April 17, 1962 B. A. KROEN 3,029,562

STATOR BORE HONING MACHINE AND METHOD OF HONING

Filed Aug. 12, 1959 3 Sheets-Sheet 1

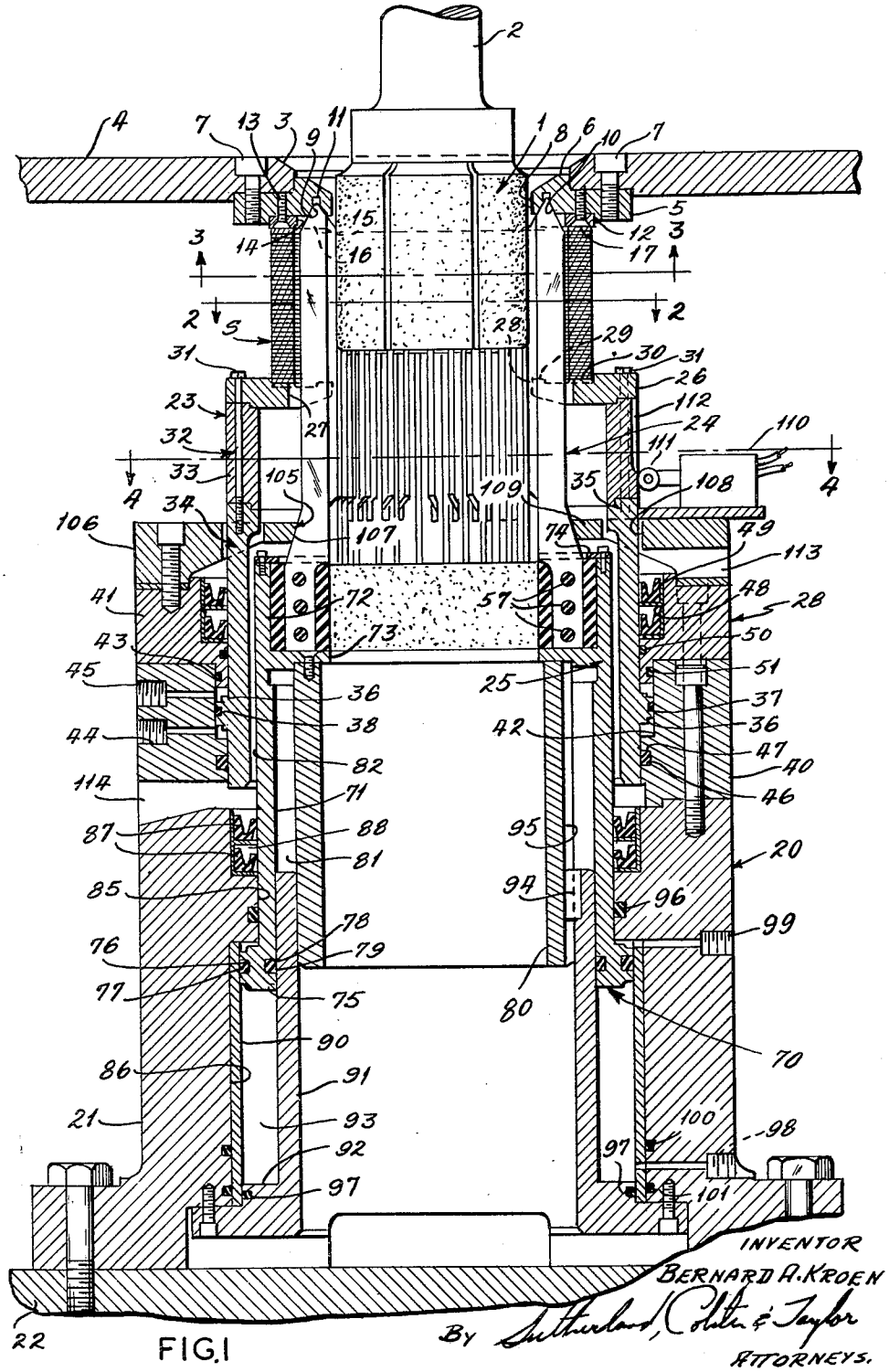


FIG. 1

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STATOR BORE HONING MACHINE AND METHOD OF HONING

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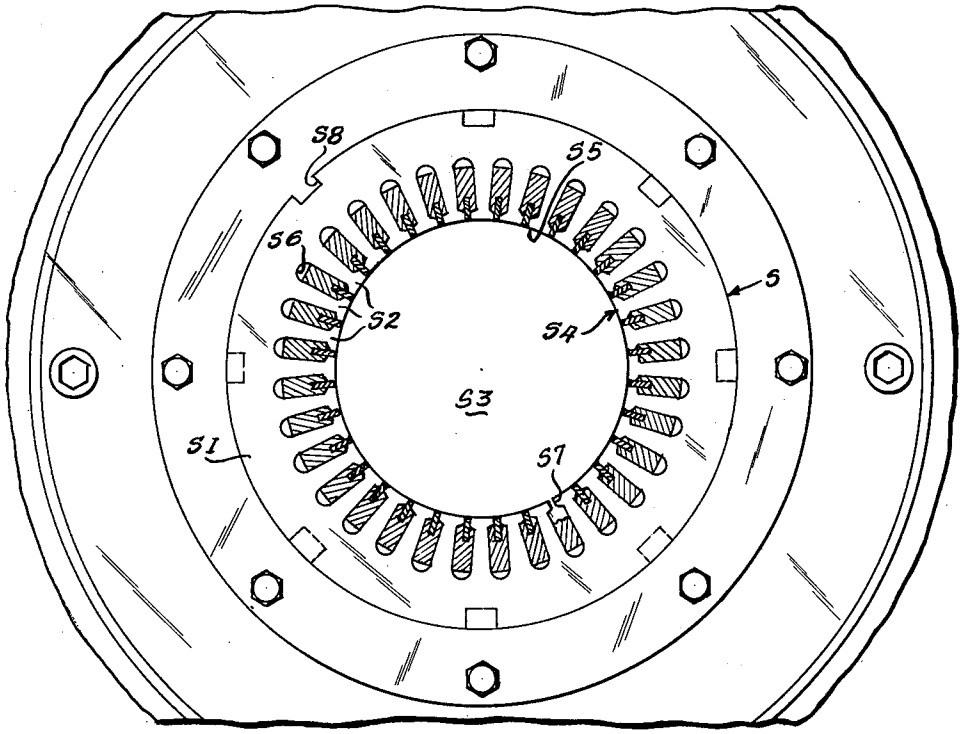


