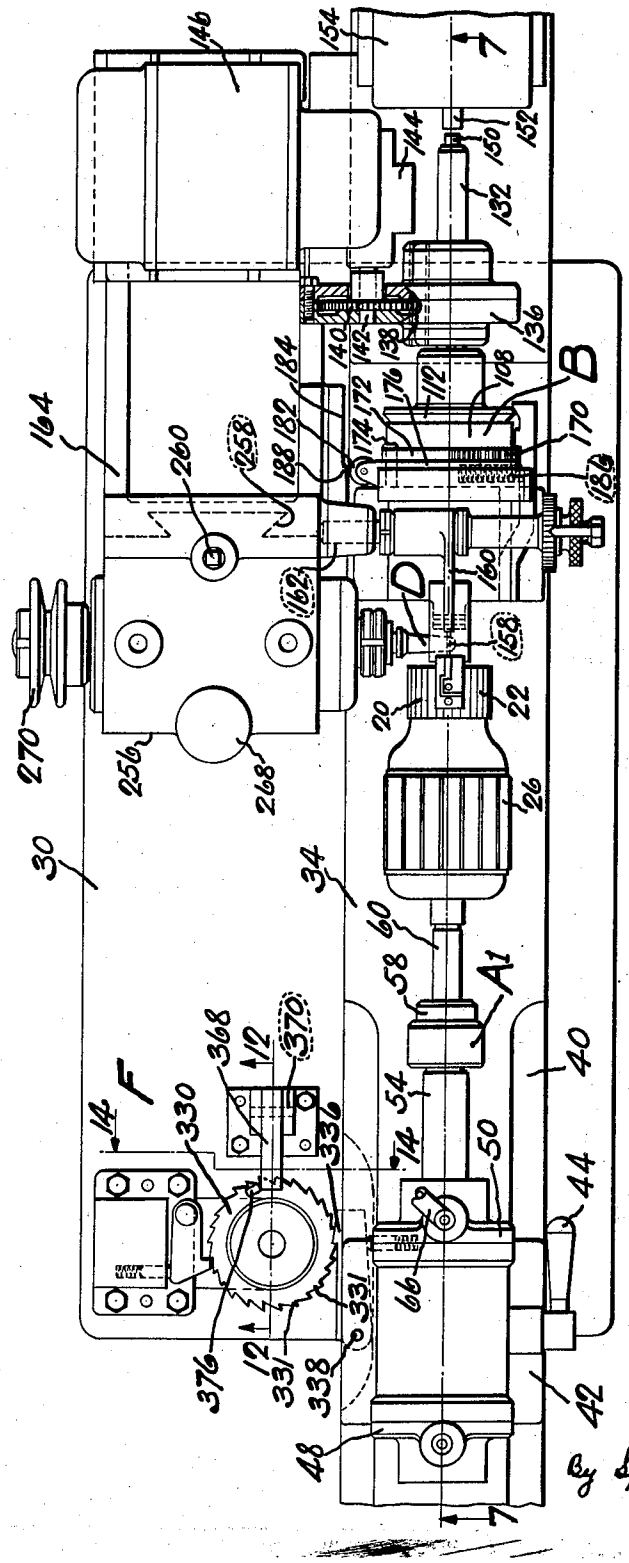


Fig. 2

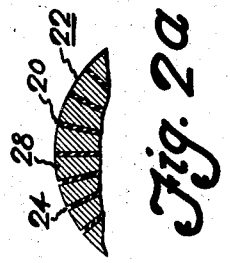


Fig. 2a

Inventor
Lora E. Poole

By Spencer, Hardman & Fehr
His Attorneys

Nov. 21, 1939. L. E. POOLE 2,180,771

COMMUTATOR SEPARATOR UNDERCUTTING MACHINE

Filed April 12, 1937 10 Sheets-Sheet 3

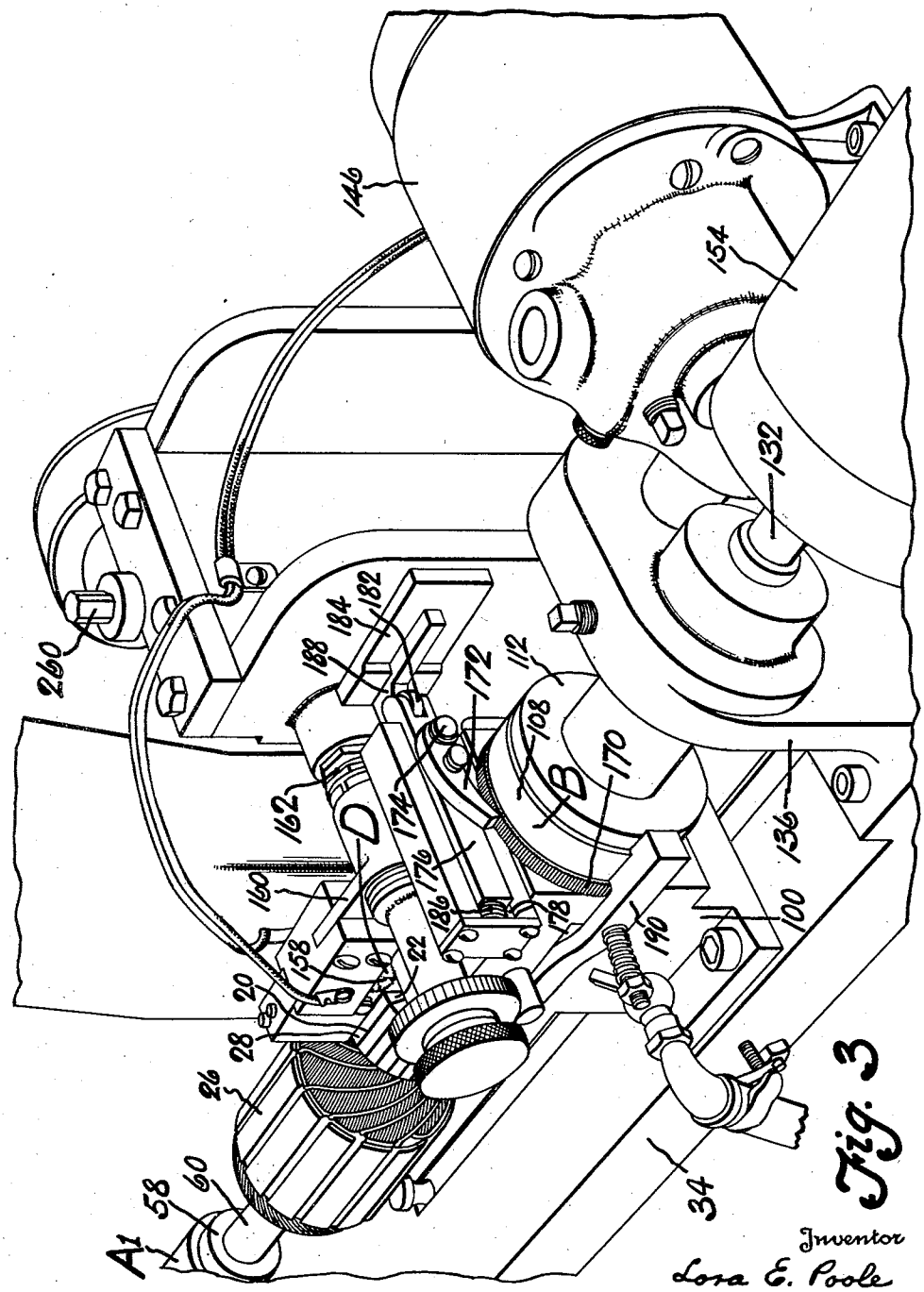


Fig. 3

Inventor
Lora E. Poole

By Spencer, Hardman & Fehr
Attorneys

Nov. 21, 1939. L. E. POOLE 2,180,771

COMMUTATOR SEPARATOR UNDERCUTTING MACHINE

Filed April 12, 1937 10 Sheets-Sheet 4

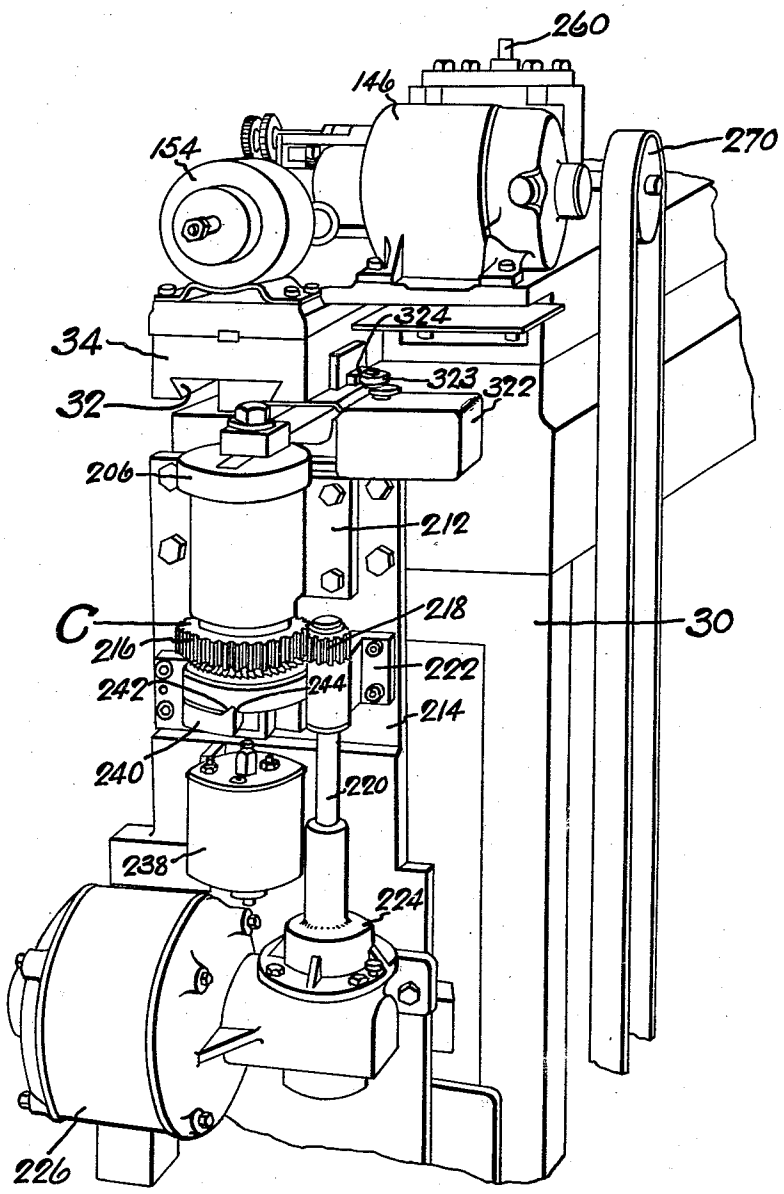


Fig. 4

Inventor
Lora E. Poole

By Spencer, Hardman & Fehr
his Attorneys

Nov. 21, 1939. L. E. POOLE 2,180,771

COMMUTATOR SEPARATOR UNDERCUTTING MACHINE

Filed April 12, 1937 10 Sheets-Sheet 5

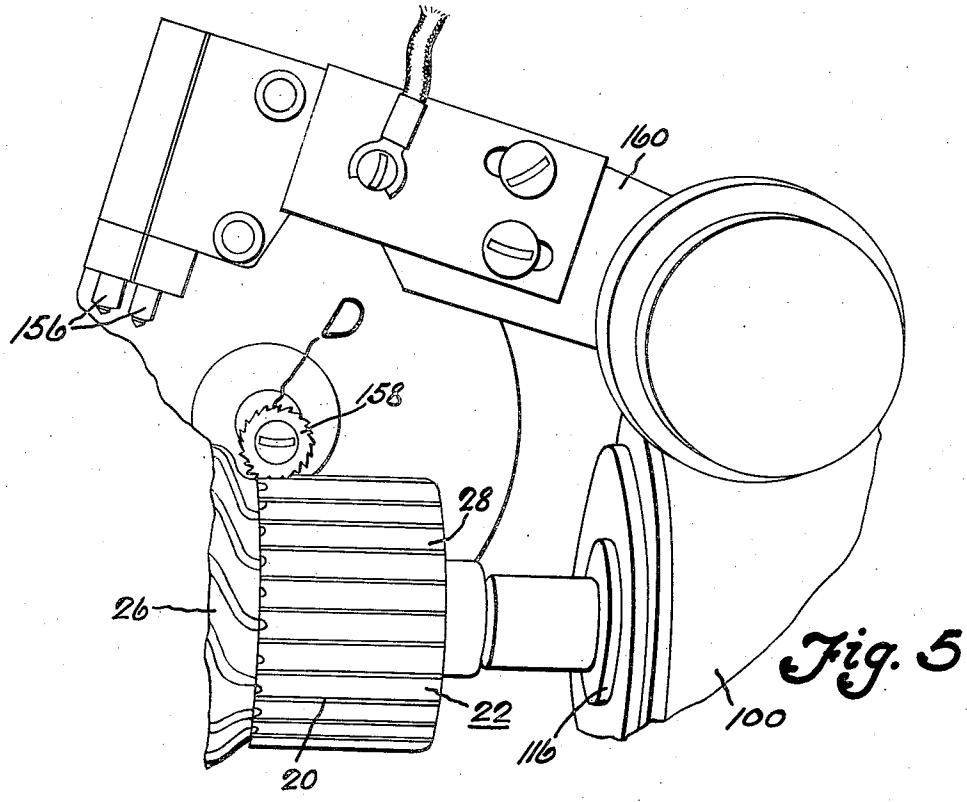


Fig. 5

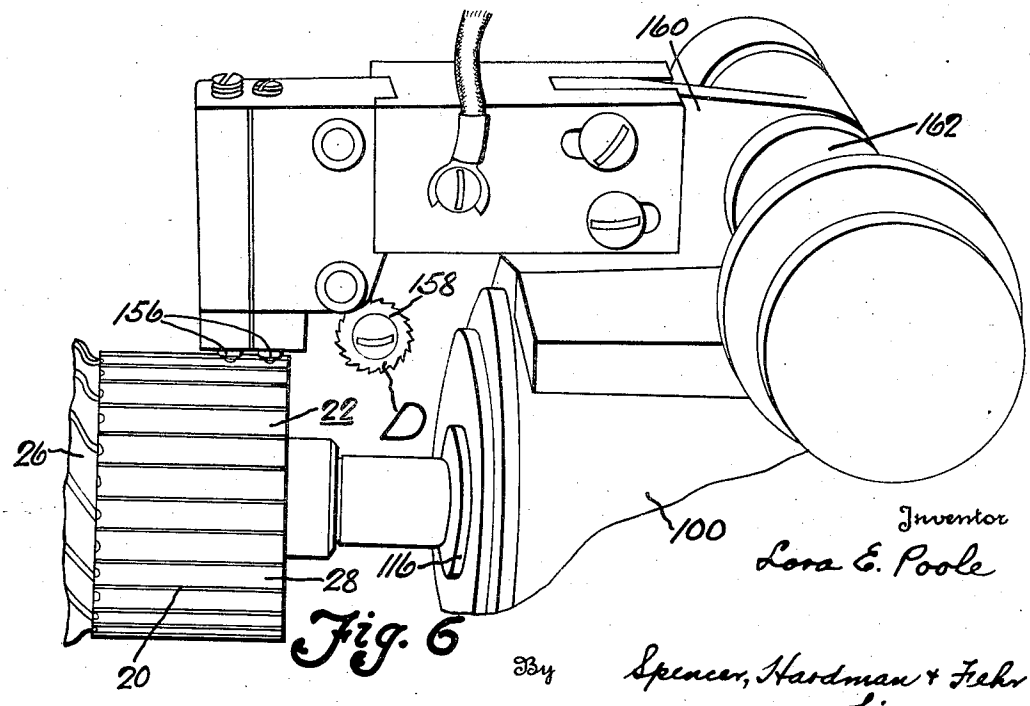


Fig. 6

Inventor
Lora E. Poole

By Spencer, Hardman & Fehr
his Attorneys

Nov. 21, 1939. L. E. POOLE 2,180,771

COMMUTATOR SEPARATOR UNDERCUTTING MACHINE

Filed April 12, 1937 10 Sheets-Sheet 6

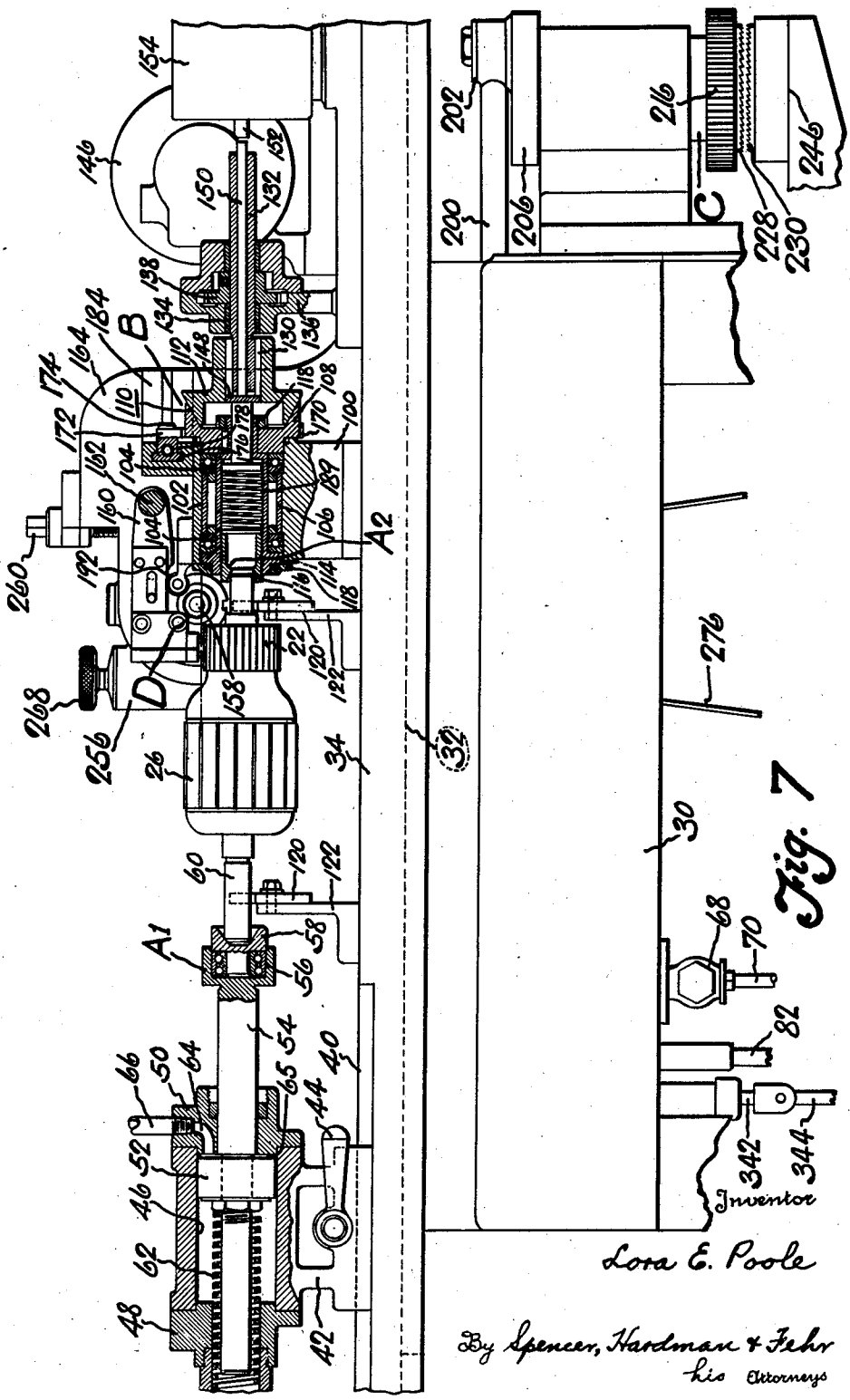


Fig. 7

Nov. 21, 1939. L. E. POOLE 2,180,771

COMMUTATOR SEPARATOR UNDERCUTTING MACHINE

Filed April 12, 1937 10 Sheets-Sheet 7

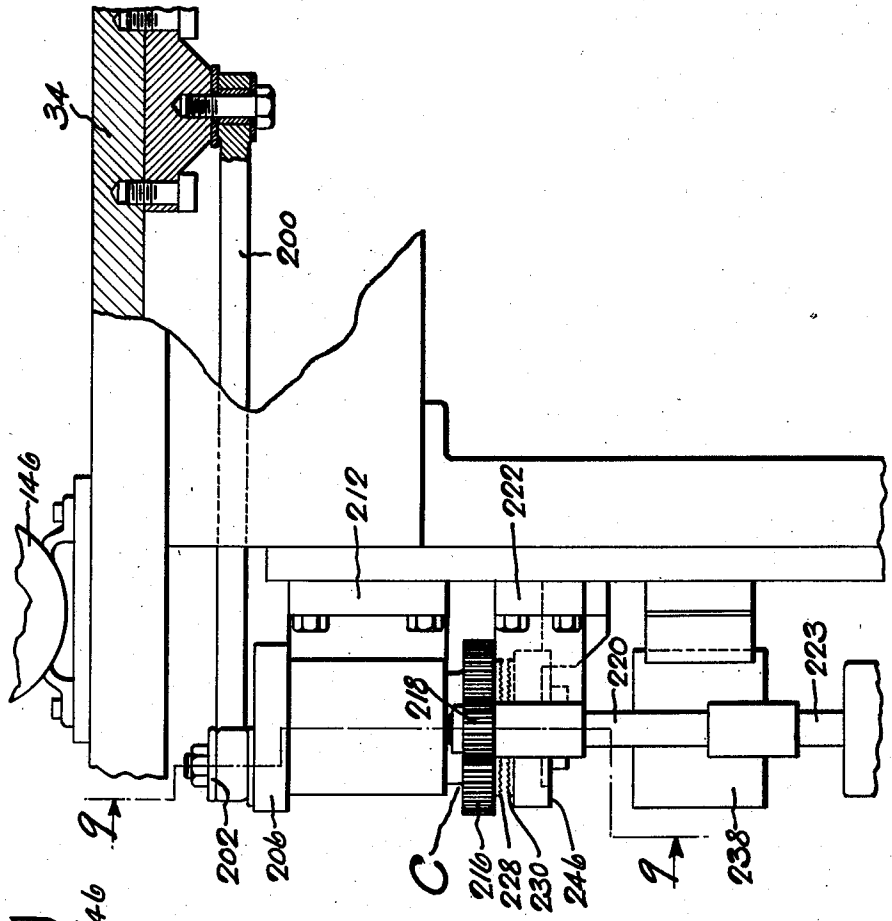


Fig. 8

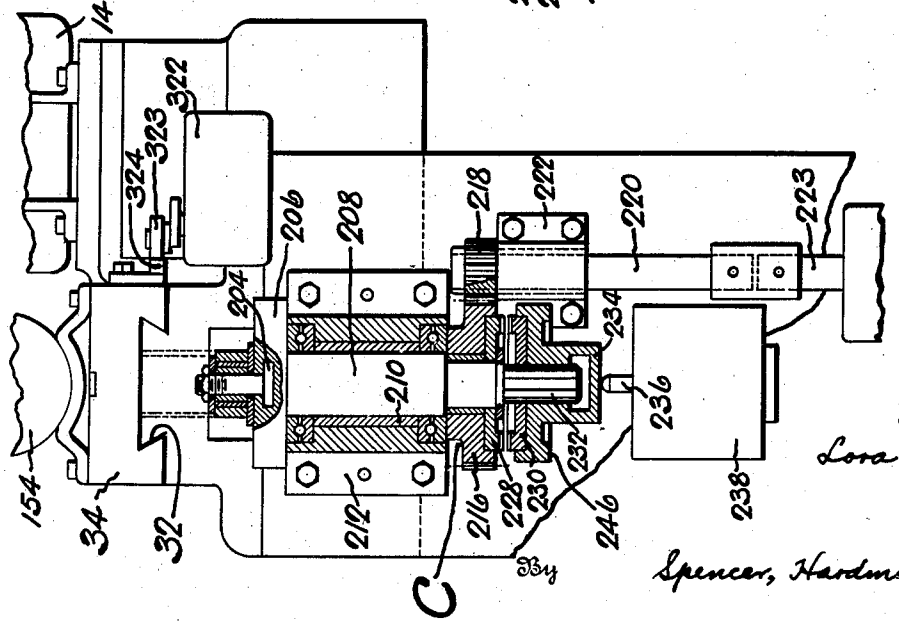


Fig. 9

Inventor
Lora E. Poole

By
Spencer, Hardman & Fehr
Attorneys

Nov. 21, 1939. L. E. POOLE 2,180,771

COMMUTATOR SEPARATOR UNDERCUTTING MACHINE

Filed April 12, 1937 10 Sheets-Sheet 8

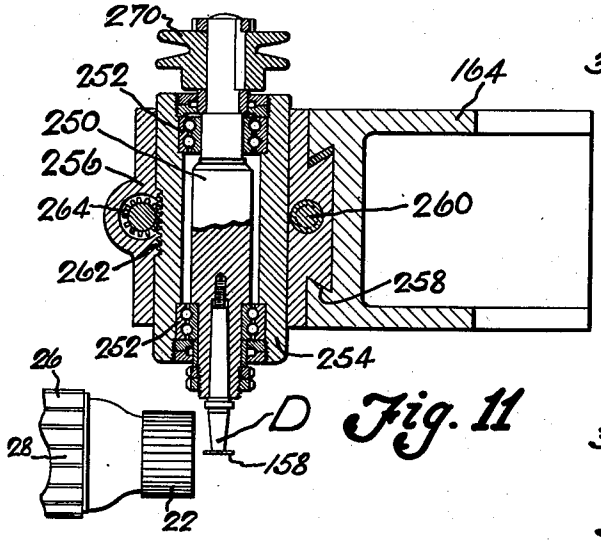


Fig. 11

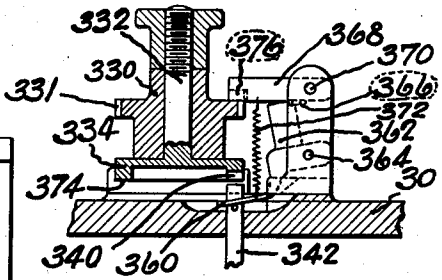


Fig. 12

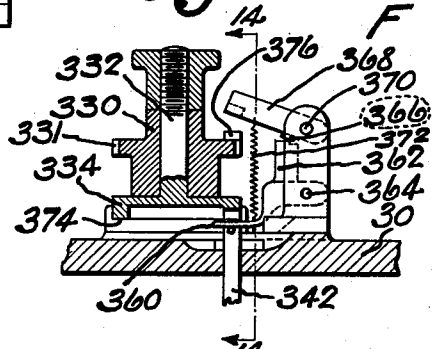


Fig. 13

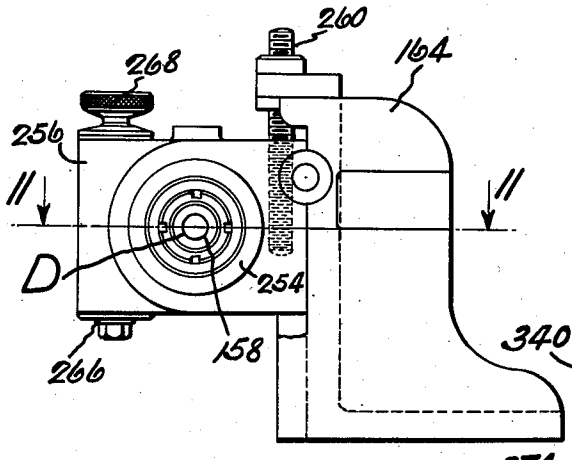


Fig. 10

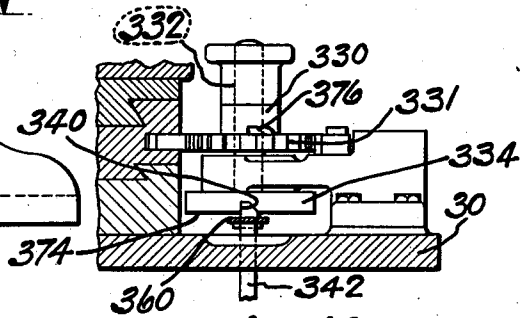


Fig. 14

Inventor

Lora E. Poole

By Spencer, Hardman & Fehr

his Attorneys

Nov. 21, 1939. L. E. POOLE 2,180,771

COMMUTATOR SEPARATOR UNDERCUTTING MACHINE

Filed April 12, 1937 10 Sheets-Sheet 9

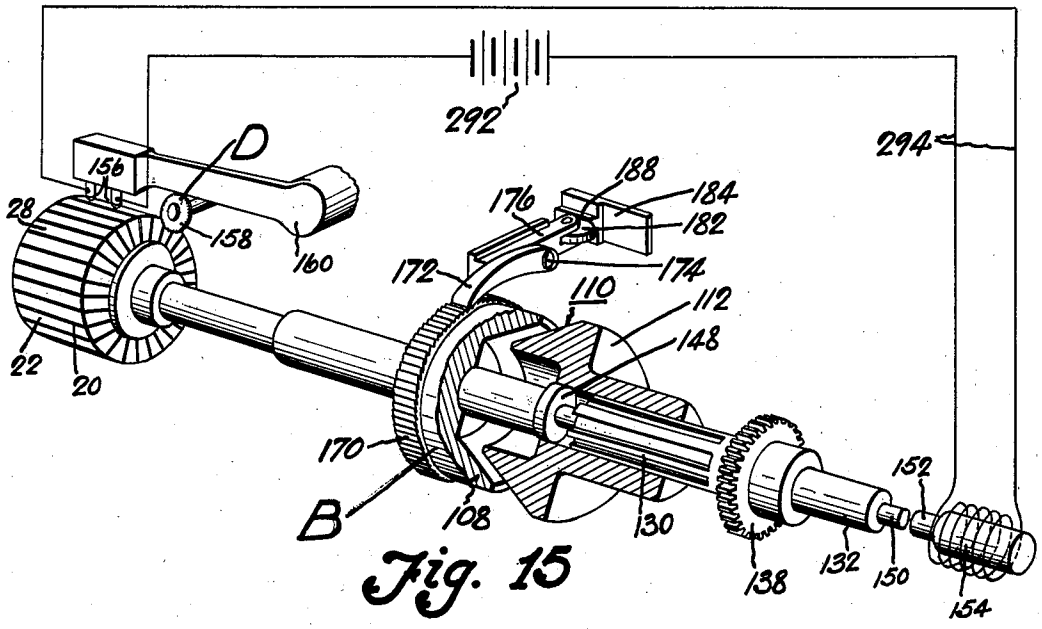


Fig. 15

