Dec. 27, 1955 K. H. WEBER 2,728,269

MACHINE FOR SLOTTING COMMUTATORS

Filed Dec. 7, 1951 5 Sheets-Sheet 1

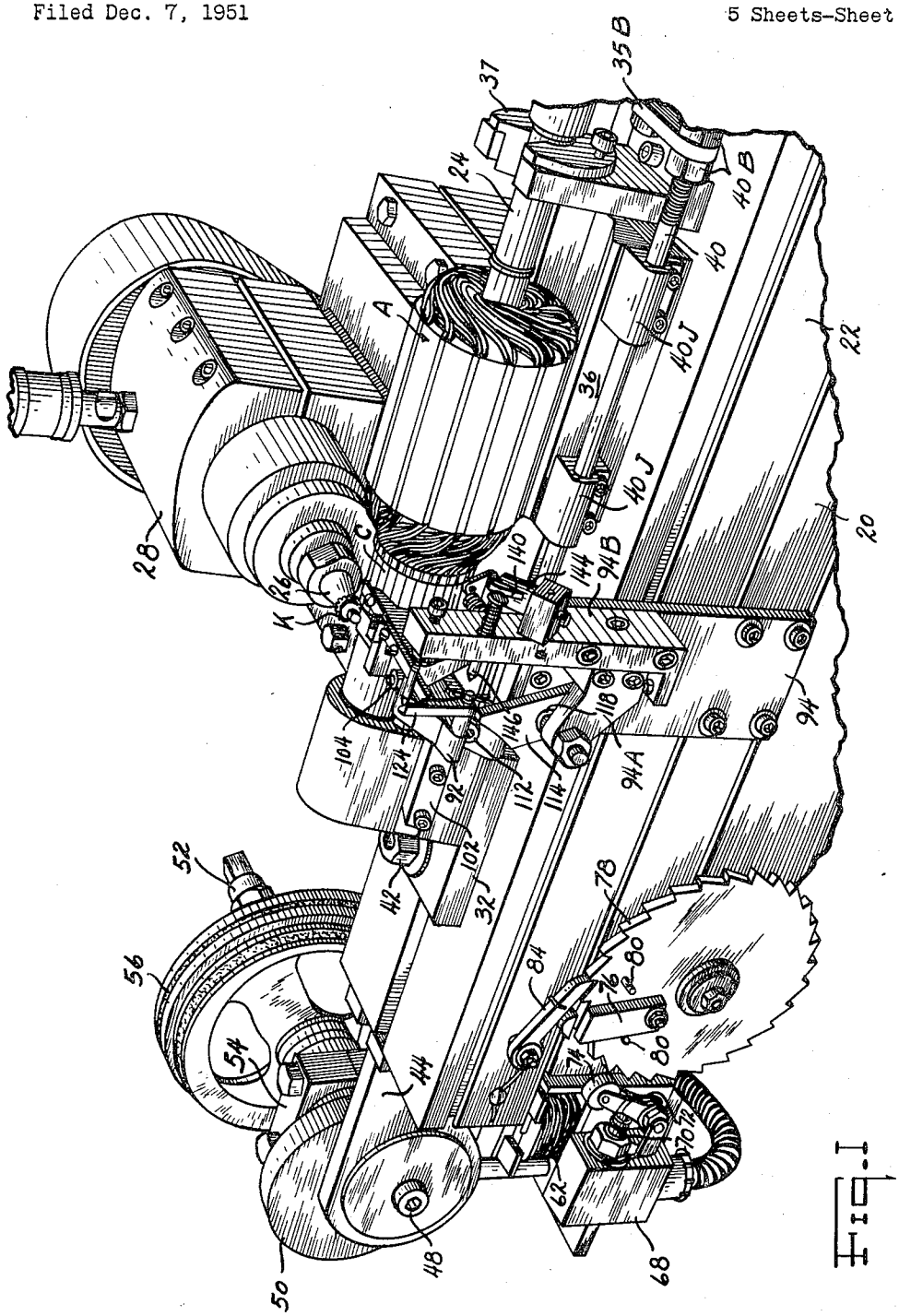

FIG. 1

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MACHINE FOR SLOTTING COMMUTATORS