FIG. 2

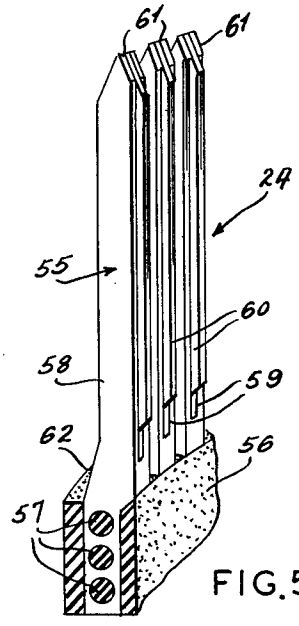


FIG. 5

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STATOR BORE HONING MACHINE AND METHOD OF HONING

Filed Aug. 12, 1959 3 Sheets-Sheet 3

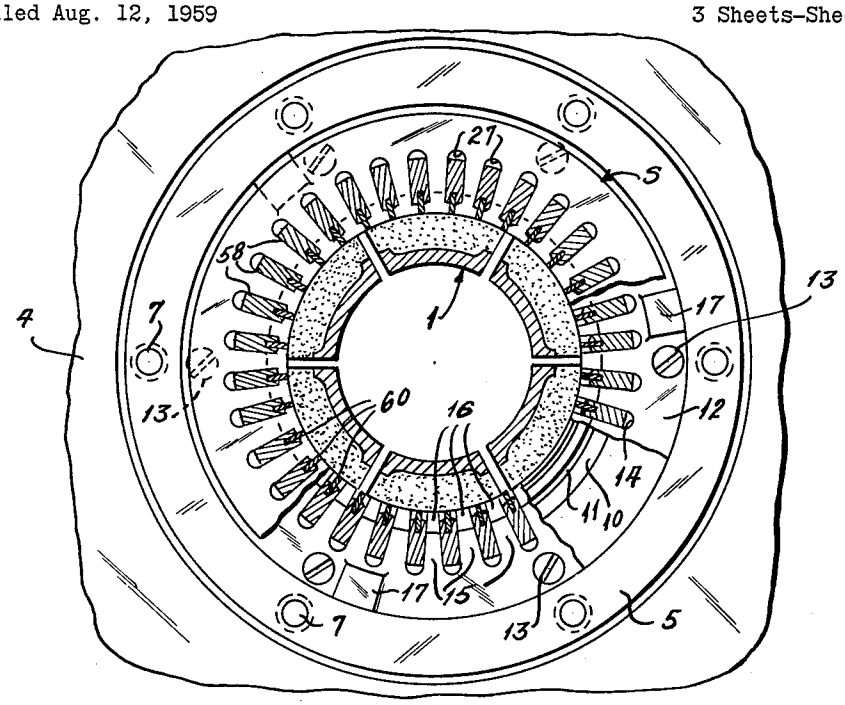


FIG.3

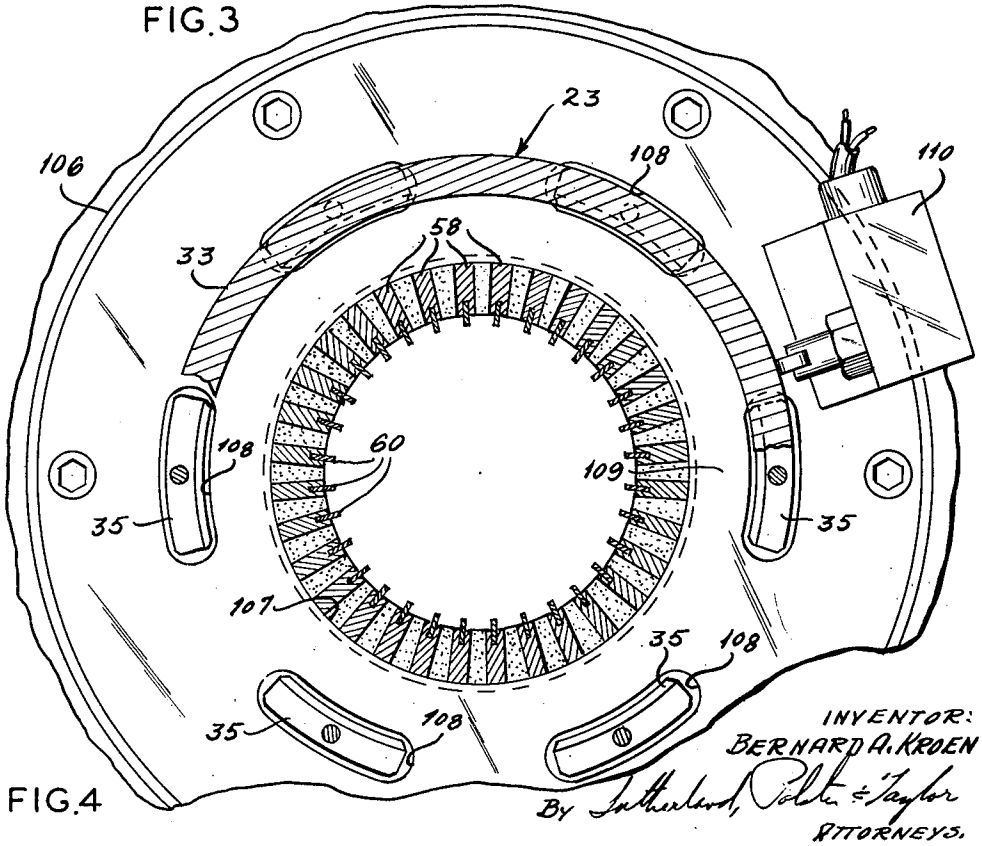


FIG.4

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STATOR BORE HONING MACHINE AND METHOD OF HONING

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12 Claims. (Cl. 51—34)

This invention relates to the machining of a discontinuous surface of a stack of laminations. It has particular application to the honing of the wall defining the bore of a laminated stator, and will be described in connection therewith, but its utility is not confined to that particular application.

The honing of the bore-defining wall of a laminated stator presents peculiar difficulties. Such a stator is made up of a large number of relatively thin laminations with radially inwardly extending teeth, which, when stacked, define a substantially circular bore with parallel, axially extending slots, which open into the bore wall through gaps which are narrow compared with the width of the main body of the slots. The laminations are secured in the stack either by welds running axially of the stack along the outside surface of the laminations, or by clamping strips, also running axially along the outside surface of the laminations or by other conventional means. This leaves the individual teeth unsupported at their free ends and causes them to "fan". This not only makes the axial height of the stack vary from its outside to its inside diameter (e.g. in a three inch stack of four inch I.D. laminations, the height at the I.D. is commonly 1/16" greater than at its O.D.) but tends to separate the contiguous teeth so as to deprive them of frictional support against lateral displacement. When a rotating hone is inserted in the bore, to hone the face of the free ends of the teeth, which collectively form the bore-defining wall of the stator, it frequently happens that individual teeth are bent by the hone into the adjacent slot, which ruins the stator. It has been found that this happens even when the stator is clamped between two plates with very high hydraulic pressure, and with the best selection of hones. The application of high pressure to the teeth has the additional disadvantage that when the bore is honed when the teeth are "compressed", and the pressure is then released, the "refanning" of the teeth distorts the bore from its pre-selected condition.

