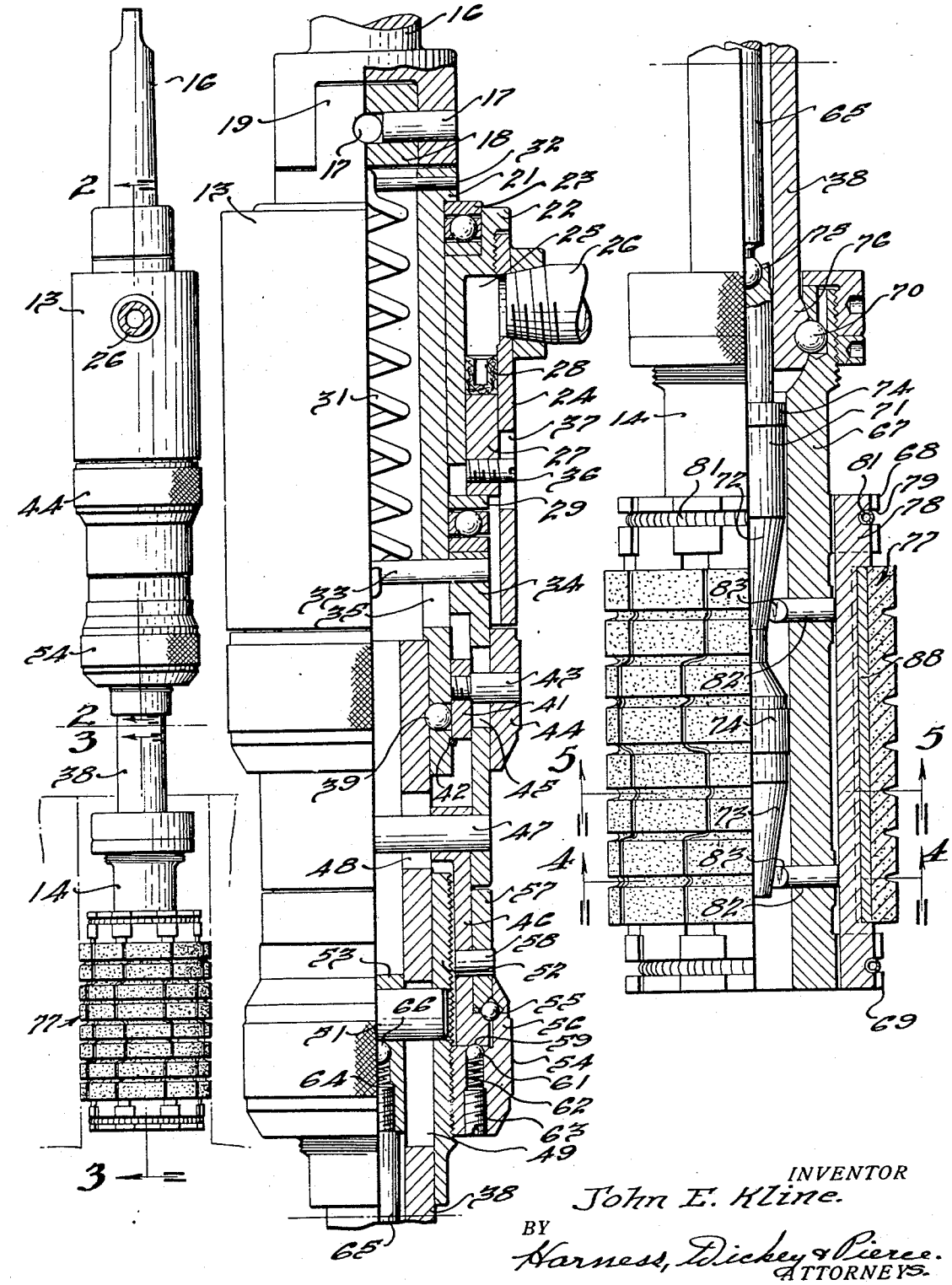
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HONING TOOL

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FIG. 1. FIG. 2. FIG. 3.



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HONING TOOL

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FIG. 4.