Filed Dec. 7, 1951 5 Sheets-Sheet 2

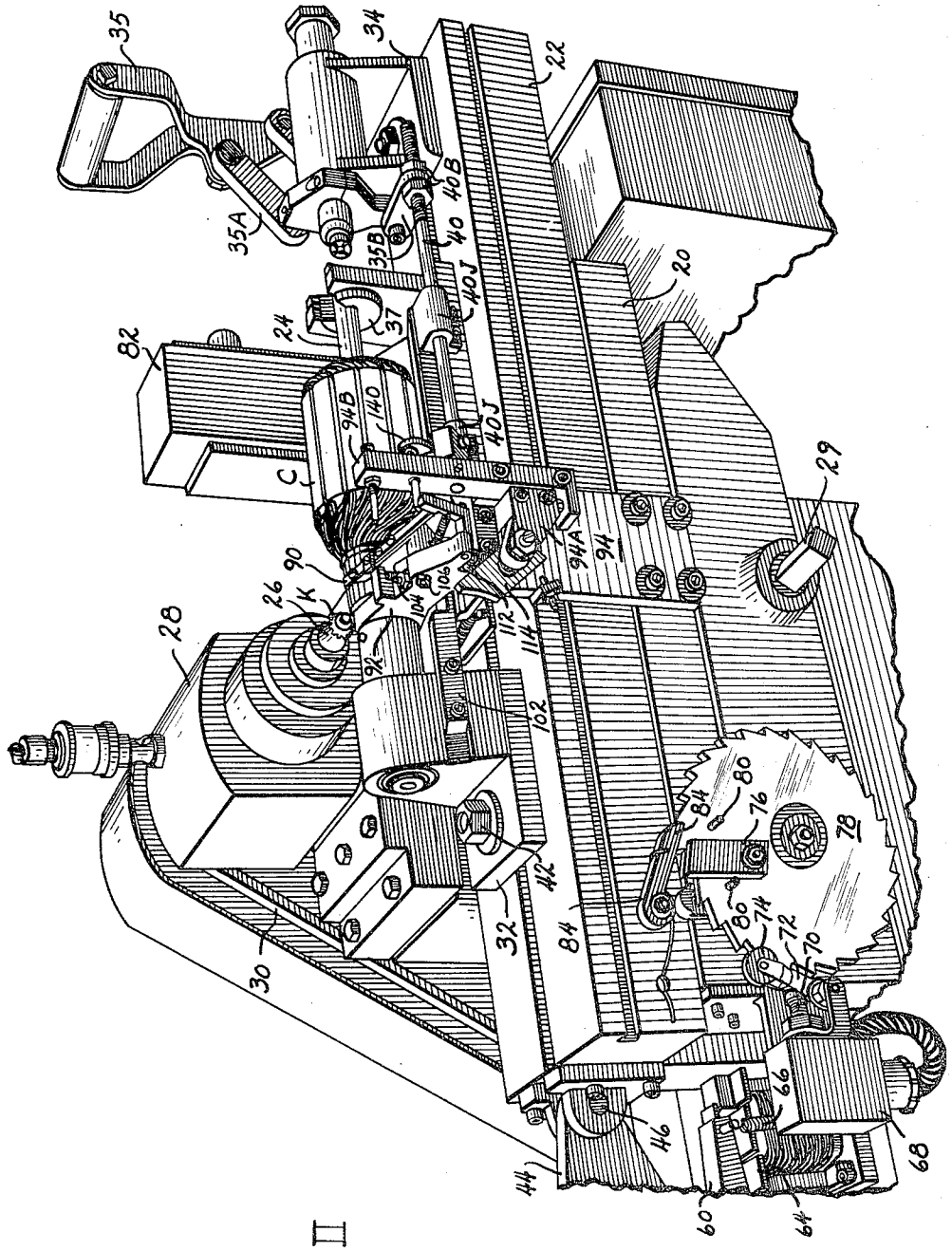

Fig. II

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MACHINE FOR SLOTTING COMMUTATORS

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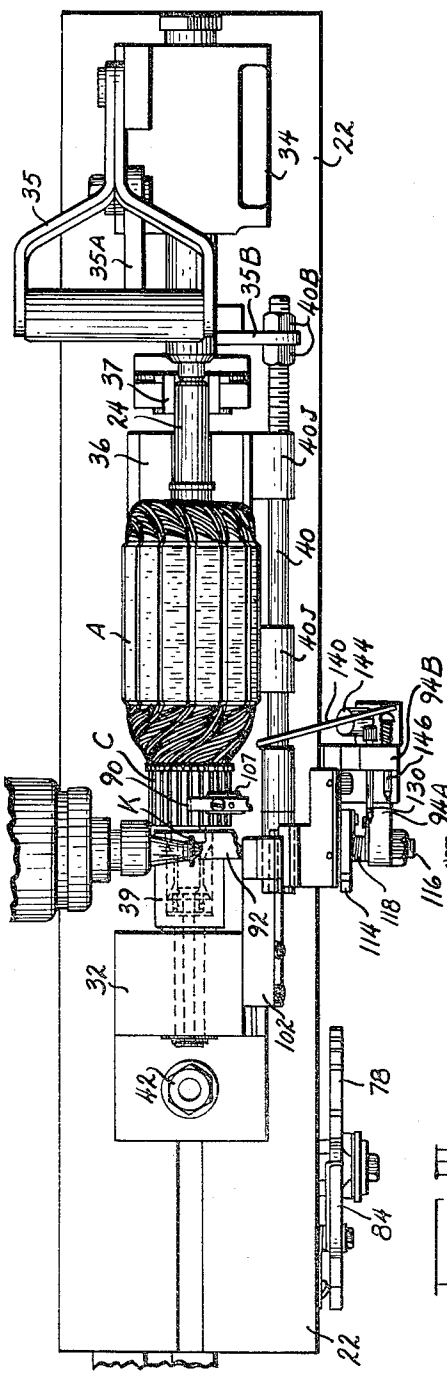

FIG. III

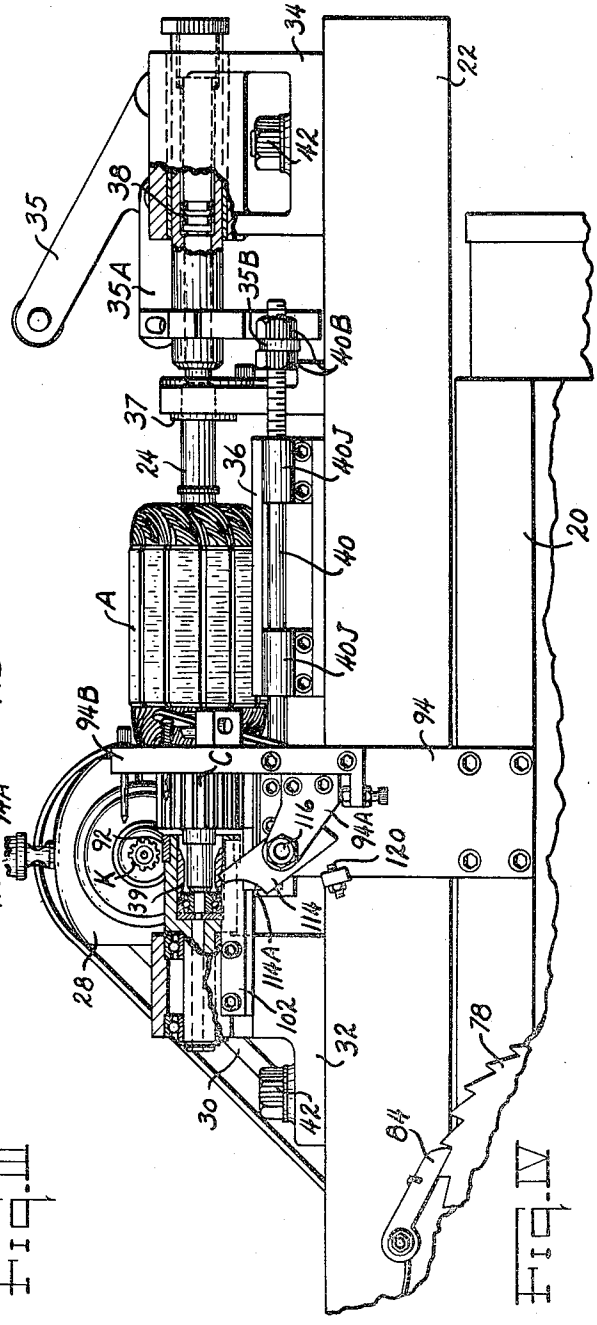

FIG. IV

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MACHINE FOR SLOTTING COMMUTATORS