A further complication of the honing problem arises from the fact that in commercial production, individual laminations may be, and frequently are, slightly misaligned with respect to contiguous laminations, and the laminations from top to bottom of the stack may be skewed so that the slots do not extent exactly parallel with the stator bore axis.

One of the objects of this invention is to provide apparatus by which a surface defined by a plurality of laminations, and interrupted by a plurality of transversely extending slots, can be machined by a tool exerting a force in a plane parallel with the plane of the laminations, without permanently distorting the laminations.

Another object is to provide apparatus for machining, with a rotary tool, the bore-defining wall of a laminated stator, more quickly, easily, and efficiently than apparatus known heretofore.

Still another object of this invention is to provide such an apparatus which will tolerate misalignment or skewing of the laminations, within usual manufacturing standards.

Other objects will become apparent to those skilled in the art in the light of the following description and accompanying drawing.

In accordance with this invention, generally stated,

apparatus is provided for machining a surface made up of a plurality of laminations, which surface is interrupted by slots extending substantially at right angles to the plane of the laminations. A principal element of the apparatus is a plurality of blades which are introduced into the slots. The blades are dimensioned to slide loosely into and from the slots but to support the lands or teeth, intervening the slots, against movement, in response to the force of a tool acting in the plane of the laminations, beyond the elastic limit of the lands or teeth. The blades are preferably mounted to permit limitedly independent movement of the blades with respect to one another while they are being inserted. This feature, along with the looseness of the fit of the blades, permits their use even when the laminations are somewhat misaligned or skewed.