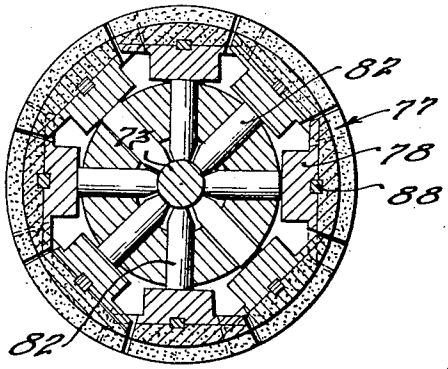


FIG. 5.

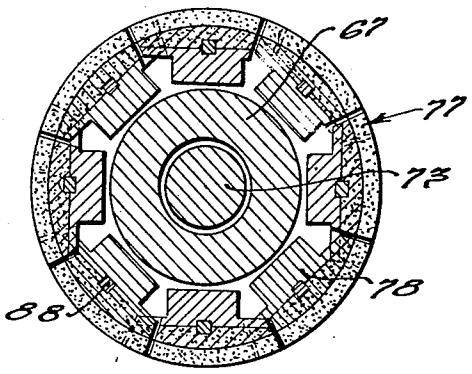


FIG. 6.

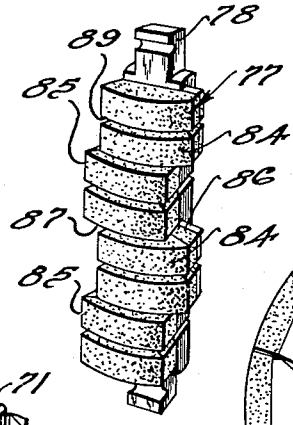
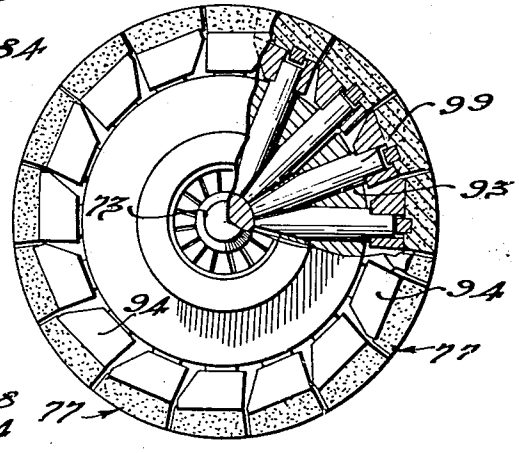


FIG. 8.



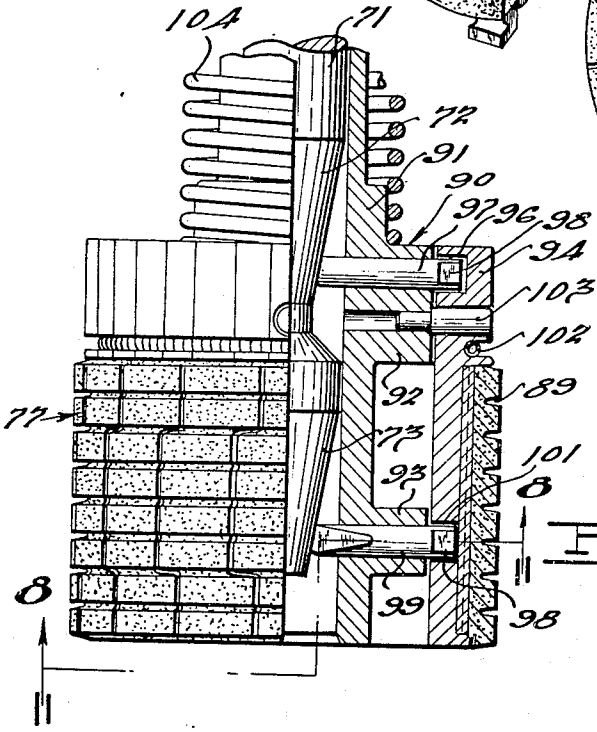


FIG. 7.