Filed Dec. 7, 1951 5 Sheets-Sheet 4

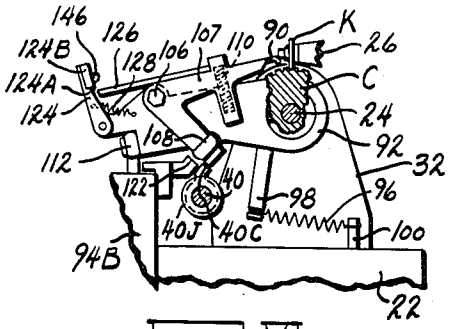

FIG. VI

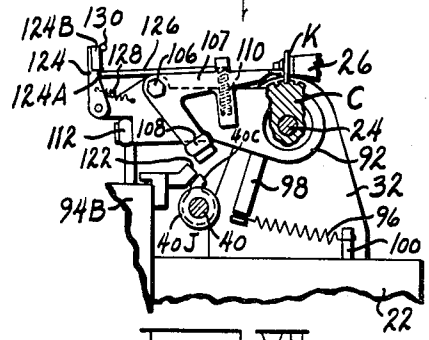

FIG. VII

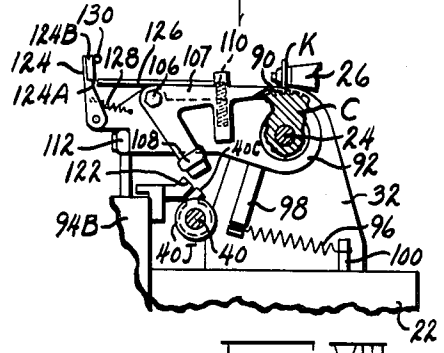

FIG. VIII

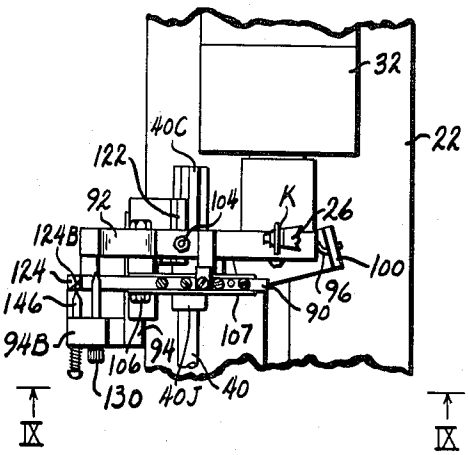

FIG. IX A

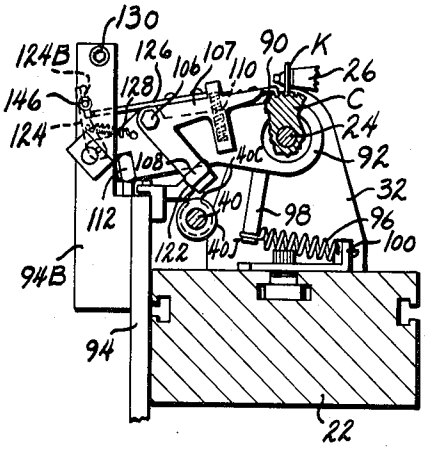

FIG. IX

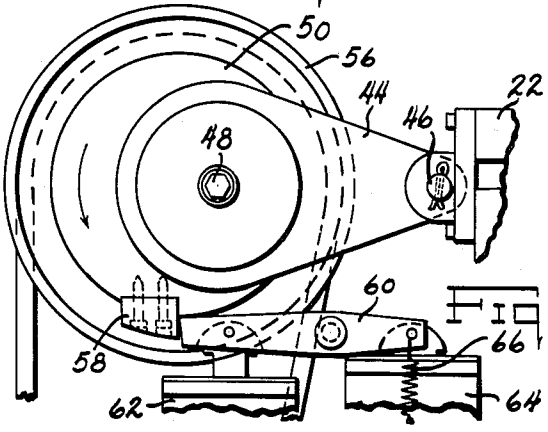

FIG. V

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MACHINE FOR SLOTTING COMMUTATORS

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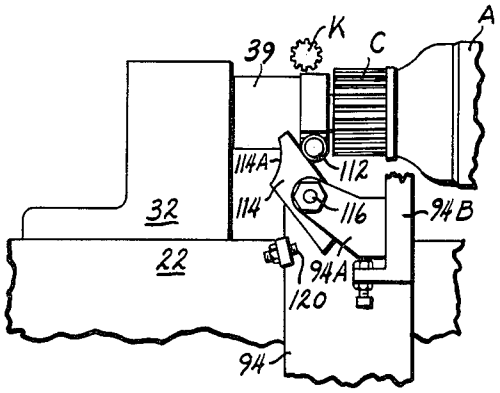

FIG. X

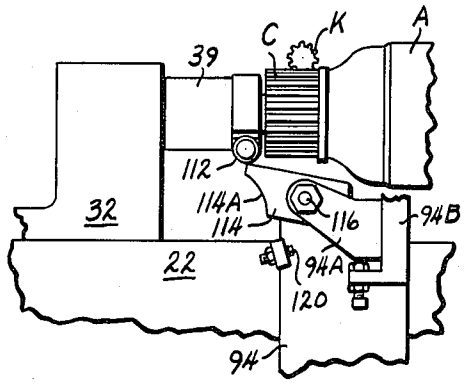

FIG. XI

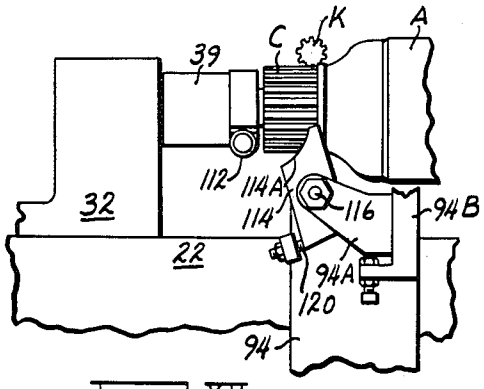

FIG. XII

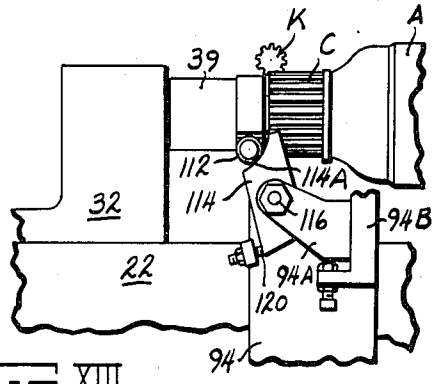

FIG. XIII

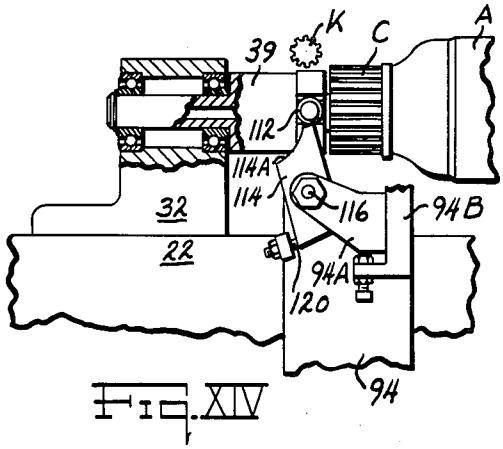

FIG. XIV

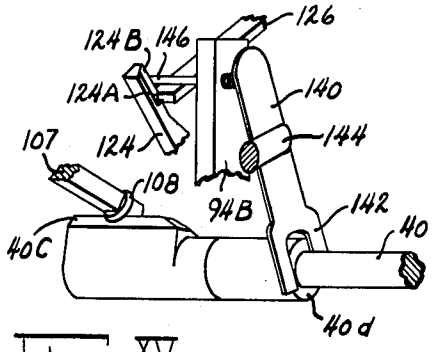

FIG. XV

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United States Patent Office 2,728,269 Patented Dec. 27, 1955

2,728,269

MACHINE FOR SLOTTING COMMUTATORS

Karl H. Weber, Toledo, Ohio

Application December 7, 1951, Serial No. 260,360

10 Claims. (Cl. 90—15.1)

This invention relates to machines for undercutting the mica between the segments of a commutator, more particularly to a semi-automatic machine which will automatically undercut a complete commutator after being loaded manually thereon.