In the preferred embodiment of this invention, as applied to a machine for honing the bore-defining wall of a laminated stator, the blades, arranged complementarily to the stator slots, are mounted at one end in a resilient matrix, such as rubber. Preferably, means are provided for moving the blades radially inwardly, against the bias of the resilient matrix, toward the end of the axial travel of the blades as they are inserted in and through the slots of the stator.

Provision is made for clamping the stator, during the honing operation, in such a way as to maintain the "fanned" dimensions of the stator during the honing process, so that upon release of the clamping pressure, the stator bore is not distorted.

In the drawing, FIGURE 1 is a fragmentary sectional view of one illustrative embodiment of apparatus constructed in accordance with this invention;

FIGURE 2 is a sectional view taken along the line 2—2 of FIGURE 1;

FIGURE 3 is a fragmentary sectional view; partly broken away, taken along the line 3—3 of FIGURE 1;

FIGURE 4 is a fragmentary sectional view, partly broken away, taken along the line 4—4 of FIGURE 1; and

FIGURE 5 is a fragmentary view in perspective, partly in section, of blades of the apparatus of this invention, mounted in a resilient matrix.

Referring now to the drawing, reference letter S indicates a laminated stator to be honed. The "stator" S is properly a stator core, because the honing is done before the stator is wound, and the term "stator" as used herein means an unwound stator. The stator S is made up of a multiplicity of laminations S1, each with radially inwardly extending teeth S2. The teeth S2 are substantially aligned axially in the stator, although as has been indicated, there is liable to be some misalignment or skewing. The stator S has a bore S3 defined by a wall S4 constituted by end faces S5 of the teeth S2. The teeth S2 are roughly T shaped in plan view, and define between them slots S6, opening into the bore through relatively narrow gaps S7. The laminations are secured together, as by welding or riveting or by clamping strips, none of which is shown, in the conventional manner. The entire stator S is, in fact, conventional. A locating or "tell-tale" notch S8 is provided in the usual manner at an edge margin of the stator. In the drawing, thirty-two identical teeth and slots are shown, simply by way of illustration. The apparatus of this invention can be adapted for use with stators in which the teeth are not identical and with any number of teeth and slots.

The teeth S2 are slightly fanned outwardly in both directions from the center of the stack. The difference in the distance (height) between the top and bottom faces of the stator along the bore wall, from the distance (height) along the outside wall of the stator, is referred to herein-

after as the fanning differential. About half of the fanning differential is made up at each end.

In the illustrative embodiment of apparatus of this invention shown in the drawing, reference numeral 1 indicates a hone, mounted on the lower end of a vertical shaft 2. The shaft 2, hence the hone 1, rotates and also moves up and down (reciprocates). In FIGURE 1, the hone is shown in an intermediate position vertically.

The hone 1 extends through a circular opening 8 in a fixed top plate 5 which si piloted in an opening 3 in a heavy shelf plate 4, which is a rigid part of the honing frame. A channel 9, with upwardly convergent sides 10, extends concentrically with the hone axis around the underside of the inwardly projecting part of the fixed top plate 6. The convergent sides 10 of the channel 9 do not meet in a line, but are relieved at the "bottom" of the channel, as indicated at 11 in FIGURE 1.

A top clamping plate 12 is fastened to the underside of the fixed top plate 5, by means of flathead socket screws 13. The top clamping plate 12 is annular, and is provided with slots 14 defined by fingers 15. The slots 14 correspond in size and position with the slots S6. The fingers 15 are cut away on their undersurface through a part of their length, and the undersurface of a radially inner part 16 of the fingers 15, which engages the upper surface of the teeth S of the stator S is higher (i.e. projects downwardly less far) than the undersurface of three radially outer boss portions 17 of the clamping plate 12, which engage the upper surface of the outer marginal area of the stator, by about one-half of the "fanning differential" of the stator.

In the embodiment shown and described, the hone 1, shelf 4, fixed top plate 5, and top clamping plate 12, all are part of a stationary honing machine.

Reference numeral 20 indicates a fixture, which is shiftable laterally with respect to the honing machine. The fixture 20 has two operating units, which are moved back and forth with the shifting of the fixture 20 from a position at which one unit is aligned axially with the axis of the hone 1 while the other unit is in a position at which it is remote from the hone 1 (and top clamping plate 12), to a position at which the other unit is aligned and the first unit is remote.

The fixture 20 includes a base 21, which carries both operating units. The base 21 is bolted to a carriage 22. Power means, not here shown, are provided for reciprocating the carriage laterally.

Each operating unit in the fixture includes a stator clamping assembly 23; a blade assembly 24; and a blade assembly supporting mechanism 25. The operating units are identical in principle and operation, and only one is shown and described.

In the embodiment shown, the stator clamping assembly 23 includes a lower clamping plate 26, the upper surface of which is machined to provide a seat closely dimensioned to receive the stator S and to position the stator in alignment with the hone. A key, not here shown, extends into the seat to engage the tell-tale notch S8 in the stator. The lower clamping plate 26 has slots 27 defined by radially inwardly extending fingers 28. The slots 27 correspond in size and position with the slots S6 in the stator. The fingers 28 are cut away through part of their length on their upper side, so that the upper surface of a radially innermost part 29 of the fingers 28, which engages the underside of the teeth S2 of the stator, is lower than the upper surface of intermediate bosses 30 of the lower clamping plate 26, which engage the lower surface of the outer marginal area of the stator, by about one-half of the "fanning differential."