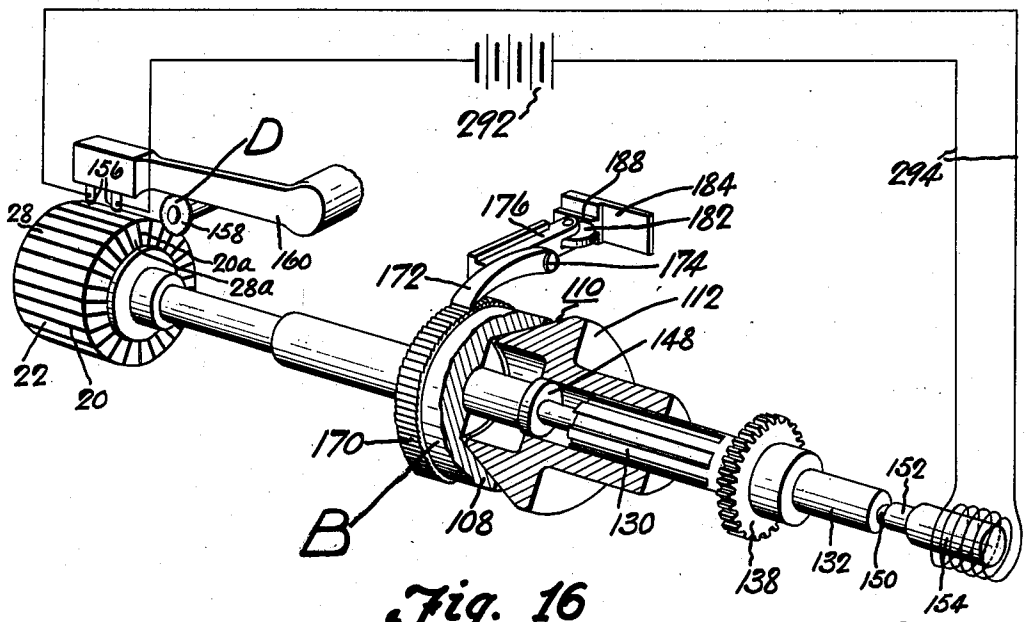


Fig. 16

Inventor

Lora E. Poole

By Spencer, Hardman & Fehr

his Attorneys

Nov. 21, 1939. L. E. POOLE 2,180,771

COMMUTATOR SEPARATOR UNDERCUTTING MACHINE

Filed April 12, 1937 10 Sheets-Sheet 10

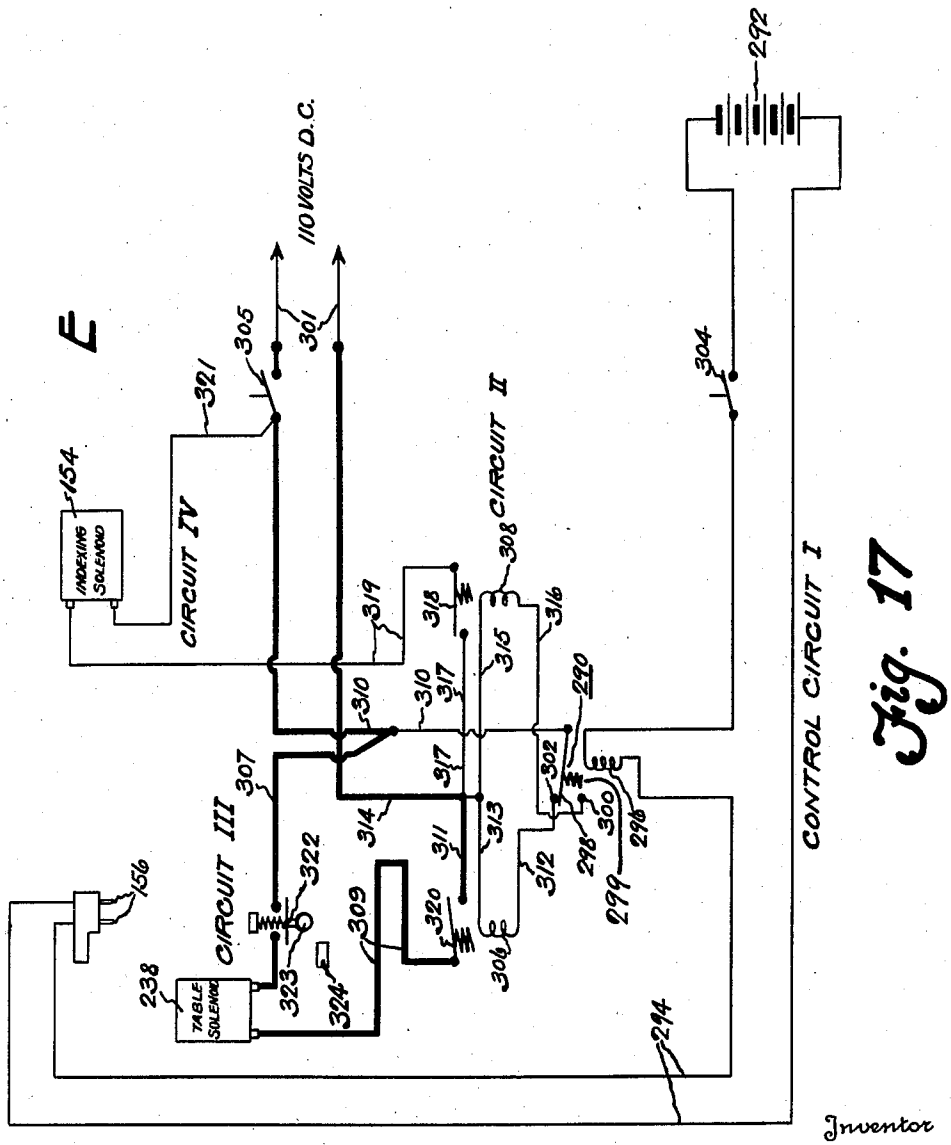


Fig. 17

Inventor

Lora E. Poole

By Spencer, Hardman & Fehr

his Attorneys

Patented Nov. 21, 1939 2,180,771

UNITED STATES PATENT OFFICE

2,180,771

COMMUTATOR SEPARATOR UNDERCUTTING MACHINE

Lora E. Poole, Anderson, Ind., assignor to General Motors Corporation, Detroit, Mich., a corporation of Delaware

Application April 12, 1937, Serial No. 136,464

23 Claims. (Cl. 90—15.1)

This invention relates to a machine for undercutting the mica separators between the conductive bars of commutators.

Mica undercutting machines which are operated automatically are provided with commutator indexing devices which turn the commutator, previous to each undercutting operation, equi-angular distances, and therefore operate successfully only when the mica separators are spaced equi-angular distances. If it happens that, due to variations in thickness of the commutator bars and/or the mica separators or to variations in manufacture, the latter are not exactly spaced equi-angular distances apart, an attempt is made to undercut the mica separators of such a commutator on a machine using any of the automatic indexing mechanisms heretofore known the result is that, frequently, the cutter is not located exactly in alignment with the mica separators and therefore only a partial width of a mica separator is undercut while the remaining width thereof remains flush with the periphery of an adjacent commutator bar. These variations of spacing the mica separators must therefore be met by manually indexing the commutator to bring the mica separators into exact alignment with the cutter, an operation which is slow and, hence, increases cost of manufacture.

It is the primary aim and object of the present invention to provide a machine which automatically undercuts the mica separators of a commutator rapidly and accurately.