Mica undercutting machines in the past have been unsatisfactory for use in mass production lines due to the tediousness of the manual operations, particularly in that eye strain was rapidly developed by the operator during working. Furthermore, the machine could not be made semi-automatic because the indexing was a difficult problem which had not been satisfactorily solved for the reason that the commutators were not absolutely uniform in form or dimension. The width of the commutator bars varies considerably, also the thickness of the mica insulating spacers is not absolutely uniform even in one commutator, nor are the commutator bars always parallel with the axis of the shaft, so that a slight angularity develops which aggravates the problem of cutter alignment and the longitudinal movement of the cutter along the slots of the commutator. It often developed that the cutter would leave the mica entirely and cut a slot into the adjacent commutator bar.

The present invention contemplates the provision of a machine which will obviate these difficulties of the prior art. The machine is manually loaded with single commutators usually a part of a completely-wound armature, with the operation being automatic thereafter to completely undercut all the relatively frangible mica in between the metallic segments of a commutator by a rotating cutter. The cutter is controlled by the conditions found in the individual commutators wherein it is guided by the substantially parallel sides of the commutator segments during the cutting operation, with the whole armature including the commutator, suspended in floating condition about the axis of the shaft in live centers cooperating with the ends of the shaft, so that the commutator accommodates itself to the cutter.

It is, therefore, a principal object of this invention to provide a semiautomatic machine for undercutting the mica insulation between the segments of an armature commutator.

It is a further object of this invention to provide an undercutting machine for commutators wherein the cutter is guided and controlled by the conditions in the commutator with the commutator being freely suspended for rotation about its longitudinal axis.

It is a further object of this invention to provide an undercutting machine for commutators wherein a rotating cutter is held in fixed position with means provided to reciprocate the commutator along its longitudinal axis to move the rotating cutter along the slots and back, the commutator being suspended to allow free rotation about its longitudinal axis, so that the commutator can accommodate itself to the cutter whereby the cutter closely follows the slots.

It is a further object of this invention to provide an indexing device for a commutator undercutting machine

which will engage the just-cut slot in the commutator to move the commutator, so that the rotating cutter will engage the next slot and the indexing device will release itself from such slot after entry by the cutter into the new slot whereby the commutator is free to rotate about its longitudinal axis so as to accommodate itself fully to the cutter during the undercutting operation.

Other objects and advantages of this invention relating to the arrangement, operation and function of the related elements of the structure, to various details of construction, to combinations of parts and to economies of manufacture, will be apparent to those skilled in the art upon consideration of the following description and appended claims, reference being had to the accompanying drawings forming a part of this specification wherein like reference characters designate corresponding parts in the several views.

Referring to the drawings:

Fig. 1 is a perspective view from the right of the machine showing the driving connections;

Fig. 2 is a perspective view from the left showing the loading mechanism;

Fig. 3 is a plan view;

Fig. 4 is an elevational view;

Fig. 5 is an elevational view of a stop mechanism;

Figs. 6 to 9 inclusive are end elevational views of the indexing device;

Fig. 9A is a plan view of the indexing device;

Figs. 10 to 14 inclusive are elevational views partly simplified to show actuating means for indexing device; and

Fig. 15 is a perspective view of a detail related to the indexing device.

Referring now to the drawings, particularly to Fig. 1, a machine is shown incorporating the invention. The machine comprises a base member **20** adapted to form a guide for a reciprocating member **22** adapted to reciprocate an armature A longitudinally of the base member and under a relatively fixed rotating cutter K positioned above the commutator C of the armature in such a manner that it undercuts the mica between the commutator segments as the armature is moved longitudinally along the base member. The armature A is removably held by its shaft **24** on the reciprocating member **22** by manually manipulatable means to be described in detail hereinafter, so that an operator can position an armature in the machine for undercutting the mica between the segments of the commutator in an automatic operation after once being manually indexed by the operator and, after completion of such undercutting operation, the armature can be removed by the operator and a new armature inserted for the beginning of a new cycle.

Since the commutator C has a predetermined number of copper segments separated by an equivalent number of mica segments which must be undercut, it is essential for automatic operation of the machine that the reciprocating member 22 carrying the armature A, reciprocate the commutator C under the cutter K, so that the cutter enters each slot between the commutator segments to undercut the mica. A special mechanism is provided with a control means, which will be described in detail hereinafter, to reciprocate the armature and its commutator a predetermined number of times to attain such end, after which the control means automatically stops the reciprocation, so that the operator may remove the completed armature and insert a new armature to begin a new cycle. For automatic operation, the new armature, after once being lined up by the operator in the machine, a special indexing mechanism is provided which will also be described hereinafter under a special heading, which rotates the commutator C through a predetermined angle when the cutter

K is free of the commutator, so that at the next reciprocation of the member **22**, the cutter K can enter the next adjacent slot whereby all slots of the commutator may be consecutively engaged by the cutter to complete the undercutting of the mica therein.

The reciprocating mechanism and its control device

The relatively-fixed rotating cutter K, which overhangs the commutator C, rotates in the plane of the reciprocatory motion of the member **22**, so that it moves along the commutator slots, which are in substantially parallel juxtaposition with the shaft **24** of the armature, although it often occurs that a slight angularity is found therebetween, whereby, to have the cutter K follow the slot between the commutator segments, a slight rotation of the commutator is essential. The mechanism whereby this is attained relates to the suspending means for the armature A which floats between live centers, so that the cutter K, which is tapered on its side, preferably to an included angle of 30 degrees, will exactly follow the mica between the commutator segments and will slightly turn the armature and its commutator about its longitudinal axis to compensate for any slight angularity in some commutators with the axis of the shaft arising from faulty assembly of the commutator.

The cutter K is a small milling cutter rotated at relatively high speed by its shaft **26** journaled in a large bearing **28** fixedly mounted with reference to the bed **20** which is manually adjustable by any suitable means **29** to allow adjustment of the depth of cut in the undercutting of the commutator. The mounting of the cutter K and its adjustment by movement of bed **20** are well known in the art and will not be described in further detail. The back end of the shaft **26** is provided with a pulley **30** which is belt-driven by an electric motor (not shown). The cutter K is removably mounted on its shaft **26** by well known means to allow replacement thereof after being used for a time.

