July 10, 1945. J. E. KLINE ET AL 2,380,317

DEVICE FOR HONING SPIRAL GROOVES

Filed Aug. 29, 1942 3 Sheets-Sheet 1

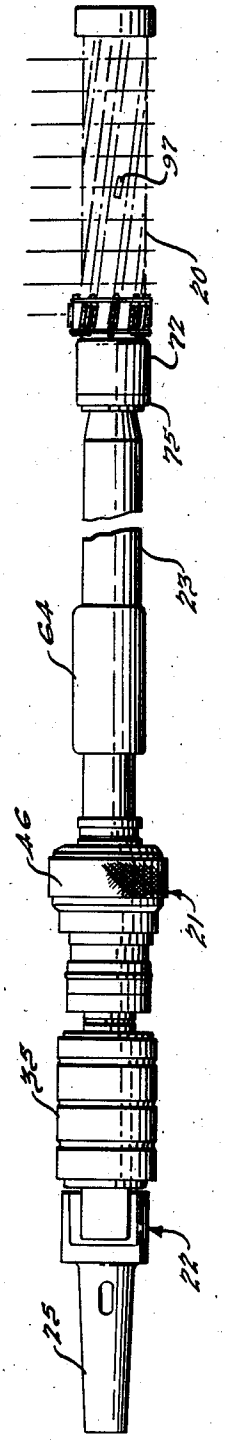


Fig. 1.

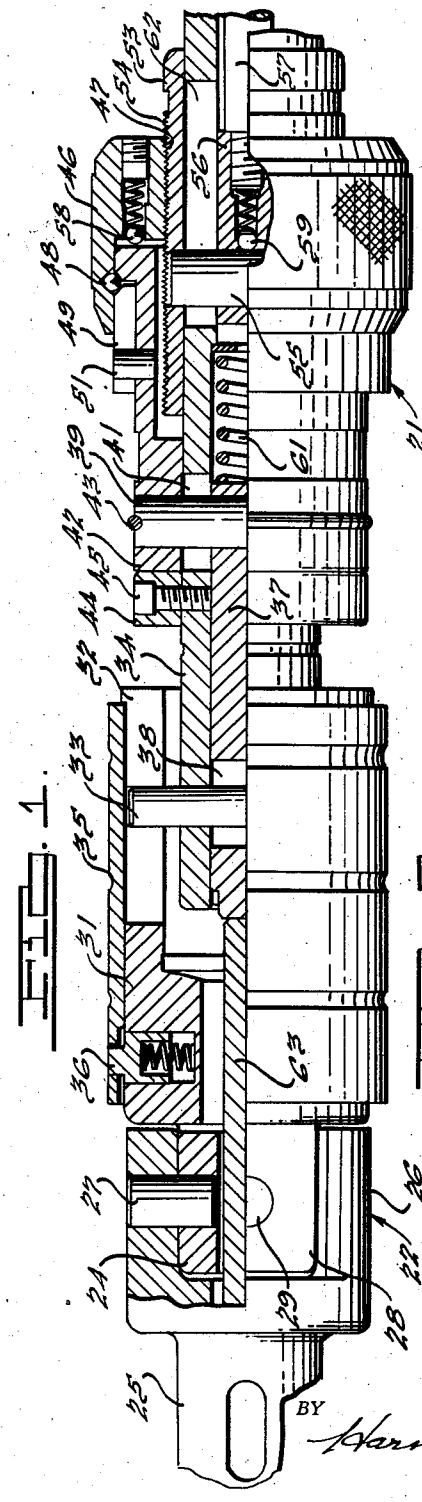


Fig. 2.