It is more particularly an object of the present invention to incorporate in the machine an automatically performing mechanism which rapidly and accurately aligns successive mica separators of a commutator with the cutter.

These and other objects of the present invention are accomplished by providing a table which is reciprocable relative to a rotary cutter and on which a rotary chuck for a commutator is mounted. This chuck includes a ratchet turned by a pawl which is actuated by a stationary cam during the latter part of one reciprocation of the table, whereby the chucked commutator is slightly turned sufficiently to disalign the last undercut mica separator from the cutter. A suitable power drive, including a normally disconnected friction clutch, is adapted to continue the indexing of the commutator until the next mica separator is in alignment with the cutter. Clutch engagement is made by a solenoid, the energizing circuit of which can be closed only through a conductive commutator bar. Therefore, a relatively stationary arm is provided with two contact points which are part of the solenoid circuit and spaced apart longitudinally of the commutator. These points simultaneously contact either a mica separator or a conductive bar of the commutator, and close the solenoid circuit when the latter contact is established. Their location is such relative to the cutter that they contact that mica separator only which is in operative alignment with the cutter. Consequently, upon disalignment of the last undercut mica separator from the cutter by the earlier mentioned cam operated ratchet mechanism, the energizing circuit for the solenoid is closed across the points by the contacted conductive commutator bar. The energized solenoid causes engagement of the friction clutch and corresponding rotation of the commutator. The points remain in contact with the moving commutator bar and maintain the solenoid circuit closed