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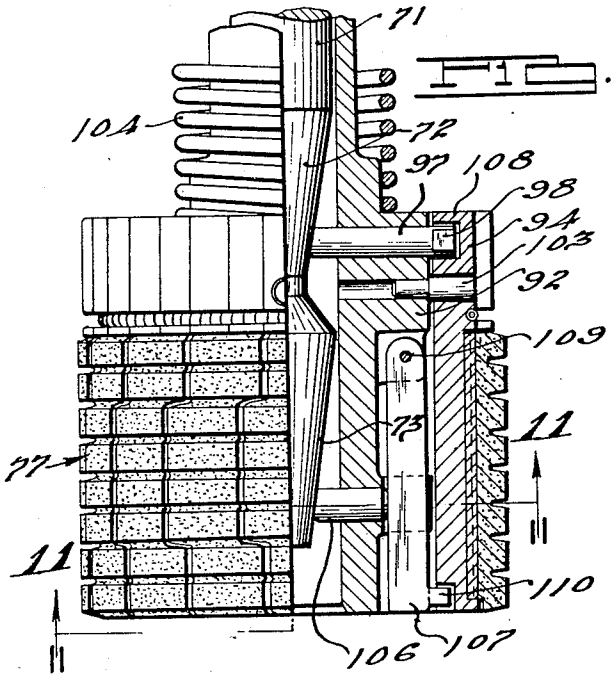


FIG. 9.

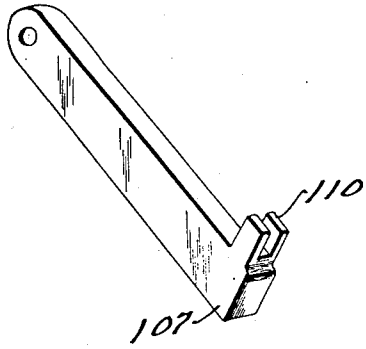


FIG. 10.

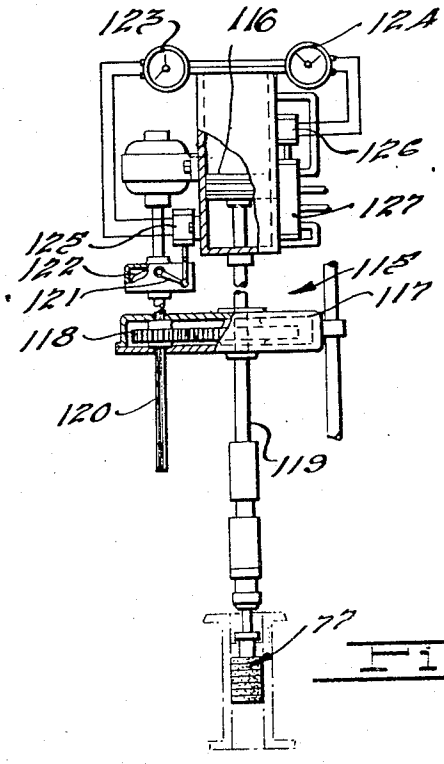


FIG. 12.

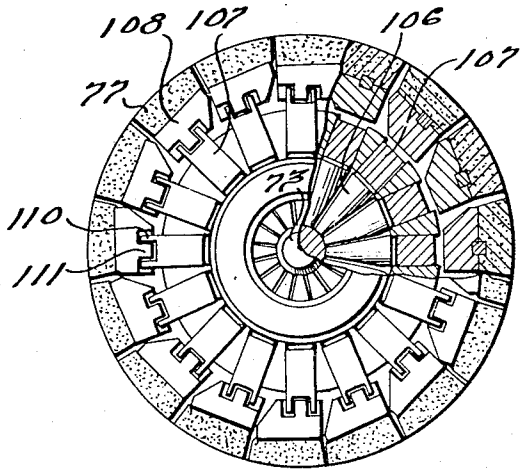


FIG. 11.