The lower clamping plate 26 is mounted, by means of cap screws 31, on a hollow cylindrical stator clamping piston 32.

The stator clamping piston 32 is made up of a clamp support ring 33 and a piston section 34, bolted together. The piston section 34 is cut away in sections at its upper end, to accommodate the arms of a spider described hereafter, leaving piers 35 on which the clamp support ring 33 rests. Around the outside of the piston section 34, near but above its lower end, is a piston ring boss 36, with a ring groove 37, in which a sealing ring 38 is seated.

The piston 32 is arranged to move axially in a cylinder built up of a clamp cylinder 40 and a top ring 41. The clamp cylinder 40 is bolted to the base 21 and the top ring 41 is bolted to the clamp cylinder 40. The inner surface of the clamp cylinder 40 is cut away to provide a bottom and side wall of a chamber 42. The lower surface of a depending flange 43, on the top ring 41, forms the top wall of the chamber 42. A lower clamping port 44 extends radially through the clamp cylinder 40 and communicates with the chamber 42, below the boss 36 while an upper clamping port 45 extends radially through the clamp cylinder 40 and communicates with the chamber 42 above the boss 36. The ports 44 and 45 are connected, through an electrically controlled valve, selectively to a source of fluid under pressure and to exhaust, so that when one port is connected to the pressure fluid, the other is connected to exhaust any fluid on its side of the boss 36. This valve system is conventional, and is not illustrated.

A sealing ring 46 in a groove 47 in the clamp cylinder 40 below the chamber 42 seals the space between the cylinder wall and the wall of the piston 32.

The top ring 41 is cut away around the upper part of its inside wall, to form a large gland 48, which holds large sealing rings 49. The sealing rings 49 bear on the surface of the outside wall of the piston 32, to seal off the space between the piston and the cylinder in which it rides, from coolant and metal particles and the like. Sealing rings 50 and 51, above the chamber 42, serve to seal off the chamber from the spaces between the top ring 41 and the piston 32 and between the clamp cylinder 40 and the top ring 41, respectively.

The blade assembly 24 is made up of a multiplicity of blades 55, arranged complementarily to the slots S6 of the stator S, the bore-defining wall S4 of which is to be honed. The blades 55 are mounted at their lower ends in a resilient matrix. In the embodiment shown, the resilient matrix is a ring 56 of rubber, into which the blades 55 are molded. Anchorage of the blades 55 in the rubber ring 56 is insured by the provision of holes 57, extending transversely through the lower end of the blades, into which the rubber flows. In the embodiment shown, the blades 55 are composites of a body portion 58, in the inner face of which is a channel 59, and a gap insert 60, secured within the channel 59. The upper ends of the blades 55 are provided with chamfered surfaces 61 complementary to the sides 10 of the channel 9 in the fixed top plate 5. From the lower edge of the chamfered surfaces 61, the blades are straight, through a distance greater than the height of the stator S. On the radially outer "back" of the blades, this straight shank section terminates above the upper edge of the rubber ring 56. Between the lower end of the straight shank section and the top of the rubber ring 56, the back of the blade flares outwardly downwardly, to provide a cam surface 62. The inner face of the rubber ring 56 is aligned with the inner face of the body portion 58 of the blades above the top of the rubber ring, and the front face of each blade is cut away between the top of the rubber ring and the lower end of the blade to provide a substantial thickness of rubber on the inside of the embedded blade end.

In the illustrative embodiment shown in FIGURE 2, all of the blades are shown as having the same cross-sectional configuration. It can be seen that if the stator slots vary in their configuration, the blades can and should be made with a configuration complementary to the configuration of the various slots.

The blade assembly 24 is carried for vertical movement by the blade assembly supporting mechanism 25. The

blade assembly supporting mechanism 25 includes a hollow cylindrical piston 70, which has a skirt 71 and a head 72. The head 72 is defined internally by an inwardly extending annular shelf 73, upon which the rubber ring end of the blade assembly 24 rests. A retaining ring 74, bolted to the top of the piston 70, extends over the top edge of the rubber ring 56, and prevents axial shifting of the rubber ring, hence of the blade assembly. A boss 75, integral with the skirt 71, extends outwardly around the lower edge of the skirt 71. A groove 76 in the exterior surface of the boss 75 contains a sealing ring 77. A groove 78 in the inside surface of the wall of the skirt 71 in the boss area, contains a sealing ring 79.

An inner guide sleeve 80, concentric with the skirt 71 but of smaller diameter, is bolted at its upper end to the underside of the shelf 73, leaving a bottom-opening space 81 between the skirt 71 and the guide sleeve.

The piston 70 is of less diameter than, and concentric with the stator clamping piston 32, and the head and upper part of the skirt of the piston 70 extend within the clamping piston 32, leaving an annular passage 82 between them. The lower skirt portion 71 moves up and down in a bore 85 and a counterbore 86 in the base 21. The space between the bore 85 and the skirt 71 is sealed off by the pair of large sealing rings 87 in a gland 88 in the bore of the base. A liner 90, in the counterbore 86, provides a machined cylinder wall, against which the skirt boss sealing ring 77 bears.