until the next mica separator moves into contact with the points, whereupon the solenoid circuit is interrupted and the friction clutch disconnected. This next separator is now in perfect alignment with the cutter due to the explained coordinated location of the contact points and the cutter. The point carrying arm is pivotally mounted, and provision is made to let the points descend upon the commutator immediately after the latter comes to rest upon a complete reciprocation of the table, thus protecting the contact points against unnecessary wear, yet allowing no idle time to pass between a completed reciprocation of the commutator and the indexing thereof. In order to start the table on its next reciprocation immediately after a concluded indexing operation upon the commutator, use is made of an electric control system which causes the energizing circuit of another solenoid to be closed immediately after the energizing circuit of the indexing solenoid is opened. This other solenoid is adapted to connect a normally disconnected one revolution clutch which establishes a driving connection between a power drive and a crank mechanism for reciprocating the table once during one revolution of said clutch. Suitable mechanism is also provided for stopping the machine automatically when all mica separators of a commutator are undercut.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred embodiment of the present invention is clearly shown.

In the drawings:

Fig. 1 is a fragmentary front elevation of a machine embodying the present invention.

Fig. 2 is a plan view of the machine.

Fig. 2*a* is an end elevational view of a commutator.

Fig. 3 is a fragmentary perspective view of part of the machine as viewed in the direction of arrow 3 in Fig. 1.

Fig. 4 is another fragmentary perspective view of one end of the machine as viewed in the direction of arrow 4 in Fig. 1.

Figs. 5 and 6 are enlarged fragmentary perspective views of details of the machine in different positions of operation.