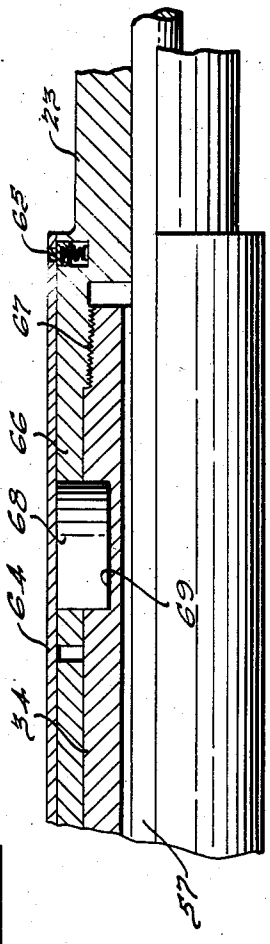


Fig. 3.

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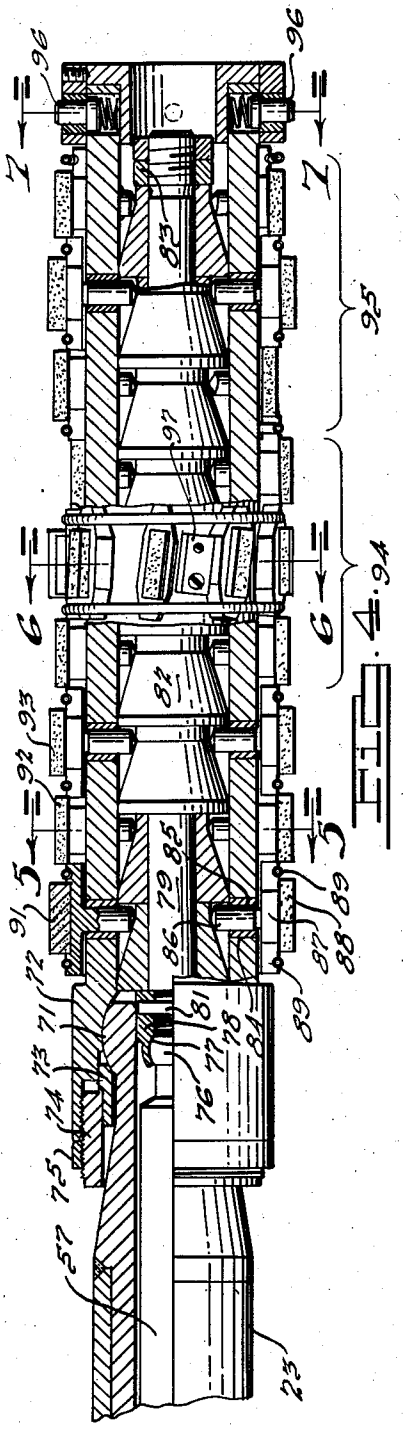


Fig. 4.

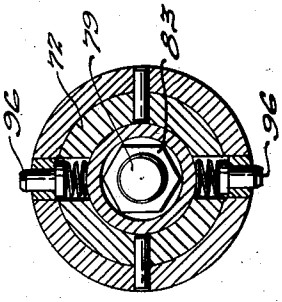


Fig. 7.

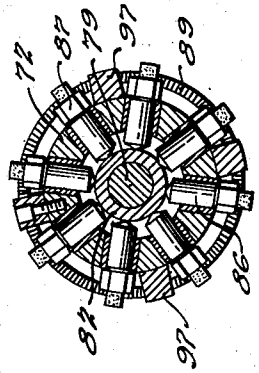


Fig. 6.

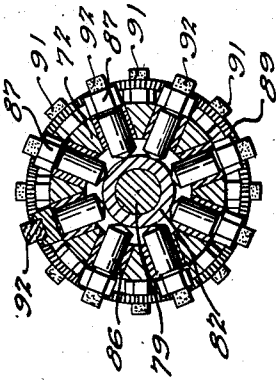


Fig. 5.