A cylindrical guide sleeve 91, with a heavy, stepped base flange 92, is bolted, through the flange 92, to a shoulder in the base 21, and extends, concentrically with the piston 70, into the space 81.

The cylindrical guide sleeve 91 serves the double function of providing the bottom and inside side wall of a chamber 93 in which the boss 75 is confined, and of providing a rigid guide, to insure accurate movement of the piston 70. To this latter end, the guide sleeve 91 extends closely within the space 81, and a key 94 in the guide sleeve 91, rides in a keyway 95 in the wall of the inner guide sleeve 80. The outer side wall of the chamber 93 is provided by the liner 90. The top wall of the chamber 93 is provided by the shoulder between the bore 85 and counterbore 86. The sealing ring 77 in the skirt boss groove 76 bears against the outer side wall of the chamber 93. The sealing ring 79 in the skirt groove 78 bears against the inner side wall of the chamber 93. The spaces between the bore 85 and the skirt 71 above the chamber 93, and between the liner 90 and the guide sleeve 91 below the chamber 93 are sealed by sealing rings 96 and 97 respectively.

A lower port 98 extends through the wall of the base 21 and the liner 90, to communicate with the chamber 93 below the boss 75. Upper port 99, extends through the wall of the base 20 and the liner 90, to communicate with the chamber 93 above the boss 75.

The upper and lower ports 98 and 99 are connected, through an electrically controlled valve, selectively with fluid under pressure and with an exhaust device, so that when fluid under pressure is admitted through one port, the other is exhausting. This, too, is conventional and the valve, and its electrical control system, are not illustrated.

The spaces between the liner 90 and the counterbore 86 above and below the lower port 98 are sealed off by sealing rings 100 and 101 respectively.

The blades 55 extend through an opening 105 in a taper plate 106, bolted to the top ring 41. The opening 105 in the taper plate 106 is defined by an upwardly inwardly slanted face 107, which forms a cam surface against which the cam surface 62 of the blades 55 bears when the blades are in their uppermost position, as illustrated in FIGURE 1. Openings 108, arranged around the tapered opening 105, admit the piers 35 of the stator clamping piston 32, and form a spider with arms 109.

A microswitch 110, mounted on the taper plate 106, is provided with a roller 111, which rides in and out of a keyway 112 running axially in the upper outer surface of the clamp support ring 33 of the clamping piston 32.

Drainage ports 113 and 114 are provided to permit the drainage and collection of cooling liquid which flows over the hone during the honing operation. The drainage ports 113 extend radially through the taper plate above the top ring; the drainage ports 114 extend radially through the clamping cylinder, and the base 20, communicating with the cavity 82.

The blades 55 are smaller than the slots within which they are to be positioned. For example, in a stator with slot openings (gaps) of .085 inch, the width of the inserts 60 may be .076 inch, leaving .009 inch of clearance. While, in response to the side thrust of the hone, some of the teeth may be pushed sideways through this distance, it has been found that this movement does not approach the elastic limit of the steel from which the stator teeth are made, so that they spring back after the hone passes the face of the teeth. Even if the hone made only one pass, so that the face of each displaced tooth were cammed with respect to the other, unsprung, teeth, by virtue of its temporary misalignment, the camming is so slight as to be unimportant as a practical matter. Of course, when the hone makes a number of passes, the chance of a tooth's being cammed diminishes.

In operation, assuming that the hone is in its retracted position, at which it does not extend below the lower surface of the fixed top plate 5; that the blade assembly 24 and its supporting mechanism 25 of one operating unit are in their retracted, lowermost, position, with the upper ends of the blades below the upper surface of the lower clamping plate 26; that the lower clamping plate 26 and its supporting piston are in their retracted, lowermost position, and that the carriage 22 is in a position at which the operating unit is remote from the opening 8 and clear of the shelf 4, so that a stator S may be placed on the lower clamping plate 26 in such a position that the key in the lower clamping plate 26 engages the tell-tale notch S8 in the stator, to assure proper positioning of the stator.

An electrical circuit is next completed, as by pushing a start button, to energize the power means to move the carriage 22, hence the loaded operating unit, to a position at which the stator S is directly aligned with the axis of the hone, beneath the opening 8. Then, either in response to a programming device already set in motion by the making of the "carriage" electric circuit, or in response to the manual making of another, valve, circuit, fluid under pressure is admitted to the lower port 98 communicating with the chamber 93 beneath the boss 75 at the lower end of the blade assembly supporting mechanism piston 70. This causes the piston 70 to rise, and the blades 55 to move axially upwardly through the slots 27 in the lower clamping plate, thence through the corresponding slots in the stator. As the blades reach the upper end of their travel, the upper ends of the blades pass through the slots 14 in the top clamping plate 12, where they are aligned circumferentially, and enter the channel 9 in the fixed top plate 5, where they tend to be cammed inwardly radially by the interaction of the outer side 10 of the channel of the chamfered surface 61 on the radially outward side of the blade. Simultaneously, at this point in the travel of the blades, the engagement of the inclined face 107 of the taper plate, with the cam surface 62 of the blades 55 causes the blades to move slightly radially inwardly parallel with the movement of the upper ends of the blades, so that the blades are aligned vertically and positioned radially.