Mounted on the reciprocating members **22** is a head stock **32** and a tail stock **34** which hold the armature shaft **24** between live centers as shown in Figs. 3 and 4, the tail stock **34** being provided with a manually-operable reciprocating portion **35** which allows the armature A to be inserted in operable position in the machine when in retracted position (Fig. 2) upon an adjustable V-block **36** cooperating with the laminated portion of the armature as shown in Fig. 1 with the shaft **24** positioned in open-sided bearing **37**. When the reciprocating portion **35** is moved to operable position (Figs. 3 and 4) by manual manipulation of its locking toggle **35A**, a spring **38** places a bias against the end of the armature shaft to thrust the opposite end into the head stock **32** where it is held in a live center **39**, a conical section being provided to facilitate the entry of the shaft therein. In this manner, the armature A is inserted in the machine with its shaft **24** in substantially horizontal position, so that the commutator is held in predetermined position with reference to the cutter K to give the desired depth of undercut of the mica between the segments thereof, and also held in freely rotatable relation about the axis of its shaft whereby the commutator is free to rotate so as not to bend the cutter K but allows the cutter to follow the micas uniformly even if canted without cutting into an adjacent segment in the event the commutator is not accurately assembled. The slot of the commutator thereby always remains in the plane of rotation of the cutter K.

The headstock **32** and the tail stock **34** are conveniently attached to the reciprocating member **22** by bolts **42**, so that both will move with the member **22** when it is reciprocated by a connecting pitman **44** attached thereto at the left end (Fig. 1) by pin **46** (Fig. 2). The pitman **44** is oscillated by crank pin **48** mounted eccentrically on face plate **50** mounted on a rotating shaft **52** journaled in bearing **54**. At its end distal from the face plate **50**, the shaft **52** is provided with a friction clutch **56**, preferably including a leather-faced disk splined to the shaft resiliently urged (adjustable) against a driver plate belt driven by a separate electric motor (not shown), so that a flexible drive relation is established which will allow the motor to overrun when the face plate **50** is stopped at a predetermined position whereby the reciprocating member **22** is located at a predetermined position for the removal of the completed armature and the substitution of a new armature by the operator for the initiation of a new cycle of operation. The mechanism to accomplish such end will now be described.

The stop mechanism for the reciprocating member **22** comprises a lug **58** extending from the edge of face plate **50**, as is shown in Fig. 5, the face plate rotating in a counterclockwise direction, so that the lug contacts the end of a pivoted lever **60** under control of the armatures of a pair of solenoids **62** and **64** acting on the lever **60** on opposite sides of its pivot. A spring **66** is provided to bias the lever into the path of the lug **58**, being aided by the solenoid **64**, while solenoid **62** pulls the lever end out of the path of the lug against the bias of spring **66**. The cooperative relation between the lug and lever stops the reciprocating member **22** at the predetermined point required, the friction clutch **56** slipping for a moment while the driving motor overruns.

The driving motor for the reciprocating means and the solenoid **64** are alternately controlled by a single throw, double pole switch **68** (Figs. 1 and 2) mounted adjacent the solenoids **62** and **64**, the switch being operated by a spring-actuated plunger **70** reciprocated by a pivoted lever **72** having a roller **74** on its end which is positioned in the path of a pivoted lug **76** mounted on a relatively-fixed rotatable ratchet wheel **78** to extend beyond its periphery. The pivoted lug **76** moves between stop pins **80** whereby the switch **68** is momentarily actuated by the lug **76** to deenergize the driving motor and energize the solenoid **64** for a short period and thereafter clears itself to allow initiation of a new cycle. A manual switch **82** (Fig. 2) again energizes the motor and also solenoid **62** for the initiation of the new cycle of operation on a new armature and its commutator.

As pointed out hereinbefore, for the automatic operation of the machine, it is essential that the reciprocating member **22** reciprocate once for every slot in the commutator, whereby the cutter K may enter each such slot to perform the undercutting of the mica insulation. This sequential operation is controlled by switch **68** after the new cycle is started by the operator actuating the manual switch **82** which starts the motor and energizes solenoid **62**. The solenoid **62** is then continuously energized until switch **68** is again actuated by lug **76**. This occurs after the ratchet wheel **78** rotates a complete revolution, being moved step by step by spring finger **84** which reciprocates with the member **22** and actuates the ratchet wheel **78** one step when it moves to the right therewith (Fig. 1). The ratchet wheel **78** has the same number of teeth as there are slots in the commutator C. Upon completion of a complete revolution of the ratchet wheel **78**, the lug **76** will again actuate the switch **68** to momentarily energize solenoid **64** to simultaneously move the lever **60** so that the lug **58** contacts its end to stop the reciprocation of the member **22** at the predetermined point. The commutator having been completely undercut during the cycle, the operator removes it and inserts a new one and actuates manual switch **82** to begin a new cycle of operation.

Commutator indexing device

After the armature with its commutator is mounted between the live centers by an operator, as already described, it is essential that the cutter K enter the slot between the commutator segments, so that the mica may be cut away therebetween as the commutator is moved into the cutter by the base **22** by a mechanism already described. The alignment between cutter K and the first slot is attained at initiation of a cycle of operation by the operator by manual manipulation of the commutator, by aligning an indexing finger **90** with the mica in the

next adjacent slot as a positive guide, until the cutter enters the aligned slot to begin the cutting operation whereat the finger **90** is removed upwardly by mechanisms to be described hereinafter to release the commutator, so that it may rotate on the live centers to accommodate itself to the cutter which then closely follows adjacent the segment sides even though they may be slightly canted. The cutter then makes a complete excursion, being moved in and then reversing and moving out of the slot again as controlled by the eccentric **48** and the pitman **44** moving the base **22** as already described.

For convenience and clarity in description, the separation between the adjacent commutator segments in which the mica insulation is positioned and which is to be undercut by the herein described machine, is called a slot, even though the mica before undercutting may extend beyond the perimetrical surface of the commutator.

On the return movement of the base **22**, which moves the cutter K back out of the slot, an indexing mechanism is being energized which prepares to move the commutator one slot circumferentially by engaging the finger **90** behind the cutter K in the slot which has just been cut away, so that when the cutter K is clear of the slot, such circumferential movement (counterclockwise Fig. 6) occurs, whereby the next adjacent slot is aligned with the cutter K to be engaged thereby when the cutter is caused to make another excursion relative to the commutator to cut away the mica therein. After the cutter enters the new slot, the finger **90** will again be released to free the commutator, so that it may again accommodate itself to the cutter. The mechanisms to attain this result will now be described.