Fig. 7 is a fragmentary elevational view of the machine. Part of the machine is shown in section which is taken substantially on the line 7—7 of Fig. 2.

Fig. 8 is a fragmentary rear elevation of part of the machine.

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

Fig. 10 is a detail view of the cutter-carrying frame.

Fig. 11 is a section taken on the line 11—11 of Fig. 10.

Fig. 12 is a fragmentary section taken on the line 12—12 of Fig. 2.

Fig. 13 is a section similar to Fig. 12, showing certain elements thereof in a different position of operation, however.

Fig. 14 is a fragmentary section taken substantially on the line 14—14 of Fig. 2.

Figs. 15 and 16 are diagrammatic perspectives, showing the cooperation between certain structures of the machine.

Fig. 17 is a wiring diagram of the electrical control system of the machine.

The present machine is adapted to undercut the mica separators 20 of a commutator 22 in the manner illustrated at 24 in Fig. 2*a*. The commutator is already assembled with an armature 26 when operated upon by the present machine. The insulating mica separators 20 are more particularly interposed between conductive commutator bars 28 which are usually of copper. The present machine is so constructed that all mica separators 20 of a commutator 22 will be undercut automatically once the machine is started, and an automatic stop becomes effective when all mica separators of the commutator are undercut.

Referring more particularly to Figs. 1, 2 and 7, the present machine comprises a machine frame 30 which has guideways 32 for a reciprocable table 34. Some of the operating mechanisms of the present machine are carried by the table 34, while other operating mechanisms of the machine are mounted on the machine frame 30. These mechanisms are: an idle chuck A_1, a driving chuck A_2, an indexing mechanism B, a table operating mechanism C, a cutter D, an electrical control system E, and an automatic stop F. These mechanisms shall now be described in detail in the order just mentioned.

Idle chuck A_1

Referring more particularly to Figs. 2 and 7, the table 34 is provided with guideways 40 to which a saddle 42 may be clamped by the handle 44 in any adjusted position therein. This saddle 42 comprises a cylinder 46 which is closed by end covers 48 and 50 and receives a single-acting piston 52, a rod 54 of which carries a ball bearing 56 that journals a center 58 for one end of a shaft 60 of an armature 26. Interposed between the end cover 48 and the piston 52 is a compression spring 62 which normally urges said piston into the right end position illustrated in Fig. 7. The end cover 50 is provided with a duct 64 which provides communication between the active cylinder side 65 and a conduit 66, connected with a valve 68 which is mounted on the machine frame 30. This valve, which may be of any suitable type, is in permanent communication with a suitable source of fluid pressure (not shown) through a conduit 70, and includes a valve stem 72 which assumes the illustrated, raised position in Fig. 1 when the valve is normally closed. Pivoted at 74 to suitable lugs 76 is an arm 78 which is connected through a link 82 with a foot pedal 86, suitably pivoted at 88 to the machine frame 30. The valve stem 72 is depressed by the arm 78 upon depression of the foot pedal 86, whereupon fluid pressure is admitted through the valve 68 and through conduit 66 to the active cylinder side 65, thereby forcing the piston 52 to the left as viewed in Fig. 7 against the compression of spring 62. The released foot pedal 86 is returned to the illustrated position in Fig. 1 by a spring 90 which forces the pedal into engagement with a stop 92, thereby permitting the valve stem 72 to be returned to its normal valve closing position in which a vent passage (not shown) of the valve 68 permits the fluid pressure in cylinder 46 to escape so that the piston 52 may advance into the illustrated position in Fig. 7 under the compression of spring 62.

Driving chuck A_2

Also mounted on the table 34 is a bracket 100 which provides a cylindrical bore 102, containing two thrust bearings 104 which are spaced apart by a sleeve 106. Journaled in the bore 102 is a driven element 108 of a friction clutch 110, the driving element of which is designated by the numeral 112. Journaled in the bore 102 and in the driven clutch element 108 is a sleeve 114 which bears against one of the thrust bearings 104. Threadedly received in said sleeve 114 is a center or driving chuck 116 for the other end of the armature shaft 60. Suitable nuts 118 retain the driven clutch element 108 and the sleeve 114 in place and more particularly in engagement with the thrust bearings 104, as appears readily from Fig. 7. It can now be understood that the driving chuck or center 116 for the armature shaft 60 is freely rotatable only, whereas the opposite center or idle chuck 58 is freely rotatable and movable longitudinally. Suitable armature locating bars 120 are adjustably mounted on brackets 122 on top of the table 34, and serve for the ready alignment of the shaft of an armature with the chuck centers 58, 116 before the shaft is properly received thereby.

Indexing mechanism B

Referring particularly to Figs. 2, 4, 7 to 9, inclusive, 15 and 16, the earlier described driving element 112 of the friction clutch 110 is splined at 130 to a hollow shaft 132 which is journaled in bushings 134 of a housing 136, mounted on the table 34. Mounted on the shaft 132 is a gear 138 which is in permanent mesh with another gear 140, carried by a slow shaft 142 of a reduction gearing 144 that is driven by an electric motor 146. The driving clutch element 112 is provided with a plate 148 in alignment with a rod 150 which is received by the hollow shaft 132. The other end of rod 150 is in alignment with an armature 152 of a solenoid 154, the energizing circuit of which can only be closed

through one of the copper bars 28 of a commutator which is operated upon by the machine. When this solenoid is energized, the armature 152 forces the driving clutch element 112 into frictional engagement with the driven clutch element 108 by means of the rod 150. When the machine is in operation, the constantly running motor 146 drives the driving clutch element 112 continuously through intermediation of shaft 132, gears 138 and 140, and reduction gearing 144. The energizing circuit for the clutch engaging solenoid 154 will be described later, it being sufficient at present to state that this circuit includes two contact points 156 which will have to be bridged by a conductive commutator bar 28 in order to close said circuit. When the machine is in operation and the contact points 156 are in engagement with one of the conductive commutator bars 28, the solenoid circuit is closed and the armature 152 thereof moves to cause engagement of the friction clutch 110 and corresponding rotation of the chucked armature. The indexing of the armature amounts each time to the angular distance between successive mica separators 29, and successive mica separators will thus be moved into alignment with a rotary cutter 158, as can be best understood from Figs. 2, 15 and 16. The contact points 156 are more particularly in alignment with the cutter 158 so that they simultaneously contact that mica separator which is in operative alignment with said cutter. The contact points 156 are carried by an arm 160 which is journaled on a stub shaft 162, depending from a frame 164 on top of the machine frame 30. It is obvious from the preceding that the solenoid 154 is not energized and the clutch 110 is disengaged after a concluded undercutting operation since the contact points 156 are then in alignment with an insulating mica separator 29. In order to close the solenoid circuit, the chucked armature will have to be turned slightly so as to bring a conductive commutator bar 28 into alignment with the contact points 156.

Means for slightly turning the commutator

This slight turning of the armature is accomplished by mechanical means during the latter part of one complete reciprocation of the table 34. The driven clutch element 108 is provided with ratchet teeth 170 with which cooperates a pawl 172, pivotally mounted at 174 to a bar 176 which is guided for linear movement in suitable ways 178 of the bracket 100. Bar 176 carries a roller 182 which is normally urged against a cam 184 on the frame 104 by a compression spring 186. Cam 184 has a rising lobe 188 which is adapted to cooperate with the roller 182 in moving the bar 176 against the compression of spring 186 and slightly turn the driven clutch element 108 in indexing direction through intermediation of the pawl 172 and the ratchet teeth 170. The cam lobe 188 is so located that the just mentioned slight turn of the driven clutch element takes place during the latter part of a complete reciprocation and just before the table 34 comes to rest in the home position illustrated in Fig. 2, in which the cutter 158 is remote from the commutator 22 and permits rotation of the latter without interfering with the cutter. When the armature has thus been slightly turned, the contact points 156 are then in alignment with a conductive commutator bar 28 which connects these contact points, thereby closing the solenoid circuit and causing clutch engagement. This condition is illustrated diagrammatically in Figs. 15 and 16. More particularly, Fig. 15 shows the end of the slight turn of the armature as caused by the stationary cam 184. It will be noted in Fig. 15 that the clutch 110 is still disconnected, however, the contact points 156 will at the next moment close the solenoid circuit across the conductive commutator bar 28*a* and cause clutch engagement in the manner illustrated in Fig. 16. Of course, the solenoid circuit remains closed while the contact points 156 rest on the moving commutator bar 28*a*, and is opened when the contact points come to rest on the mica separator 29*a* which is to be undercut next. This insulating mica separator, being then the only connection between the contact points 156, causes opening of the solenoid circuit and immediate disconnection of the friction clutch 110 under the force of a spring-urged plunger 189. To prevent overtravel of the driven clutch element 108, a yielding brake 190 restrains rotation of this clutch element in the manner shown in Fig. 3. To avoid interference between the contact points 156 and the while the latter reciprocates the point carrying arm 160 is cammed out of the path of movement of said armature by a roller 192 which is mounted on top of the bracket 100. Thus, when the table 34 moves in a direction in which the commutator approaches the cutter 158, the arm 160 is rocked clockwise as viewed in Figs. 5, 6 and 7. The arm 160 will rock back toward the commutator upon movement of the table in the opposite direction, i. e. into the home position shown in Figs. 2 and 7. More particularly, the roller 192 is so located that it will permit descent of the contact points 156 into contact with the commutator at the end of a complete reciprocation of the slide, i. e. after the slight turn of the commutator has already been accomplished by the cam 184. The contact points 156 will, consequently, come to rest upon a moving commutator bar and the sliding engagement therebetween extends only over a distance which is less than the thickness of the commutator bar. Thus, the comparatively fine points 156 are not worn excessively and will perform satisfactorily for a long time before requiring resharpening.