Fluid, under pressure, is now admitted to the lower port 44 in the clamping cylinder 40, which, acting on the underside of the boss 36 of the stator clamping piston 32, moves that piston, hence the lower clamping plate 26, upwardly until the stator S is clamped firmly between the top clamping plate 12 and the lower clamping plate 26.

In practice, the movement of the lower clamping plate need be only about 3/16 inch, because that is all of the clearance which need be allowed between the top of the stator and the upper clamping plate when the lower clamping plate is in its lowermost position. If a single fixture is used, so that the stator must be placed in position immediately beneath the hone, a greater clearance might be necessary. As the stator clamping piston **32** moves upwardly, the roller of the microswitch **110** moves to the right, as it moves out of the keyway **112**, as viewed in FIGURE 1, closing the hone circuit, not here shown, and causing the hone to rotate and descend into the stator bore. In practice, the hone is arranged to make several passes through the bore. A suitable switch mechanism is used to cause the hone to retract and to de-energize the hone circuit after the stator bore is honed to a predetermined size and to energize the circuit which controls the admission of fluid under pressure, first to the upper clamp port **45** through the clamping cylinder, to move the lower clamping plate **26** to its lowermost position, and then to admit fluid under pressure to the upper port **99** in the base **20**, to move the blade assembly mechanism downwardly to retract the blades from the slots. When the blade assembly piston **70** reaches the lowermost part of its travel, it trips a switch, not here shown, which permits the energization of the carriage moving circuit, to shift, into honing position, the other operating unit, which has, in the meanwhile, been loaded with a stator to be honed, and to shift the unit bearing the honed stator to the remote position at which the honed stator can be removed and an unfinished stator be put into position for honing.

The freedom of the blades **55** to move almost universally through a limited but substantial distance as they are going through the stator slots, and the looseness of their fit, permits their insertion in spite of the normally experienced misalignment or skew of the laminations. By using a fluid blade-raising system, no damage is done even if one or more blades should not seat perfectly in the slant-sided groove in the top plate.

The inserts in the blades may even extend radially inwardly a shade too far to begin with, because they will be honed to exact fit, along with the teeth end faces.

It can be seen that while the apparatus of this invention has particular application to the honing of stator bores, it can also be applied to the machining of rotor cores or other laminated structures with a transversely interrupted surface defined by teeth or lands which are liable to be bent by a tool exerting side thrust in the plane of the laminations. The amount of permissible clearance of the blades will be determined in each instance by the elastic limit of the teeth or lands.

Having thus described the invention, what is claimed and desired to be secured by Letters Patent is:

1. In apparatus for machining a surface of a stack of laminations, said surface being defined by the end faces of a multiplicity of teeth adjacent ones of which define axially extending slots in said surface, the improvement, comprising blades arranged complementarily to said slots, one end of said blades being mounted in a resilient matrix for limitedly independent movement of the blades with respect to one another; blade assembly supporting means on which said matrix is mounted with the free ends of the blades projecting axially thereof; stack mounting means axially aligned with said blade assembly supporting means and adapted to support said stack of laminations with the slots in complementary alignment with the free ends of said blades, and means for effectuating relative axial movement between said blade assembly supporting means and said stack mounting means between a position at which the free ends of the blades substantially clear said stack mounting means and a position at which the free ends of the blades extend beyond said stack mounting means a distance greater than the height of the stack of laminations to be machined.

2. The apparatus of claim 1 including means for moving said blades radially against the bias of the resilient matrix, as the blades reach the position at which they extend beyond the stack supporting means a distance greater that the height of the stack to be machined.

3. A machine for honing the bore of a laminated stator, comprising a base; a clamping plate supported by said base and adapted to support a stator; a blade assembly supporting mechanism carried by said base, and axially aligned with said clamping plate and movable axially relative thereto; a blade assembly mounted on said blade assembly supporting mechanism, said blade assembly comprising a multiplicity of blades arranged complementarily to slots in the stator to be honed, said blades being mounted at one end in a resilient matrix for limitedly independent movement of the blades with respect to one another, and said resilient matrix being mounted on said blade assembly support mechanism, with the free ends of the said blades projecting in the direction of the clamping plate, said clamping plate being apertured to admit said blades, and means for moving said blade assembly supporting mechanism axially relative to said clamping plate between a position at which the blades do not project substantially beyond said clamping plate and a position in which said blades project beyond said clamping plate a greater distance than the axial height of the stator to be honed.

4. The machine of claim 3 wherein each of the blades is provided on its radially outward edge surface with a transverse cam surface immediately above the matrix, and wherein a cam plate, carried by the base, is positioned to engage said cam surface of each blade as the blades move toward their position of greatest extension with respect to the clamping plate, whereby the blades are cammed radially inwardly against the bias of said matrix.