The indexing device comprises a movable laterally-extending arm **92** which controls the movements of the finger **90**, already referred to, cooperating with elements in fixed position mounted on a bracket **94** affixed to the base member **20** whereby the various movements of the finger **90** are controlled and actuated in timed relation with the movement of the commutator C as reciprocated by the member **22**. The arm **92** is brazed to the live center **39** through a collar as shown in Fig. 4 and is rotatable about the axis of rotation of the armature shaft **24**, being biased for rotation in a counterclockwise direction (Figs. 6 to 9) by spring **96** active between a downwardly extending pin **98** affixed to the arm **92** and an anchor pin **100** affixed to the member **22** (Fig. 9). To limit the rotation, a stop bar **102** is affixed to the head stock **32** to underlie the arm **92**, an adjustable stud **104** (Fig. 2) being provided therein to contact the bar **102** to provide an adjustment. The arm **92** is freely rotatable with reference to the armature shaft which, in turn, is freely rotatable in the live center **39** as already described.

Mounted on the rotatable arm **92** on pivot pin **106** is a V-shaped member **107**, on the upper arm of which is attached finger **90** by a suitable means such as screws, and the lower arm, being relatively shorter than the upper, is provided with a roller **108** adapted to cooperate with relatively fixed camming members therebelow as will be described further hereinafter. The member **107** is urged clockwise (Figs. 6 to 9) about its pivot pin **106** by compression spring **110** acting between suitable abutments as shown, whereby the finger **90** is urged toward the commutator below it, and roller **108** is urged toward the camming members below it. Spring **110** is relatively weak as compared to larger main spring **96** active on arm **92** and will be overcontrolled by its action on the machine elements.

On the forward end of the arm **92** a roller **112** is provided, as seen in Figs. 6 to 9, and also Figs. 10 to 14, which cooperates with a pivoted cam member **114** positioned in relative fixed relation on the bracket **94** by arm **94A** and adapted to move about pivot **116**. A bias is provided by spring **118** to rotate the cam **114** clockwise about the pivot **116**, the spring being conveniently positioned thereon, as shown in Fig. 3, whereby the lower end of the cam member is urged against an adjustable stop **120** which holds it in substantially upright position as shown in Fig. 12. In Figs. 10 to 14 inclusive, the interaction of the roller **112** and the cam member **114** is shown by various steps, whereby the arm **92** is raised and lowered in timed relation with the movements of the commutator C to actuate the indexing device during the return stroke which backs the cutter K out of the commutator slot already undercut, and prepares the relation between the cutter K and the commutator C for the initiation of a new cycle in the next adjacent slot of the armature.

Referring to Figs. 9 and 11, the cutter K is in undercutting position in a slot of the commutator C, with the cutter being advanced into the slot by the advance of the commutator C by movement of the member **22** as shown in Fig. 11. In this figure, the roller **112** is deflecting the cam **114** against the bias of the spring **118**, while the stronger spring **96** holds the arm against its stop **104** cooperating with the underlying bar **102** and finger **90** is freed from the underlying commutator slot against bias of spring **110** by contact of roller **108** with a cam surface **122** (Fig. 9) affixed on the bracket **94**. The cam surface **122** is positioned in a relation with the cutter K, so that just after the cutter K enters a new commutator slot just adjacent to the newly cut slot engaged by the finger **90**, the roller **108** will engage the front face of the cam surface **122** to rotate the V-shaped member **107** about its pivot **106** against the bias of spring **110**, just sufficient to cause the finger **90** to disengage its slot and free the armature and its commutator to rotate about its shaft **24** held in the live centers, whereby the commutator can accommodate itself to the cutter K to allow it to follow the slot accurately even though slightly canted.

The deflection of the cam member **114** in a counterclockwise direction by the roller **112** begins already with the parts as shown in Fig. 10 where the cutter K is adjacent its maximum retarded position entirely free of the commutator where a new commutator may be positioned after the completely undercut one with its armature is removed if so desired and the machine elements are in the required relation. The deflection continues as the cutter K moves into cutting relation with the slot, as shown in Fig. 11, where an intermediate position of the coacting parts is shown, and then continues until the cutter K is in its maximum advanced position, shown in Fig. 12, having just completed undercutting the slot of the commutator, and, in the meantime, the roller **112** has overrun the cam element **114** which is returned to its stop **120** by the bias of spring **118** and is ready to perform its function on the return stroke of the cutter K when the roller **112** reverses itself as shown in Fig. 13. The roller **112** here contacts the reverse side of the cam member **114** from that shown in Figs. 10 and 11, and since the stop **120** prevents clockwise rotation of the cam member **114**, the roller **112** begins to displace the arm **92** upwardly against the bias of spring **96**, which prepares the indexing mechanism to position the finger **90** into the slot engaged by the cutter K so as to move the commutator about its shaft one slot distance after the cutter is clear, so that the cutter, on its next excursion, will engage the next adjacent slot for the purpose of undercutting the mica therein.

The front arcuate face **114A** is engaged by the roller **112** and lifts the arm **92** upwardly (clockwise Figs. 7 and 8) which advances the finger **90** into the plane of the cutter K so as to overhang the slot of the commutator just undercut by the cutter. The lifting of the arm **92** carries with it the V-shaped member carrying the finger **90** and clears the roller **108** from the cam surface **122**. However, the finger **90** is not allowed to contact the commutator face as urged to do by the bias of spring **110** by a latch element **124** engaging a bar **126** at the distal end of the arm **92** immediately above the roller **112** as is best seen in Figs. 6 to 9 inclusive.

The bar 126 is attached to the V-shaped member 107 and is adapted to project outwardly beyond the pivot 106 to cooperate with the latch element 124, which is pivoted at the far end of the arm 92 to extend upwardly, as shown, and is urged to rotate clockwise about its pivot by tension spring 128 acting between it and a suitable anchor on the arm 92. The latch element 124 is provided with an overhang 124A which engages the end of the bar 126 to prevent clockwise rotation of the member 107 about its pivot 106 and thereby prevents the finger 90 from contacting the surface of the commutator C until the latch 124 is disengaged. A cam surface 124B is provided on the upper end of the latch element 124 (Fig. 10) which is oblique to the axis of the commutator C and faces toward the cone-shaped end of cam pin 130 with which it cooperates to rotate the latch element 124 in a counterclockwise direction about its pivot to release bar 126 from the overhang 124A, so that finger 90 drops down into the commutator slot just undercut, by the bias of spring 110. This action is shown in Fig. 8, where the roller 112 is on the apex of cam member 114 (see Fig. 14) and roller 108, as a consequence, is free from cam surface 122. The cutter K clears the commutator slot just after the finger 90 drops into the slot which the cutter has just undercut.

The cam pin 130 is adjustably mounted in horizontal position parallel to the axis of the commutator in a portion 94B of the fixed bracket 94 (Fig. 9) and projects toward the headstock 32 at such a juxtaposition as to engage cam face 124B when it is raised to its highest position by the roller 112 riding over the apex of cam 114 (Figs. 10 and 14) to rotate the arm 92 in a clockwise direction. The parts come into contactual relation, namely, cam pin 130 and cam face 124B through the rotation of the arm 92 about the live center 39 by the action of the cam 114 as already described and also by the longitudinal juxtaposition of the arm 92 with reference to the fixed bracket 94 as shown in Figs. 1 and 8.