Table operating mechanism C

Referring to Figs. 1, 4, 8 and 9, the table 34 is connected through a link 200 with a crank pin 202 which is adjustably mounted in a radial slot 204 of a disc 206 on a stub shaft 208, suitably journaled in a sleeve 210 of a bracket 212 which is mounted on the machine frame 30. Journaled on the stub shaft 208 is a gear 216 which is in permanent mesh with a smaller gear 218 on a shaft 220, suitably journaled in a bearing bracket 222 and connected to a slow shaft 223 of a reduction gearing 224 which is driven by an electric motor 226. Gear 216, which is continuously driven when the machine is in operation, carries a clutch element 228, a companion element 230 of which is splined at 232 to the stub shaft 208. Cooperating with a yoke 234 of the clutch element 230 is an armature 236 of a solenoid 238 which is adapted to force the clutch element 230 into engagement with its companion element 228. The elements 228, 230 form a one revolution clutch together with a stationary arm 240 which has a beveled point 242. To engage the clutch, the solenoid 238 is energized only for a short time which is less than that required for one revolution of the clutch. However, energization of the solenoid 238 lasts sufficiently long to cause ro-

tation of the engaged clutch elements 228, 230 until a beveled notch 244 of clutch element 230 is out of alignment with the beveled point 242. The beveled point 242 registers with the beveled notch 244 (Fig. 4) only when the clutch is disengaged. The clutch is engaged in any other angular position of the element 230 in which a bottom surface 246 thereof rides on top of the beveled point 242. Thus, only a short energization of the solenoid 238 is required to cause clutch engagement through one complete revolution of the same, i. e. until the beveled notch 244 realigns and registers with the beveled point 242. Suitable electrical control provisions, to be described later, effect the closing of the energizing circuit for the solenoid 238 immediately after the opening of the energizing circuit for the indexing solenoid 154, i. e. immediately upon alignment of a mica separator with the cutter 158.

Cutter D

Referring more particularly to Figs. 1, 2, 10 and 11, the cutter 158 is mounted on a spindle 250 which is journaled in ball bearings 252 of a quill 254, slidable horizontally in a frame 256 which is in turn vertically slidable in suitable guideways 258 of the frame 164, and is secured in adjusted position therein by suitable screws 260. The quill 254 is provided with rack teeth 262 which mesh with a gear 264 on a spindle 266 which is journaled in the frame 256 and provided with a hand knob 268 for turning the gear 264, thereby moving the quill 254 so as to adjust the cutter in perfect alignment with a mica separator which is disposed in a vertical plane. Suitable means (not shown) secure the quill 254 to the frame 256 in properly adjusted position. The other end of the spindle 250 carries a pulley 270 which is driven by a larger pulley 272 of an electric motor 274 through a belt 276. Motor 274 is pivotally mounted at 278 to the machine frame 30 and is otherwise suspended on the belt 276 which is tensioned by rocking the motor 274 counterclockwise as viewed in Fig. 1 by means of a screw and nut 280, 282.

Control mechanism E

Referring more particularly to the wiring diagram in Fig. 17, the electrical control of the present machine comprises four circuits: a control circuit I, another control circuit II, the energizing circuit III for the table solenoid 238, and the energizing circuit IV for the indexing solenoid 154. It is the function of the control circuits I and II alternately to close the solenoid circuits III and IV by means of a single pole double-throw switch 290 which is magnetically controlled. The solenoid circuits III and IV and the control circuit II operate preferably with 110 volts D. C., whereas the control circuit I operates with a lower voltage approximately 12 volts D. C. so as to prevent sparking at the contact points 156 which are part of said control circuit. The control circuit I may draw its power from any suitable source such as a generator or battery. Fig. 17 shows a battery 292 as the power source for the control circuit I. Besides the earlier mentioned contact points 156, the control circuit I further includes a relay magnet 296 which is adapted to draw a blade 298 of the switch 290 against the resistance of a spring 299 into engagement with a contact 300 thereof which normally holds the blade 298 in contact with the other switch contact 302. The control circuit I includes also a foot operated switch 304 which is closed while the machine is in operation. The control circuit II includes the double-throw switch 290 and two relay magnets 306 and 308 which may be alternately connected with a suitable source of 110 volts D. C. current upon engagement of the switch blade 298 with the contacts 300 and 302, respectively. Normally, the relay magnet 306 is energized due to the normal engagement of switch blade 298 with the contact 302, whereas the other relay magnet 308 is normally deenergized, as can be readily understood. Upon closing the control circuit I by a commutator bar 28 engaging contacts 156, the switch blade 298 is drawn into engagement with contact 300 by the energized relay 296, and the control circuit II is then closed through the relay magnet 308. More particularly, the control circuit II is connected with the lines 301 of a 110 volts D. C. supply through the lead 310, switch blade 298, contact 300, lead 316, relay 308 and the leads 315 and 314. The manually operated switch 305 in one of the power lines 301 is closed when the machine is in operation. The energized relay 308 draws a normally open switch 318 closed, thereby closing the solenoid circuit IV through the following connections: leads 314 and 317, switch 318, lead 319, solenoid 154 and lead 321. The control circuit I is closed as long as the points 156 contact a conductive commutator bar 28. Therefore, when the points engage a mica separator 20, the control circuit I is opened, and the switch blade 298 returns to normal contact with pole 302, thereby closing control circuit II through the relay 306 by way of the leads 312 and 313. The energized relay 306 closes a normally open switch 320 of the solenoid circuit III which comprises the leads 314 and 311, switch 320, lead 309, solenoid 238, a switch 322 (normally open but then held closed) and the leads 307 and 310. The limit switch 322 is closed when its lever 323 is in engagement with a cam lug 324 of the table 34 as best shown in Fig. 4. The table is then in its home position in which the cutter 158 is separated from the commutator (see Figs. 2 and 7). When the solenoid circuit III is thus closed as indicated in heavy lines in Fig. 17, the one revolution clutch 228, 230 is engaged and the table 34 starts a reciprocation. The cam 324 releases the switch lever 323 shortly after the table 34 started on its reciprocation, whereupon switch 322 assumes its normal open position and interrupts the solenoid circuit III. The cam 324 is long enough to delay the opening of switch 322 until the one revolution clutch has turned sufficiently to be held closed by arm 240. The cam 324 reengages the switch lever 323 and closes the switch 322 shortly before the table 34 completes one reciprocation. Of course, the solenoid circuit III is reopened after a concluded reciprocation of the table 34 by the double-throw switch 290 upon closing of the control circuit I, following the partial indexing of the armature by the stationary cam 188 and renewed contact of the points 156 with the next conductive commutator bar. It can now be understood that the solenoid circuits III and IV are alternately opened and closed, resulting in alternate mica undercutting operations and armature indexing operations.

Automatic stop F

Referring more particularly to Figs. 1, 2 and 12 to 14 inclusive, a ratchet 330 is mounted on a stub shaft 332 which carries at its lower end a disc 334. Cooperating with the ratchet 330 is a spring-urged pawl 336 which is pivotally

mounted at 338 on the table 34 and adapted to index the ratchet 330 the angular distance of one ratchet tooth 331 for each reciprocation of the table. There are as many ratchet teeth 331 as there are mica separators in a commutator so that the ratchet has completed one revolution after all mica separators have been undercut. The disc 334 is provided with a notch 340 which receives the upper end of a lock bar 342 when the machine is at rest. As more particularly shown in Fig. 1, this bar 342 is connected to a foot pedal 346 through a link 344. A collar 348 is mounted on bar 342 and is guided in a spring retainer 350 which is secured to the machine frame 30 and contains a compression spring 352. This spring 352 normally urges bar 342 into the illustrated uppermost position in Figs. 1, 13 and 14, in which the upper end of said bar projects into the notch 340. Mounted on suitable cross bars 354 of the machine frame 30 are the two switches 304 and 305, between which the link 344 passes. This link carries a collar 356 which operates simultaneously on the arms 358 of both switches 304, 305 and closes the same upon depression of the foot pedal 346. Thus, in order to start the machine, the operator steps on the foot pedal 346, thereby not only closing the switches 304, 305 but also withdrawing bar 342 from registry with the notch 340 and permitting disc 334 and ratchet 330 to rotate. Of course, the closing of the switches 304, 305 upon depression of the foot pedal 346 causes immediate closing of one of the solenoid circuits III or IV and the following alternate energization of both solenoids until all mica separators of a commutator are undercut. Some time will naturally elapse before the disc 334 and ratchet 330 are rotated sufficiently to bring the notch 340 out of alignment with the bar 342 even though the table solenoid 238 should be the first to be energized upon depression of the foot pedal 346. This is evident from the fact that the ratchet disc 330 is not indexed by the pawl 336 until near the conclusion of one reciprocation of the table 34. To prevent bar 342 from again registering with the notch 340 and thereby permit reopening of the normally open switches 304, 305 before the notch 340 has moved out of alignment with bar 342, the latter is immediately arrested in the illustrated depressed position in Fig. 12 by the arm 360 of a lever 362 which is pivotally mounted at 364 on top of the machine frame 30. This lever is arrested in the illustrated locking position in Fig. 12 by a stud 366 of a lever 368 which is pivotally mounted at 370 to the machine frame 30. When the machine is at rest, the lever 368 rests on lever 362 in the manner shown in Fig. 13. When the foot pedal 346 is depressed, gravity causes lever 362 to follow the descending bar 342 into the position shown in Fig. 12, and the stud 366 of lever 368 is snapped in place behind lever 362 by a tension spring 372. The stud 366 locks lever 362 in the position shown in Fig. 12 against the compression of spring 352 (see Fig. 1). Lever 362 preferably keeps bar 342 depressed to such an extent that there is a clearance maintained between said bar and the bottom surface 374 of disc 334 so as to eliminate any friction between said disc and the bar 342 while the former is indexed. The ratchet disc 330 is further provided with a cam lug 376 which is angularly spaced from the notch 340 to such an extent that it will cooperate with lever 368 and rock the same clockwise sufficiently to release lever 362 just when the notch 340 aligns with the bar 342. The purpose for angularly spacing cam lug 376 from notch 340 is to have the cam lug 376 out of alignment with the lever 368 when the machine is in home position, i. e. when bar 342 projects into the notch 340, so as to permit lever 368 to descend on top of the ratchet disc 330 and lock lever 362 immediately upon renewed depression of the foot pedal 346 for a restart of the machine. Of course, when the bar 342 moves into registry with the notch 340 after a complete revolution of disc 334, the switches 304, 305 are permitted to open and disconnect the electrical control devices from their power source.