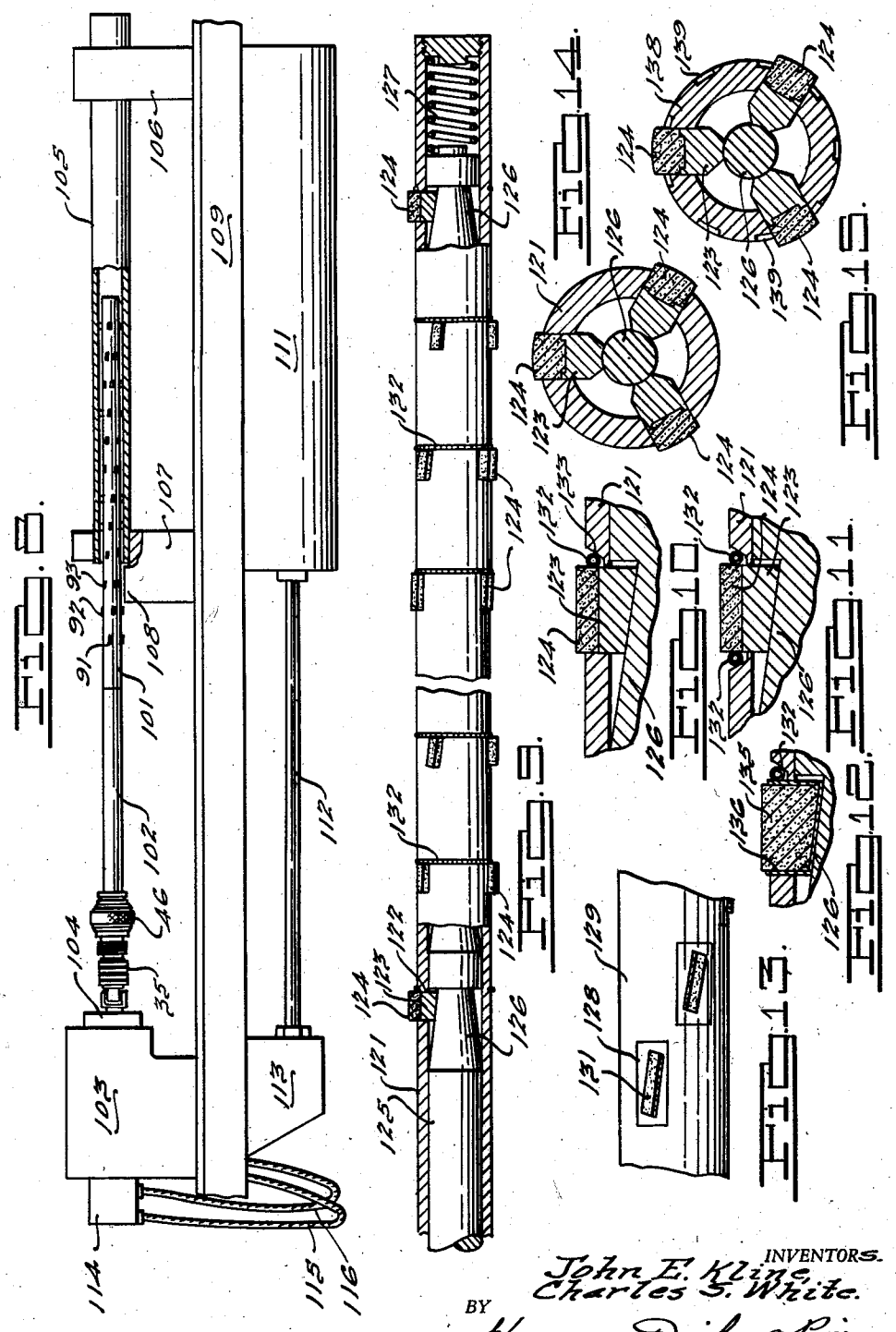
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Patented July 10, 1945 2,380,317

UNITED STATES PATENT OFFICE

2,380,317

DEVICE FOR HONING SPIRAL GROOVES

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Application August 29, 1942, Serial No. 456,608

13 Claims. (Cl. 51—184.3)

This invention relates to honing tools and particularly to a honing tool for honing helical slots for producing the lands or splines in the inner wall of a tubular element.