5. The machine of claim 4 wherein each of the blades is provided at its outer end with a chamfered surface, and a plate, fixed against lateral movement with respect to the clamping plate and aligned with and spaced axially from said clamping plate, is provided with a seat for said chamfered surface, whereby when the blades move to their position of greatest extension with respect to the clamping plate, the outer ends of said blades are seated in radially fixed, inwardly cammed, position.

6. In apparatus for machining a surface of a stack of laminations, said surface being defined by the end faces of a multiplicity of limitedly elastic, projecting teeth unsecured to one another along their length, said teeth defining between them a plurality of slots extending transversely of said laminations and lengthwise of said stack, the improvement comprising stack mounting means; a tooth end face machining tool mounted for movement relative to said stack mounting means and positioned to bear against and exert a sidewise thrust on the end faces of teeth of a stack mounted on said stack mounting means, tending to bend said teeth into said slots, beyond the elastic limit of said teeth; and a plurality of tooth-supporting blades fixed with respect to said stack mounting means during the machining operation, said blades being mounted in a position corresponding to the slots in the stack mounted on said stack mounting means and extending within the said slots during the machining operation, adjacent the machining tool, said blades being of such size and position as to slide easily within said slots but to support said teeth against deflection, in response to the thrust of said tool, beyond their elastic limit.

7. The apparatus of claim 6 wherein the blades are embedded at one end in a resilient matrix to permit limitedly independent movement of said blade with respect to one another when said blades are unconfined.

8. The apparatus of claim 7 wherein the stack mounting means includes clamping plates at either heightwise end of said stack, and blade end receiving means, fixed with respect to one of said clamping plates and located at the free end of the blades, for holding the free ends of said blades during the machining operation.

9. The apparatus of claim 6 wherein the stack mounting means includes clamping plates at either heightwise end of said stack and said clamping plates have parts clampingly engaging a part of said end faces of said stack different from the said teeth whereby the said teeth are left in substantially relaxed condition while the stack is clamped.

10. In an apparatus for machining the bore of a stator formed of a stack of laminations, the wall of the bore to be machined being defined by the end faces of a multiplicity of radially inwardly projecting teeth, adjacent of said teeth defining between them a plurality of slots extending longitudinally of the stator, said teeth being unsecured to one another along their length, said laminations being tightly secured along their radially outer periphery whereby teeth of the stator fan axially, the improvement comprising stator clamping means having parts engaging the stator radially outwardly of the teeth whereby to clamp the stator against rotation without compressing the teeth axially, a rotary tool mounted for rotation and axial movement with respect to said clamping means, positioned radially inwardly from said clamping means and adapted to engage the end faces of teeth of the stator to exert a thrust on said teeth in the direction of a slot adjacent each tooth, and blades, arranged complementarily to and to extend within the slots of the stator to be machined, extending within the compass of said clamping means radially inboard of said stator-engaging parts thereof and radially outboard of the said tool, said teeth being proportioned to slide loosely within said slots but to prevent movement of the teeth into the slots beyond their elastic limit.

11. The method of machining the bore-defining wall of a laminated stator, said wall being defined by the end of a multiplicity of radially inwardly extending teeth defining axially extending slots between them, the laminations of said stator being tightly secured together along their radially outer periphery and the teeth being unsecured to one another along their length, whereby in their relaxed condition the teeth are fanned with respect to the radially outside of the stator, comprising restraining the said stator against rotation while maintaining the teeth in substantially relaxed condition, exerting a machining force on the end faces of teeth of the stator in a direction of the plane of the laminations of which said teeth are a part and restraining bending beyond their elastic limit, of teeth moved laterally into adjacent slots by said force, by a counterforce exerted upon said teeth in the plane of the said laminations.

12. In apparatus for machining the cylindrical wall defining the bore of a laminated stator, said wall being defined by the end faces of a multiplicity of limitedly elastic radially inwardly projecting teeth unsecured to one another along their length, said teeth defining between them a plurality of slots opening into the said bore through restricted gaps, said slots extending lengthwise of said bore, the improvement comprising blades arranged complementarily to said slots, one end of said blades being mounted in a resilient matrix for limitedly independent movement of the blades with respect to one another; blade assembly supporting means on which said matrix is mounted with the free ends of the blades projecting axially thereof, stator mounting means axially aligned with said blade assembly supporting means and adapted to support said stator with its slots in complementary alignment with the free ends of said blades; power means for effectuating relative axial movement between said blade assembly supporting means and said stator mounting means between a position at which the free ends of the blades substantially clear said stator mounting means and a position at which the free ends of the blades extend beyond said stator mounting means a distance greater than the height of the stator to be machined, and means for biasing the blades radially inwardly against the bias of the resilient matrix as the blades reach the position at which they extend beyond the stator mounting means a distance greater than the axial height of the stator.

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CERTIFICATE OF CORRECTION

Patent No. 3,029,562 April 17, 1962

Bernard A. Kroen

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 1, line 47, for "pre-selected" read -- pre-released --; column 3, line 10, for "si" read -- is --; column 6, line 61, for "of" read -- on --; column 10, line 40, for "2,327,358" read -- 2,327,352 --.

Signed and sealed this 11th day of September 1962.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

DAVID L. LADD
Commissioner of Patents