Mode of operation

Before starting the machine, the operator steps on the foot pedal 86 to cause withdrawal of the movable center 58, and then aligns an armature with the chuck centers 58, 116, thereupon releasing the foot pedal. The machine is now ready for operation and the operator will next depress the foot pedal 346, thereby not only withdrawing bar 342 from locking engagement with the disc 334, but also closing the switches 304, 305. The control circuits are connected with their power sources and one of the solenoid circuits III and IV is immediately closed, depending on the location of the points 156 relative to a mica separator or a conductive commutator bar of the armature. The points 156 contact in most cases engages a commutator bar which causes closing of the solenoid circuit IV and consequent indexing of the armature until the next mica separator is contacted by said points. The double-throw switch 290 closes the solenoid circuit III immediately after the opening of the circuit IV thereby causing one complete reciprocation of the table 34 in the earlier explained manner. Due to the explained electrical control, indexing operations alternate with undercutting operations until the last mica separator is undercut. The notch 340 realigns then with the bar 342 which has been previously released by the cam 376, whereupon said bar reenters notch 340 and permits the switches 304, 305 to reopen and break all connections between the electrical control devices and their power sources. The machine then comes to rest and the operator depresses the foot pedal 86 in order to withdraw the center 58 from the armature shaft to permit removal of the finished armature from the machine and deposition of a new armature therein. Renewed depression of the other foot pedal 346 restarts the machine for operation on the newly deposited armature.

While the embodiment of the present invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. A machine for undercutting the insulating separators of a commutator comprising, in combination, means for supporting a commutator, means for undercutting the insulating separators, means for producing relative bodily movement between the commutator supporting means and the separator undercutting means, power operated means for intermittently indexing the commutator to move the separators successively into alignment with the undercutting means, electrical means for controlling the indexing means including a contact in alignment with the undercutting means for engaging the commutator and a circuit established by the engagement of the

contact with a commutator bar to cause the commutator to be rotated until the bar is moved away from the contact, and means for causing a commutator bar to be engaged by the contact subsequent to an undercutting operation.

2. A machine for undercutting the insulating separators of a commutator comprising, in combination, means for supporting a commutator, means for undercutting the insulating separators, means for producing relative bodily movement between the commutator supporting means and the separator undercutting means, power operated means for intermittently indexing the commutator to move the separators successively into alignment with the undercutting means, electrical means for controlling the indexing means including a contact in alignment with the undercutting means for engaging the commutator and a circuit established by the engagement of the contact with a commutator bar to cause the commutator to be rotated until the bar is moved away from the contact, and means responsive to relative bodily movement between the commutator supporting means and the undercutting means, the one away from the other, for causing a slight rotation of the commutator to move a bar thereof into position to be engaged by the contact whereby the power operated indexing means is started.

3. A machine for undercutting the insulating separators of a commutator comprising, in combination, means for supporting a commutator, means for undercutting the insulating separators, means for producing relative bodily movement between the commutator supporting means and the separator undercutting means, power operated means for intermittently indexing the commutator to move the separators successively into alignment with the undercutting means, electrical means for controlling the indexing means including a contact in alignment with the undercutting means for engaging the commutator and a circuit established by the engagement of the contact with a commutator bar to cause the commutator to be rotated until the bar is moved away from the contact, means for causing a commutator bar to be engaged by the contact subsequent to an undercutting operation, and means functioning after a predetermined number of undercutting operations having been performed for rendering inoperative the means which produces relative bodily movement between the commutator supporting means and the separator undercutting means, and for interrupting an electrical circuit of the index controlling means.

4. A machine for undercutting the insulating separator of a commutator comprising, in combination, means for supporting a commutator, means for undercutting the insulating separators, means for producing relative bodily movement between the commutator supporting means and the separator undercutting means, power operated means for intermittently indexing the commutator to move the separators successively into alignment with the undercutting means, electrical means for controlling the indexing means including a contact in alignment with the undercutting means for engaging the commutator and a circuit established by the engagement of the contact with a commutator bar to cause the commutator to be rotated until the bar is moved away from the contact, means responsive to relative bodily movement between the commutator supporting means and the undercutting means, the one away from the other, for causing a slight rotation of the commutator to move a bar thereof into position to be engaged by the contact whereby the power operated indexing means is started, and means functioning after a predetermined number of undercutting operations having been performed for rendering inoperative the means which produces relative bodily movement between the commutator supporting means and the separator undercutting means, and for interrupting an electrical circuit of the index controlling means.

5. A machine for undercutting the insulating separators of a commutator comprising, in combination, means for supporting a commutator, means for undercutting the insulating separators, means for producing relative bodily movement between the commutator supporting means and the separator undercutting means, power operated means for intermittently indexing the commutator to move the separators successively into alignment with the undercutting means, electrical means for controlling the indexing means including a contact in alignment with the undercutting means for engaging the commutator and a circuit established by the engagement of the contact with a commutator bar to cause the commutator to be rotated until the bar is moved away from the contact, means for causing a commutator bar to be engaged by the contact subsequent to an undercutting operation, means functioning after a predetermined number of undercutting operations having been performed for rendering inoperative the means which produce relative bodily movement between the commutator supporting means and the separator undercutting means for interrupting an electrical circuit of the index controlling means, and for effecting the release of the commutator from its supporting means.

6. A machine for undercutting the insulating separators of a commutator comprising, in combination, means for supporting a commutator, means for undercutting the insulating separators, means for producing relative bodily movement between the commutator supporting means and the separator undercutting means, power operated means for intermittently indexing the commutator to move the separators successively into alignment with the undercutting means, electrical means for controlling the indexing means including a contact in alignment with the undercutting means for engaging the commutator and a circuit established by the engagement of the contact with a commutator bar to cause the commutator to be rotated until the bar is moved away from the contact, means responsive to relative bodily movement between the commutator supporting means and the undercutting means, the one away from the other, for causing a slight rotation of the commutator to move a bar thereof into position to be engaged by the contact whereby the power operated indexing means is started, means functioning after a predetermined number of undercutting operations having been performed for rendering inoperative the means which produce relative bodily movement between the commutator supporting means and the separator undercutting means and for interrupting an electrical circuit of the index controlling means, and for effecting the release of the commutator from its supporting means.

7. A machine for undercutting the insulating separators of a commutator comprising, in combination, means for supporting a commutator, means for undercutting the insulating separators, means for producing relative bodily movement

between the commutator supporting means and the separator undercutting means, mechanical means for intermittently indexing the commutator to move the separators successively a predetermined angular distance to establish an electrical circuit, electrically controlled means for moving the separators into alignment with the undercutting means to open the circuit, and means for causing the machine to stop automatically after predetermined number of undercutting operations have been performed and for effecting the release of the commutator from its supporting means.

8. A machine for undercutting the insulating separators of a commutator comprising, in combination, means for supporting a commutator, means for undercutting the insulating separators, means for producing relative bodily movement between the commutator supporting means and the separator undercutting means, mechanical means for intermittently indexing the commutator to move the separators successively a predetermined angular distance and out of alignment with the undercutting means, electrical means operable after the operation of the mechanical means for controlling the indexing means to move the separator into alignment with the undercutting means, and means for rendering ineffective the electric means for controlling the indexing means, for stopping the machine and for effecting the release of the commutator from its supporting means.

9. A machine for undercutting the insulating separators of a commutator comprising, in combination, means for supporting a commutator, means for undercutting the insulating separators, power operated means including a reciprocating member for producing relative bodily movement between the commutator supporting means and the separator undercutting means, power operated means for intermittently indexing the commutator to move the separators successively into alignment with the undercutting means, electrical means for controlling the reciprocating member and the indexing means and comprising a contact in alignment with the undercutting means and engageable with the commutator, a circuit established in response to engagement of the contact with a commutator bar for causing the indexing means to operate until the contact is separated from the bar by rotation of the commutator, and a circuit established in response to the completion of the indexing operation for causing the reciprocating member to operate and means responsive to movement of the reciprocating member subsequent to the undercutting operation for causing the commutator to be turned slightly to cause a bar thereof to move into position to be engaged by the contact.

10. A machine for undercutting the insulating separators of a commutator comprising, in combination, means for supporting a commutator, means for undercutting the insulating separators, power operated means including a reciprocating member for producing relative bodily movement between the commutator supporting means and the separator undercutting means, power operated means for intermittently indexing the commutator to move the separators successively into alignment with the undercutting means, electrical means for controlling the reciprocating member and the indexing means and comprising a contact in alignment with the undercutting means and engageable with the commutator, a circuit established in response to engagement of the contact with a commutator bar for causing the indexing means to operate until the contact is separated from the bar by rotation of the commutator, and a circuit established in response to the completion of the idexing operation for causing the reciprocating member to operate and means responsive to movement of the reciprocating member subsequent to the undercutting operation for causing the commutator to be turned slightly to cause a bar thereof to move into position to be engaged by the contact, and means for interrupting both circuits automatically after predetermined number of undercutting operations have been performed.

11. A machine for undercutting the insulating separators of a commutator comprising, in combination, means for supporting a commutator, means for undercutting the insulating separators, power operated means including a reciprocating member for producing relative bodily movement between the commutator supporting means and the separator undercutting means, and including a one-revolution clutch for connecting a source of mechanical power with the reciprocating member, power operated means for intermittently indexing the commutator to move the separators successively into alignment with the undercutting means, electrical means for controlling the reciprocating member and the indexing means and comprising a contact in alignment with the undercutting means and engageable with the commutator, a circuit established in response to engagement of the contact with a commutator bar for causing the indexing means to operate until the contact is separated from the bar by rotation of the commutator, and a circuit including a solenoid energized in response to the completion of the indexing operation for causing the one-revolution clutch to be connected, and means responsive to movement of the reciprocating member subsequent to the undercutting operation for causing the commutator to be turned slightly to cause a bar thereof to move into position to be engaged by the contact.

12. A machine for undercutting the insulating separators of a commutator comprising, in combination, means for supporting a commutator, means for undercutting the insulating separators, power operated means including a reciprocating member for producing relative bodily movement between the commutator supporting means and the separator undercutting means, power operated means for intermittently indexing the commutator to move the separators successively into alignment with the undercutting means, and including a clutch for connecting a source of mechanical power with the commutator supporting means to rotate the same, electrical means for controlling the reciprocating member and the indexing means and comprising a contact in alignment with the undercutting means and engageable with the commutator, a circuit including a solenoid established in response to engagement of the contact with a commutator bar for causing the clutch to connect the source of power with the indexing means until the commutator has been turned so that the commutator bar is separated from the contact, a circuit established in response to the completion of the indexing operation for causing the reciprocating member to operate, and means responsive to movement of the reciprocating member subsequent to the undercutting operation for causing the commutator to be turned slightly to cause a bar thereof to move into position to be engaged by the contact.