It has been the practice in the art to machine grooves in the inner wall of a tubular element, such as a gun barrel, by employing a series of individual cutters or broaches which progressively cut the material from the wall as the cutters or broaches are advanced through the barrel. A master lead bar is utilized for rotating the cutters or broaches when helical slots are to be machined on the cylinder wall. The cutting or broaching operations were never satisfactory as they required extreme skill and care. As the tools progressed through the barrel, the cuttings piled up ahead of the teeth and interfered with the proper presentation of the cutting edges to the material. This resulted in the tearing and gouging of the metal from the wall, which produced rough surfaces and recesses of greater depth than desired. Because of this rough, uneven width and depth of slots between the lands, many of the barrels were so defective that they could not be used.

In the practice of the present invention, a honing tool is employed to finish hone the slots produced by the cutting tools so that, after the finishing operation, smooth and accurate grooves were formed between the lands. In view of the speed in which the honing operation can be accomplished, the honing tools are also employed for generating the complete slots between the lands in a single operation or in a roughing and finishing operation. It was found that the honing of the slot saved materially in time and tool cost and produced extremely accurate lands and grooves within the barrel.

The honing tool comprises a body for supporting honing elements consisting of a backing member and stone, which project through the body to be engaged by sloping surfaces of an adjusting member which produces the radial expansion of the stones relative to the body axis. The body is supported upon a tubular element of a length sufficient to pass the honing tool into the barrel and have it partially extend from the opposite end. The stones are mounted at an angle conforming to the helix angle of the slots between the lands and when slots have been roughed out within the barrel no turning device is required to have the stones follow the particular lead of the slots.

When the number of slots to be machined in the barrel is greater than the number of stones which may be mounted in the body in a plane transverse to the axis thereof, a series of sets of stones are employed each embodying two or more circumferential groups of stones forming a complementary set which engages all of the slots within the barrel. When a number of these sets are utilized on the tool body, a plurality of different stones operate in each of the grooves being machined within the gun barrel.

The body is reciprocated through the barrel, the length of the stroke being sufficient to have at least one complementary set of stones extend from each end of the barrel during the reciprocating movement. A driving head is mounted on the opposite end of the tubular driving member from that of the tool body which is secured to a support. Adjacent to the driving head an adjusting collar is mounted for operating a rod which moves the adjusting member within the body for controlling the radial position of the abrasive stones. The adjusting collar and rod may be actuated by a rod extending through the driving member which may be axially moved by a rod secured to a piston in a cylinder mounted in the supporting head of the machine. By introducing fluid under pressure to the cylinder and piston, the abrasive stones may have a predetermined pressure applied thereto during the honing operation and may be moved radially so as to machine the slots to depth without interrupting the reciprocation of the tool.

Garter springs may be employed on the tool body for engaging the stone holders for urging them toward the axis of the tool so that they will be retracted when the adjusting member is moved in the opposite direction from that which moves the stones radially outwardly. The springs may also be employed as wedges for preventing the abrasive stones from being free to fall from the tool body while permitting them to be urged outwardly of the body axis when the adjusting member is moved axially within the body.

Accordingly, the main objects of this invention are: to provide a honing tool with a plurality of stones which are disposed upon a helix relative to the axis to the body; to provide a honing tool with a series of sets of stones, each set comprising circumferential groups of stones out of aligned relation but spaced in such manner that each stone is aligned with a slot to be machined in a cylinder; to provide a honing tool having a body portion containing a plurality of sets of abrasive stones which are disposed on the helical lead of slots which are to be machined in an internal cylinder wall and moved radially by an adjusting mechanism within a tubular extension which is con-

trolled by a sleeve on the driving end of the tool and operated by a rod extending through the driving member thereof; and, in general, to provide a honing tool for machining helical slots in the interior wall of a cylinder which machines the slots in both directions of reciprocation of the tool.