As the cutter K approaches its maximum retarded position (Fig. 10), the roller 112 drops over to the back of the cam 114 and allows spring 96 to rotate the arm 92 in a counterclockwise direction (Fig. 9) from its position shown in Fig. 8. Due to the fact that finger 90 has dropped into the commutator slot which has just been undercut, the arm 92 and the commutator are locked together, so that the commutator will be rotated simultaneously to align the next adjacent slot of the commutator in a clockwise direction with the cutter K, so that it may, in its turn, be undercut with the next excursion of the cutter.

The face plate 50 continues to rotate until stopped by actuation of switch 68 as controlled by ratchet wheel 78 and lug 76 thereon, so that a commutator once placed in the machine will be completely undercut automatically, and after the substantial completion of one excursion of the cutter K for a slot (Fig. 6), the cutter will immediately begin a new excursion in the next consecutive slot of the commutator with a repetition of movement of the elements of the machine as set forth hereinbefore. This will continue until the lug 76 actuates switch 68 and stops the face plate 50 by having lug 58 thereon abut against the end of lever 60, which is pulled up by the spring 66 and the electromagnet 64. Electromagnet 62 which is energized through the whole undercutting cycle of the commutator to pull the lever 60 downward to clear lug 58 during reciprocation of pitman 44 is deenergized when electromagnet 64 is energized as described above.

When the commutator is completely undercut and the machine stops automatically, an operator releases the toggle 35A which retracts the center from the end of the shaft 24, and also retracts in the same direction rod 40 to actuate a safety device relative to the finger 90 to protect it from mechanical abuse by the operator while he is removing the completed armature or substituting a new one. With the toggle 35A in open position, the completed armature is removed by the operator and a new one inserted and reclosing the toggle, the operator actuates the manual push button 82 which starts a new cycle of operation by simultaneously energizing electromagnet 62 and the motor (not shown) driving face plate 50.

The purpose of the safety device actuated by the retraction (movement to right in Fig. 2) of rod 40 is to raise the actuating finger 90 of the indexing device a substantial distance to give ample clearance to allow the operator to remove the completely undercut armature from the machine and to insert a new armature for a new cycle of operation. Referring to Fig. 15, the mechanism is shown in simplified form whereby this result is attained. The rod 40 is adjustably attached to the toggle 35A by an ear 35B which is engaged by a pair of lock nuts 40B in threaded relation on the rod 40, as best seen in Fig. 2. The rod 40 is held for longitudinal movement by journals 40I affixed to the reciprocating member 22 in any suitable manner. Adjacent the bracket 94, rod 40 is provided with a shoulder 40*d* which terminates at the distal end into a laterally projecting cam member 40C which is adapted to cooperate with roller 108 to lift the V-shaped arm 107 about its pivot 106 and, in turn, finger 90 by a turning in a counterclockwise direction (Fig. 6).

The latch member 124 is cleared to allow such movement by a pivoted lever 140 (Fig. 3), the lower end 142 of which is bifurcated to cooperate (Fig. 15) with the shoulder 40*d*, so that, as the rod 40 is pulled to the right (Fig. 15) by the manual actuation of the toggle 35A, the lever 140 is rotated counterclockwise about its centrally-located pivot 144 mounted on the bracket portion 94B to actuate a spring-biased pin 146 mounted in an aperture in the bracket portion 94B in a position to contact the cam face 124B of the latch 124 to thrust it outwardly (counterclockwise Fig. 6) and thereby clear the free end of the bar 126 and allow cam 40C to raise the finger 90 clear of the commutator, so that it can be removed and a new one substituted.

When the operator again closes toggle 35A, as already described, rod 40 is moved to the left (Fig. 15) to free roller 108 from cam 40C, and release pin 146 by return of lever 140 to normal position by the spring bias on the pin. This allows the latch 124 to again restrain bar 126 and after the operator has manually aligned the finger 90 with a mica. When the cutter K enters into the first slot of the new armature, roller 108 again contacts the front face of cam face 122 which causes the latch 124 to fully engage the end of bar 126. The machine then continues to operate through its normal cycle as already described.

It is to be understood that the above detailed description of the present invention is intended to disclose an embodiment thereof to those skilled in the art, but that the invention is not to be construed as limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawings, since the invention is capable of being practiced and carried out in various ways without departing from the spirit of the invention. The language used in the specification relating to the operation and function of the elements of the invention is employed for purposes of description and not of limitation, and it is not intended to limit the scope of the following claims beyond the requirements of the prior art.

What is claimed:

1. In a device of the class described, means to suspend the commutator upon its longitudinal axis, a rotatable cutter, means to cause relative movement of the commutator with reference to the cutter whereby the cutter may enter the slots of the commutator to undercut the insulation therein, said cutter having its plane of relative movement along the longitudinal axis of the commutator, automatic indexing means including a finger operable by a cam mechanism to engage the commutator in the slot just undercut substantially simultaneously with

the disengagement of the rotatable cutter with the slot to rotate the commutator one slot distance while the cutter is clear of the commutator so that the cutter enters a new slot upon its next engagement during its relative reciprocatory movement with the commutator, said indexing means disengaging from the commutator by a second independent cam mechanism while the cutter is undercutting the new slot whereby the commutator is freely rotatable to accommodate itself to the cutter so that the slot portion being undercut is always maintained in the plane of said cutter, and means for automatically stopping the device after the commutator has had all of its slots undercut.

2. In a device of the class described, means to suspend the commutator upon its longitudinal axis, a rotatable cutter, means to cause relative movement of the commutator with reference to the cutter whereby the cutter may enter the slots of the commutator to undercut the insulation therein, said cutter having its plane of relative movement along the longitudinal axis of the commutator, indexing means in fixed relation with the commutator operable by a cam means actuated by said relative movement to engage the commutator in the slot just undercut ajdacent its outer end just before the rotatable cutter clears the slot to rotate the commutator about its longitudinal axis one slot distance while the cutter is clear of the commutator whereby the cutter enters a new slot upon its next engagement with the commutator, a second cam means operated by said relative movement to disengage the indexing means from the commutator while the cutter is undercutting the new slot whereby the commutator is freely rotatable to accommodate itself to the cutter so that the slot portion being undercut is always maintained in the plane of said cutter, and means for automatically stopping the device after the commutator has had all of its slots undercut.