13. A machine for undercutting the insulating separators of a commutator comprising, in combination, means for supporting a commutator, means for undercutting the insulating separators, power operated means including a reciprocating member for producing relative bodily movement between the commutator supporting means and the separator undercutting means, and including a one-revolution clutch for connecting a source of mechanical power with the reciprocating member, power operated means for intermittently indexing the commutator to move the separators successively into alignment with the undercutting means and including a clutch for connecting a source of mechanical power with the commutator supporting means to rotate the same, electrical means for controlling the reciprocating member and the indexing means and comprising a contact in alignment with the undercutting means and engageable with the commutator, a circuit including a solenoid established in response to engagement of the contact with a commutator bar for causing the clutch to connect the source of power with the indexing means until the commutator has been turned so that the commutator bar is separated from the contact, a circuit including a solenoid energized in response to the completion of the indexing operation for causing the one-revolution clutch to be connected, and means responsive to movement of the reciprocating member subsequent to the undercutting operation for causing the commutator to be turned slightly to cause a bar thereof to move into position to be engaged by the contact.

14. A machine for undercutting the insulating separators of a commutator comprising, in combination, means for supporting a commutator, means for undercutting the insulating separators, power operated means including a reciprocating member for producing relative bodily movement between the commutator supporting means and the separator undercutting means, and including a one-revolution clutch for connecting a source of mechanical power with the reciprocating member, power operated means for intermittently indexing the commutator to move the separators successively into alignment with the undercutting means, electrical means for controlling the reciprocating member and the indexing means and comprising a contact in alignment with the undercutting means and engageable with the commutator, a circuit established in response to engagement of the contact with a commutator bar for causing the indexing means to operate until the contact is separated from the bar by rotation of the commutator, a circuit including a solenoid energized in response to the completion of the indexing operation for causing the one-revolution clutch to be connected, means responsive to movement of the reciprocating member subsequent to the undercutting operation for causing the commutator to be turned slightly to cause a bar thereof to move into position to be engaged by the contact, and means for interrupting all circuits automatically after a predetermined number of undercutting operations have been performed.

15. A machine for undercutting the insulating separators of a commutator comprising, in combination, means for supporting a commutator, means for undercutting the insulating separators, power operated means including a reciprocating member for producing relative bodily movement between the commutator supporting means and the separator undercutting means, power operated means for intermittently indexing the commutator to move the separators successively into alignment with the undercutting means, and including a clutch for connecting a source of mechanical power with the commutator supporting means to rotate the same, electrical means for controlling the reciprocating member and the indexing means and comprising a contact in alignment with the undercutting means and engageable with the commutator, a circuit including a solenoid established in response to engagement of the contact with a commutator bar for causing the clutch to connect the source of power with the indexing means until the commutator has been turned so that the commutator bar is separated from the contact, a circuit established in response to the completion of the indexing operation for causing the reciprocating member to operate and means responsive to movement of the reciprocating member subsequent to the undercutting operation for causing the commutator to be turned slightly to cause a bar thereof to move into position to be engaged by the contact, and means for interrupting all circuits automatically after a predetermined number of undercutting operations have been performed.

16. A machine for undercutting the insulating separators of a commutator comprising, in combination, means for supporting a commutator, means for undercutting the insulating separators, power operated means including a reciprocating member for producing relative bodily movement between the commutator supporting means and the separator undercutting means, and including a one-revolution clutch for connecting a source of mechanical power with the reciprocating member, power operated means for intermittently indexing the commutator to move the separators successively into alignment with the undercutting means and including a clutch for connecting a source of mechanical power with the commutator supporting means to rotate the same, electrical means for controlling the reciprocating member and the indexing means and comprising a contact in alignment with the undercutting means and engageable with the commutator, a circuit including a solenoid established in response to engagement of the contact with a commutator bar for causing the clutch to connect the source of power with the indexing means until the commutator has been turned so that the commutator bar is separated from the contact, a circuit including a solenoid energized in response to the completion of the indexing operation for causing the one-revolution clutch to be connected, means responsive to movement of the reciprocating member subsequent to the undercutting operation for causing the commutator to be turned slightly to cause a bar thereof to move into position to be engaged by the contact, and means for interrupting all circuits automatically after a predetermined number of undercutting operations have been performed.

17. A control system for a commutator separator undercutting machine having power means including a one-revolution clutch for effecting the reciprocation of a member which produces relative bodily movement between the commutator and a separator undercutting means, and having power means including a clutch for effecting indexing rotation of the commutator to move its insulating separators successively into alignment with the undercutting means, said control system comprising in combination, a cir-

cuit including a pair of aligned contacts adapted to be bridged by a commutator bar, said circuit being interrupted by engagement of the contacts with a separator, a relay switch controlled by the bridging of said pair of contacts, said switch having a contact movable into either of two positions, a solenoid for causing the indexing mechanism operating clutch to close and energize in response to movement of said relay contact into the position responding to the engagement of a commutator bar with said pair of aligned contacts, a solenoid for causing the one-revolution clutch to close and energize in response to movement of said relay contact into the position responding to the engagement of a commutator spacer with said pair of aligned contacts, and a mechanism operated by the machine for effecting engagement of the said pair of aligned contacts with another commutator bar subsequent to an undercutting operation.

18. A control system for a commutator separator undercutting machine having power means including a one-revolution clutch for effecting the reciprocation of a member which produces relative bodily movement between the commutator and a separator undercutting means and having power means including a clutch for effecting indexing rotation of the commutator to move its insulating separators successively into alignment with the undercutting means, said control system comprising in combination, a circuit including a pair of aligned contacts adapted to be bridged by a commutator bar, said circuit being interrupted by engagement of the contacts with a separator, a relay switch controlled by the bridging of said pair of contacts, said switch having a contact movable into either of two positions, relay switches respectively energized in response to movement of said two-position contact into either of its contact making positions, solenoids energized, respectively, in response to the closing of said second-mentioned relay switches, one of said solenoids effecting the closing of the clutch which controls the indexing operation when the pair of aligned contacts is bridged by a commutator bar, and the other of said solenoids effecting the closing of the one-revolution clutch controlling the operation of the reciprocating member when the pair of aligned contacts is engaged with an insulating spacer, and a mechanism operated by the machine for effecting engagement of the said pair of aligned contacts with another commutator bar subsequent to an undercutting operation.

19. A control system for a commutator separator undercutting machine having power means including a one-revolution clutch for effecting the reciprocation of a member which produces relative bodily movement between the commutator and a separator undercutting means, and having power means including a clutch for effecting indexing rotation of the commutator to move its insulating separators successively into alignment with the undercutting means, said control system comprising in combination, a circuit including a pair of aligned contacts adapted to be bridged by a commutator bar, said circuit being interrupted by engagement of the contacts with a separator, a relay switch controlled by the bridging of said pair of contacts, said switch having a contact movable into either of two positions, a solenoid for causing the indexing mechanism operating clutch to close and energize in response to movement of said relay contact into the position responding to the engagement of a commutator bar with said pair of aligned contacts, a solenoid for causing the one-revolution clutch to close and energize in response to movement of said relay contact into the position responding to the engagement of a commutator spacer with said pair of aligned contacts and a mechanism operated by the machine for effecting engagement of the said pair of aligned contacts with another commutator bar subsequent to an undercutting operation, and means for interrupting all circuits automatically after a predetermined number of undercutting operations have been performed.

20. A control system for a commutator separator undercutting machine having power means including a one-revolution clutch for effecting the reciprocation of a member which produces relative bodily movement between the commutator and a separator undercutting means and having power means including a clutch for effecting indexing rotation of the commutator to move its insulating separators successively into alignment with the undercutting means, said control system comprising in combination, a circuit including a pair of aligned contacts adapted to be bridged by a commutator bar said circuit being interrupted by engagement of the contacts with a separator, a relay switch controlled by the bridging of said pair of contacts, said switch having a contact movable into either of two positions, relay switches respectively energized in response to movement of said two-position contact into either of its contact making positions, solenoids energized, respectively, in response to the closing of said second-mentioned relay switches, one of said solenoids effecting the closing of the clutch which controls the indexing operation when the pair of aligned contacts is bridged by a commutator bar, and the other of said solenoids effecting the closing of the one-revolution clutch controlling the operation of the reciprocating member when the pair of aligned contacts is engaged with an insulating spacer, and a mechanism operated by the machine for effecting engagement of the said pair of aligned contacts with another commutator bar subsequent to an undercutting operation, and means for interrupting all circuits automatically after a predetermined number of undercutting operations have been performed.

21. A machine for undercutting the insulating separators of a commutator comprising, in combination; means for supporting the commutator; a rotary cutter; contacts pivotally supported above and in alignment with the cutter adapted to bear against the commutator; power operated means for periodically advancing the commutator when one of the separators is in alignment with the cutter and retracting it from the cutter; mechanical means for indexing the commutator a predetermined angular distance upon retraction of the commutator to move the undercut separator out of alignment with the contacts and move an adjacent commutator bar beneath the contacts; electrical means operable after the contacts engage the bar to establish a circuit for causing the commutator to be rotated until the contacts engage another separator whereby said circuit is broken; and means for moving the contacts from the separator when the commutator is moved toward the cutter.

22. A machine for undercutting the insulating separators of a commutator comprising, in combination; means for supporting the commutator; a rotary cutter; contacts pivotally supported in

alignment with the cutter and adapted to bear against the commutator; power operated means for periodically advancing the commutator past the cutter when the cutter is in alignment with a separator and retracting it from the cutter; means for moving the contacts from the commutator on movement of the commutator toward the cutter; indexing means for slightly turning the commutator on the return movement of the commutator so that the undercut separator will be out of alignment with the cutter and allow the contacts to engage a bar and establish a circuit; electrically controlled means operable on closing of said circuit for causing the indexing means to rotate the commutator until the contacts engage another separator whereby the circuit is opened; and means functioning after a predetermined number of undercutting operations have been performed upon the commutator for stopping the machine.

23. A machine for undercutting the insulators of a commutator comprising, in combination; means for supporting the commutator; a cutter; contacts pivotally supported in alignment with the cutter and adapted to establish an electrical circuit when in engagement with a bar of the commutator; electrical means operable when the circuit is established to rotate the commutator until the contacts engage an insulator whereby the circuit is opened; power means operable after the circuit is opened for moving the commutator past the cutter to undercut said separator and retracting it from the cutter; means for moving the contacts from the commutator as the commutator approaches the cutter; means for slightly rotating the commutator near the end of the retracting movement whereby the contacts will engage another bar to establish the circuit for operating the electrical means; and means for automatically stopping the machine when all of the separators have been undercut.

LORA E. POOLE.