Other objects and features of novelty of this invention will be specifically pointed out or will become apparent, when referring, for a better understanding of the invention, to the following description taken in conjunction with the accompanying drawings, wherein:

Figure 1 is a view in elevation of a tool embodying features of this invention;

Fig. 2 is an enlarged broken sectional view of the driving end of the tool illustrated in Fig. 1;

Fig. 3 is an enlarged broken sectional view of the tubular extension of the driving end at the junction therebetween;

Fig. 4 is a broken sectional view of the tool body illustrated on the tool of Fig. 1;

Fig. 5 is a sectional view of the structure illustrated in Fig. 4, taken on the line 5—5 thereof;

Fig. 6 is a sectional view of the structure illustrated in Fig. 4, taken on the line 6—6 thereof;

Fig. 7 is a sectional view of the structure illustrated in Fig. 4, taken on the line 7—7 thereof;

Fig. 8 is a view of a tool, similar to that illustracted in Fig. 1, secured to a machine in position to hone a gun barrel;

Fig. 9 is an enlarged broken sectional view of the tool illustrated in the machine of Fig. 8;

Fig. 10 is an enlarged broken sectional view through one of the abrasive stones and the tool illustrated in Fig. 8;

Fig. 11 is a sectional view of structure, similar to that illustrated in Fig. 10, showing a further form of the invention;

Fig. 12 is a sectional view of structure, similar to that illustrated in Fig. 10, showing a still further form which the invention may assume;

Fig. 13 is a broken sectional view of structure, similar to that illustrated in Fig. 9, showing a still further form of the invention;

Fig. 14 is an enlarged sectional view of the structure illustrated in Fig. 9, taken on the line 14—14 thereof; and

Fig. 15 is a sectional view of structure similar to that illustrated in Fig. 14, showing a further form of the invention.

In Fig. 1, a tool is illustrated comprising a body portion 20, an adjusting portion 21, a driving portion 22, and a tubular extending portion 23 which joins the driving and adjusting portions to the tool body. The length of the tubular element may vary, depending upon the length of the gun barrel or cylinder being machined and the stroke in reciprocation of the tool which is moved from one end of the barrel to the other.

In Fig. 2, the driving end of the tool is illustrated as embodying a tapered shank portion 25 provided with a pair of legs 26 which are secured to opposite points on a collar 24 by a pair of pins 27. The collar 24 is secured to a pair of projecting lugs 28 interjacent the legs 26 by a set of pins 29 which produces a universal joint at the driving end of the tool. The lugs 28 extend from a sleeve 31 which has a pair of bayonet slots 32 for receiving and clamping a pin 33 extending through the tubular element 34 of the adjusting head 21. A sleeve 35 is disposed over the sleeve 31 and is retained in position by a spring-pressed pin 36. When the sleeve is released by the pin 36, it may be moved upwardly over the driving head 22 to release the pin 33, which then may be turned and removed from the bayonet slot 32.

Within the sleeve 34, a plunger 37 is provided having a slot 38 through which the pin 33 extends. A pin 39 extends through the plunger 37, through a slot 41 in the tubular element 34 and into a sleeve 42. The pin is retained against axial movement by a ring 43 extending about the sleeve. A ring 44, secured by a screw 45 to the tube 34, limits the upward movement of the sleeve 42 on the tubular element 34. The sleeve 42 supports a rotatable collar 46 which is provided with an internal thread 47. A plurality of balls 48 lock the collar to the sleeve when the balls are retained in position by a ring 49 secured by a pin 51 to the sleeve 42. A sleeve 53 is provided with external threads 54, which are engaged by the threads 47 within the collar 46.

The sleeve 53 is connected by a pin 55 to a block 56, to which an adjusting rod 57 is secured. A spring-pressed ball 58 retains the collar 46 in adjusted position while a spring-pressed ball 59 prevents the axial movement of the pin 55 relative to the sleeve 53 and block 56.

A spring 61 urges the plunger 37 toward the driving element 22 to retract the adjusting rod 57 when it is desired to contract the abrading members. The pin 55 extends through a slot 62 in the tubular element 34 and transmits movement from the plunger 37, pin 39, to the sleeves 42 and 53 to the pin 55 and rod 57. The plunger 37 may be moved axially by a rod 63 which extends through the collar 24 in the adjusting head 22 and through the end of the tapered driving shank 25.