3. In a device of the class described, means to suspend a commutator for rotation upon its longitudinal axis, a rotatable cutter, means to reciprocate the commutator longitudinally with reference to the rotatable cutter, said rotatable cutter having its plane of rotation in the longitudinal axis of the commutator and in the plane of the reciprocation of the commutator whereby the cutter may enter the slots of the commutator to undercut the insulation therein, automatic indexing means suitable for initial manual adjustment engaging the commutator slot just undercut to hold the commutator under control while the cutter is free therefrom, cam means actuating the indexing means to rotate the commutator one slot distance while the cutter is free whereby the cutter enters a new slot upon its next engagement with the commutator, a second cam means to disengage the indexing means from the commutator while the rotatable cutter is undercutting the new slot, and means to automatically stop the reciprocation of the commutator after all the slots of the commutator have been undercut.

4. In a device of the class described, means to suspend the commutator upon its longitudinal axis, a rotatable cutter, means to cause relative movement of the commutator with reference to the cutter whereby the cutter may enter the slots of the commutator to undercut the insulation therein, said cutter having its plane of relative movement along the longitudinally axis of the commutator, indexing means including a contact finger suitable for initial adjustment to engage the commutator in the slot just undercut just before the rotatable cutter clears the slot to rotate the commutator by a cam actuated by the relative movement one slot distance while the cutter is clear of the commutator whereby the cutter enters a new slot upon its next engagement with the commutator, said indexing means disengaging from the commutator by the action of a second independent cam while the cutter is undercutting the new slot whereby the commutator is freely rotatable to accommodate itself to the cutter means so that the slot portion being undercut is always maintained in the plane of said cutter, means for automatically stopping the device after the commutator has had all of its slots undercut, and a third cam capable of manual manipulation means to retract the indexing means while the commutator is removed from the device.

5. In a device of the class described, means to suspend a commutator for rotation upon its longitudinal axis, a rotatable cutter, means to reciprocate the commutator longitudinally with reference to the rotatable cutter said rotatable cutter having its plane of rotation in the longitudinal axis of the commutator and in the plane of the reciprocation of the commutator whereby the cutter may enter the slots of the commutator to undercut the insulation therein, automatic indexing means including a finger engaging the commutator slot just undercut to hold the commutator under control while the cutter is free therefrom, cam means operable by the return movement of the commutator actuating the indexing means to rotate the commutator one slot distance while the cutter is free whereby the cutter enters a new slot upon its next engagement with the commutator, a second cam means operable by the forward movement of the commutator to disengage the indexing means from the commutator while the rotatable cutter is undercutting a new slot, means to automatically stop the reciprocation of the commutator after all the slots of the commutator have been undercut, and manual means to disengage the commutator and to retract the indexing means while the commutator is removed from the device.

6. In a device of the class described, means to suspend a commutator for rotation upon its longitudinal axis, a rotatable cutter, means to reciprocate the commutator longitudinally with reference to the rotatable cutter said rotatable cutter having its plane of rotation in the longitudinal axis of the commutator and in the plane of the reciprocation of the commutator whereby the cutter may enter the slots of the commutator to undercut the insulation therein, automatic indexing means mounted on the reciprocating means engaging the commutator slot just undercut adjacent its leading end to hold the commutator under control while the cutter is free therefrom, fixed cam means actuating the indexing means during reciprocation to rotate the commutator one slot distance while the cutter is free whereby the cutter enters a new slot upon its next engagement with the commutator, a second fixed cam means to disengage the indexing means from the commutator while the rotatable cutter is undercutting the new slot, and means to automatically stop the reciprocation of the commutator after all the slots of the commutator have been undercut.

7. In a device of the class described, means to suspend a commutator for rotation upon its longitudinal axis, a rotatable cutter, means to reciprocate the commutator longitudinally with reference to the rotatable cutter said rotatable cutter having its plane of rotation in the longitudinal axis of the commutator and in the plane of the reciprocation of the commutator whereby the cutter may enter the slots of the commutator to undercut the insulation therein, automatic indexing means rotatably mounted on the same axis as the commutator and reciprocable therewith engaging the commutator slot just undercut adjacent its leading end to hold the commutator under control while the cutter is free therefrom, fixed cam means cooperating with a portion of the indexing means actuating the indexing means during the return movement of the commutator to rotate the commtuator one slot distance while the cutter is free whereby the cutter enters a new slot upon its next engagement with the commutator, a second fixed cam means cooperating with another portion of the indexing means to disengage the indexing means from the commutator during the forward movement of the commutator while the rotatable cutter is undercutting the new slot, means to automatically stop the reciprocation of the commutator after all the slots of the commutator have been undercut, and manual means to release

the commutator and to retract the indexing means while the commutator is being removed from the device.

8. In a device of the class described, including a reciprocating mounting means for mounting a commutator on its longitudinal axis for free rotation thereabout and a tapered rotatable cutter adapted by relative movement with reference to the commutator along its longitudinal axis to undercut the insulation in the slots of the commutator, characterized by an indexing means including a finger actuated by a first independent means to engage the commutator in a slot just undercut while the rotatable cutter is still engaged in the slot, said finger being then actuated by a second independent means to rotate the commutator one slot distance while engaged with a commutator slot when the cutter is clear of the commutator so that the cutter may enter a new slot in its next excursion, said finger being then actuated by a third independent means for disengaging the finger from the slot when the rotating cutter engages the new slot so that the commutator may rotate to accommodate itself to the plane of the cutter solely by the interaction of the sides of the tapered cutter and the slot sides.

9. In a device of the class described, including a reciprocating mounting means for mounting a commutator on its longitudinal axis for free rotation thereabout and a tapered rotatable cutter adapted by relative movement with reference to the commutator along its longitudinal axis to undercut the insulation in the slots of the commutator, characterized by an indexing means actuated by said relative movement including a finger adapted to engage the commutator in a slot just undercut by the action of a first cam means while the rotatable cutter is still engaged in the slot, said finger being then operated by a second cam means to rotate the commutator one slot distance while the cutter is clear of the commutator so that the cutter may enter a new slot in its next excursion, said finger being then operated by a third cam means to disengage the finger from the slot when the rotating cutter engages the new slot so that the commutator may rotate to accommodate itself to the plane of the cutter solely by the interaction of forces between the cutter and the slot sides.

10. In a device of the class described, including a reciprocating mounting means for mounting a commutator on its longitudinal axis for free rotation thereabout and a tapered rotatable cutter adapted by relative movement with reference to the commutator along its longitudinal axis to undercut the insulation in the slots of the commutator, characterized by an indexing means actuated by said relative movement of the parts including a finger adapted to move tangentially to engage the commutator in a slot just undercut by the action of a cam means actuated by said relative movement while the rotatable cutter is still engaged in the slot, said finger of the indexing means being then operated by a second cam means also actuated by said relative movement to rotate the commutator one slot distance while the cutter is clear of the commutator so that the cutter may enter a new slot in its next excursion, said finger of the indexing means being then actuated by a third independent cam means actuated by said relative movement to disengage the finger from the slot when the rotating cutter engages the new slot so that the commutator may rotate freely to accommodate itself to the plane of the cutter, and means to automatically stop the device after all the slots of the commutator have been undercut.

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