In Fig. 3 the structure employed to connect the end of the driving element 21 to the tubular extending element 23 is illustrated. The tubular element 34 has a sleeve 64 thereover, which is secured thereto by a spring-pressed pin 65. When the sleeve is released, it may be moved to the right to permit the enlarged end 66 of the tubular element 23 to project over the tubular element 34 and to be screwed upon the thread 67 thereof. A key 68 is then inserted in a slot through the enlarged end 66 into a recess 69 in the tubular element 34. The sleeve 64 is then moved over the key and sleeve 34 to a position on the enlarged end 66 at which it is secured by the pin 65.

Additional sections of the tubular element 23 may be added between the body portion 20 and the adjusting head 21 following the teaching of the J. E. Kline application, Serial No. 369,925, filed December 13, 1940, which matured as Patent No. 2,343,013, February 29, 1944, and assigned to the assignee of the present invention.

Referring to Figs. 4 to 7, inclusive, the tubular element 23 has a ball end 71 secured thereto to form a universal connection with the body 72 of the tool portion 20. The ball end is secured to the body 72 by a ring 73 and a locking ring 74, which is secured in position by a ring 75. The adjusting rod 57 has a ball end 76 which is secured in a spherical recess 77 in the block 78. A rod 79 is threaded into the block 78 and is secured in position by a pin 81. The rod has a plurality of frusto-conical elements 82 secured thereon by a pair of nuts 83. A universal connection is formed in this manner between the tool body 21 and the driving element 23 which, with the universal connection at the driving head 22, permits the misalignment of the work with the tool as the honing operation is performed.

The tool body is provided with apertures 84 having bushings 85 therein through which pins 86 extend which are secured to the stone holders 87 to which stones 88 are secured. The stones 88 are urged inwardly by the plurality of garter springs 89 which engage the holders 87.

Referring to Fig. 5, the stone holders 87 are illustrated as being grouped in a plane as close together as possible, permitting eight holders to be mounted on the circumference of the body. When 24 slots are to be machined in a rifle barrel, three sets of eight stones each will make up a group to machine all of the 24 slots. The set 91 is offset from the group 92, which is offset from the set 93 a distance equal to the pitch of the lands, so that all three sets of stones will machine all of the 24 slots within the barrel. Additional groups 94 and 95 of the stones are provided in the tool body so that a plurality of stones will operate in each of the grooves. The hone is preferably operated in reciprocation within the gun barrel throughout the length thereof and to such a degree as to have a group of the stones project from either end of the barrel at the end of each stroke. A plurality of spring-pressed pins 96 are provided on the entering end of the hone for engaging the slots which were roughed in the barrel prior to the honing operation, for turning the hone in accordance with the lead of the slot as the hone is advanced through the barrel. Blocks 97 may also be employed on the body of the tool for resting upon the top of the lands to support the weight of the tool body.

In Fig. 8 a honing tool 101 is illustrated supported on a shaft 102 which is attached to a head 103. The attaching collar 104 may freely turn within the head so as to permit the tool to follow the slots which have been roughed in the bore as it is reciprocated within a barrel 105. The barrel is supported on the fixtures 106 and 107, the latter of which is provided with an extending portion 108 to form a support for the end of the tool when the tool is withdrawn from the barrel. The base 109 of the machine supports a cylinder 111 which reciprocates a rod 112 and the head 103 which is mounted upon the carriage 113.

A cylinder 114 is provided on the head 103 having flexible conduits 115 and 116 connected thereto for controlling the position of the piston within the cylinder which operates an adjusting rod for axially moving the rod 57 within the tool for producing pressure and expansion on the abrasive stones. A group 91, 92, and 93 of the stones is illustrated as extending from the muzzle of the gun at the end of the reciprocating stroke of the honing tool to the left as viewed in the figure. A similar group of stones on the opposite end of the tool will project from the breach end of the barrel at the end of the following stroke in the opposite direction.

When the tool is to be employed for roughing and finishing the slots within the gun barrel, the pins 96 may be omitted and an attaching device is employed for producing the rotation of the tool as it is moved in reciprocation. Such a device is illustrated in the application of J. E. Kline, Serial No. 455,712, filed August 22, 1942, and assigned to the assignee of the present invention.

In Fig. 9 a form of tool is illustrated which may be employed on gun barrels of small diameters. The body 121 is a tube having a plurality of slots 122 therein in which the stone holders 123 supporting the stones 124 are secured. An adjusting element 125, which is axially movable, is provided with a plurality of conical surfaces 126 which produce the outward movement and control the radial position of the stones. A spring 127 is mounted in the end of the tubular body 121 for urging the adjusting element to the left out of engagement with the stone holders 123.

While, in Figs. 4 and 9, the stone holders are illustrated as being mounted on an angle equal to that of the lead of the slot to be machined in the gun barrel, in Fig. 13 the stone holders are of rectangular form with the longitudinal axis disposed on the axis of the tool body. The stones 131 are supported on the stone holders 128 at an angle conforming to that of the helical lead of the slots to be machined.

In Fig. 10 the stone holder 123 and stone 124 are secured in position by a garter spring 132 which is disposed in a groove 133 having a tapered side wall which binds the stone and holder within the slot.

In Fig. 11 a pair of garter springs 132 are employed for locking the stones in position. A spring is disposed in a groove at each end of the stone, the grooves having a sloping wall which wedges the spring against the stone.

In Fig. 12 a stone 135 is illustrated having a metal sheath 136 disposed thereabout on all except the outer abrasive face. When small stones are employed to hone slots in a barrel of small diameter, the sheath on the stones adds strength thereto, while eliminating the joint between the stone and the holder.

In Fig. 14 the tool body 121 is illustrated as being provided with the stones 124 which are disposed 120 degrees apart. This tool was constructed to operate on a small gun barrel having nine grooves, so that three sets of three stones constitute a complementary set which will machine all of the grooves. Each set of three stones is offset from the other an amount equal to the pitch of the lands so that each of the stones will be aligned with one of the nine grooves. Several groups of three sets of stones are employed along the tool body so that several of the stones will contact each of the slots.

In Fig. 15 a tool body 138 is illustrated which is similar to the tool body 121 with the exception that helical slots 139 are provided in the body of the tool which conform in lead angle and depth to that of the roughed out lands formed by the rough machining operation with which they engage to guide the tool in rotation as the tool is advanced through the gun barrel.

The tool of the present invention may be employed to finish honing the slots which have been rough cut in a gun barrel to produce smooth bottom and side walls which are of accurate width and depth. The tools may also be employed to generate the entire depth of slot when rotated in timed relation to its reciprocation. This is made possible by the application of pressure to the stones for moving them radially during the time the honing tool is reciprocated. The honing operation occurs in both directions of movement of the tool in reciprocation, and there is no danger of deforming the walls of the slots at any point. The honing operation for generating and finishing the slots produces a material saving in time over the use of the cutting and broaching tools. The honing operation produces accurate slots, having smooth side walls and bottom, which are of exact width and depth.

The stones 88 or 124, herein referred to, may

be made of a bonded abrasive material or of diamond impregnated material. A file-like cutting block may be employed when capable of machining in both directions of movement. Such machining materially reduces the time required to machine the grooves to desired depth.

What is claimed is:

1. A honing tool including, in combination, a tool body, a plurality of groups of abrasive elements circumferentially disposed on said body, the elements of certain of said groups being aligned with elements of others of said groups on a helix about the body axis, and spring-pressed pins extending from the body for registering said body to accord with the lead of a similar helix to be honed in a workpiece.

2. In a honing tool, a tool body, a plurality of groups of elongated independently movable abrasive elements, each group comprising sets of elements disposed circumferentially of the body, with the elements of one set disposed on helices spaced from the helices on which the elements of the other sets are disposed.

3. In a honing tool, a tool body, a plurality of groups of abrasive elements, each group comprising sets of elements disposed circumferentially of the body, with the elements of each set spaced axially and disposed on helices spaced from the helices on which the elements of the other sets in the same group are disposed, the elements in one group being disposed on the same helix as that on which the elements of another group are disposed.

4. In a honing tool, a tool body, a plurality of groups of abrasive elements, each group comprising sets of elements disposed circumferentially of the body, with the elements of each set spaced axially and disposed on helices spaced from the helices on which the elements of the other sets in the same group are disposed, the elements in one group being disposed on the same helix as that on which the elements of another group are disposed, and means within said body for radially moving the elements of all of the groups simultaneously relative to the tool body.

5. In a honing tool, a tool body, a plurality of groups of abrasive elements, a group comprising sets of elements disposed circumferentially of the body, with the elements of each set spaced axially and disposed on helices spaced from the helices on which the elements of the other sets in the same group are disposed, and guide means on said tool body engaging helical grooves in the workpiece for rotating said body into alignment therewith as it is moved axially.

6. In a honing tool, a tool body, a plurality of groups of abrasive elements, each group comprising sets of elements disposed circumferentially of the body, with the elements of each set spaced axially and disposed on helices spaced from the helices on which the elements of the other sets in the same group are disposed, and supporting elements on said body engaging the lands between the grooves being machined for supporting the body thereon.

7. In a honing tool, a tool body, a plurality of groups of abrasive elements, each group comprising sets of elements disposed circumferentially of the body, with the elements of each set spaced axially and disposed on helices spaced from the helices on which the elements of the other sets in the same group are disposed, guide means on said tool body engaging helical grooves in the workpiece for rotating said body as it is moved axially, and supporting elements on said body engaging the lands between said grooves.

8. In a honing tool, a tool body, an abrasive stone on said body, said body having a circumferential slot adjacent to said stone with a sloping wall opposite to the stone end, and a spring in said slot engaging the end of said stone and applying pressure along its longitudinal dimension.

9. In a honing tool, a tool body, an abrasive stone on said body, said body having a circumferential slot adjacent to said stone with a sloping wall opposite to the stone end, and a garter spring disposed circumferentially of said body so as to project into said slot and be forced against the stone end by said sloping wall.

10. In a tool, a set of spaced radial machining elements circumferentially disposed on helices about the tool axis, a second set of spaced radial machining elements axially offset from said first set of elements and circumferentially disposed on helices about the tool axis in spaced relation to said first helices, and a third set of spaced machining elements axially offset from said first and second sets of elements which are disposed on helices differing from the helices on which the elements of said first and second sets are disposed.

11. In a tool, a set of spaced radially adjustable machining elements circumferentially disposed on helices about the tool axis, a second set of spaced radial adjustable machining elements axially offset from said first elements and circumferentially disposed on helices about the tool axis in spaced relation to said first helices, and a third set of spaced radially adjustable machining elements axially offset from said first and second said sets of elements which are disposed on the helices thereof.

12. In a honing tool including, in combination, a tool body, a plurality of sets of abrading elements carried by said body for radial adjustment, each set embodying a plurality of circumerentially aligned abrading elements having their longitudinal axes disposed on spaced helices about said body, the elements in one set falling on helices spaced from the helices on which the elements of an adjacent set are aligned, said plurality of sets forming a group of elements which hone all of a plurality of closely adjacent helical slots to be honed.

13. In a honing tool including, in combination, a tool body, a plurality of sets of abrading elements carried by said body for radial adjustment, each set embodying a plurality of circumferentially aligned abrading elements having their longitudinal axes disposed on spaced helices about said body, the elements in one set falling on helices spaced from the helices on which the elements of an adjacent set are aligned, said plurality of sets forming a group of elements which hone all of a plurality of closely adjacent helical slots to be honed, and a second group of sets of elements mounted on said body to have a plurality of said abrading elements operate in each of said helical slots to be honed.

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