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UNITED STATES PATENT OFFICE

2,313,442

HONING TOOL

John E. Kline, Grosse Pointe Farms, Mich., assignor to Micromatic Hone Corporation, Detroit, Mich., a corporation of Michigan

Application February 23, 1939, Serial No. 257,777

19 Claims. (Cl. 51—184.3)

My invention relates to honing methods and devices, and particularly to a honing tool of new and novel construction and the machine and method of operating the tool.

Heretofore, honing tools were provided with a plurality of abrading stones spaced radially from each other about the tool axis. Means were provided in the tool for adjusting the stones relative to the axis while the tool was rotated and reciprocated within a cylinder bore or exteriorly about a cylindrical object. Various methods have been provided to control movement in reciprocation relative to that in rotation coupled with stones of particular hardness and grain structure to produce acceptable scratch marks on the finished surface and to break up cyclical relation between the marks to thereby produce an extremely high polish and desirable finish.

It is well known that all operations on materials, whether abrading or cutting, produce marks on the surface being operated upon. No matter how fine a finish is produced, scratch marks are present, though of much finer width and of materially less depth on a surface which may be said to have a high polish. Such scratch marks when disposed at a material angle to the movement of an element thereover, produce a cutting action which wears the engaging surface. Applicant has reference to the movement of rings and pistons in an engine cylinder, or the movement of a rotating shaft in a journal. In the former when the scratch marks are disposed circumferentially, material wear occurs to the piston rings and cylinder wall, due to the relative reciprocation therebetween. This is also true of the shaft when the scratch marks run substantially axially of the journal and/or of the surface of the shaft.

Included in applicant's present invention is the concept of disposing the scratch marks parallel to the movement between the surfaces so as to eliminate the cutting and material wear which occurred when the scratch marks were disposed otherwise. In a cylinder, for example, a draw honing operation occurs at the end of the machining cycle while moving the abrading elements only in reciprocation. Scratch marks are produced parallel to the axis of the rings and piston which eliminates friction and wear. A very tight seal is provided between the operating surfaces and the rings are prevented from turning relative to the cylinder wall. This further reduces wear and provides a tighter seal in cases where the cylinder wall is out of round.

The present invention contemplates the use of abrasive stones which are constructed to overlap each other within the degree of expansion of the tool. Substantial area contact is provided between the stone surface and that of the wall of the cylinder to be machined. Novelty resides in the ability to produce a honing method whereby the movement in rotation may be eliminated and the tool moved only in reciprocation. In some operations, particularly those on engine cylinder bores in which pistons are reciprocated, a movement only in reciprocation is produced at the end of the honing operation to provide scratch marks in the cylinder bore which are disposed parallel to the cylinder bore axes. The scratch marks disposed in this manner permit the piston rings to wear themselves directly into the marks to provide a tight seal with the cylinder wall. This eliminates the cutting of the rings and the wall with the resulting friction which occurred particularly during the initial operation of the piston. The longitudinally disposed scratch marks prevent the rings from rotating relative to the wall about the axes of the piston. Wear and friction are thereby reduced to a minimum and a material increase in the life of the surface of the rings and cylinder wall results.

The tool for producing the novel method of honing may have a body of the conventional type, and I have shown for the purpose of illustration a new and novel adjusting head therefor, operated under fluid pressure. The honing head is provided with a plurality of interlocking abrading stones having offset portions which nest in recesses in other stones. The resulting overlap of the stones is sufficient to prevent vertical separation within the degree of expansion of the abrading head. A pair of cones or other camming means is employed to actuate the abrading stones radially when operated by the longitudinal movement of an adjusting rod. Hydraulic pressure is delivered to a piston which moves the adjusting rod longitudinally against the bias of a spring which returns the piston and cam elements to their initial position when the fluid pressure is removed from the piston.

The machine employed to rotate and reciprocate the honing tool is of conventional type, with the exception that means are provided for stopping the movement in rotation while the cycle of reciprocation is continued. Means may also be provided in the machine to control the time of the operating cycle and to interrupt and entirely stop the machine after a predetermined number of reciprocations at the end of the honing operation. As pointed out hereinabove, the sole

movement in reciprocation of the honing head produces final scratch marks in the wall of the cylinder which are parallel to the axis of the bore, for the purpose above-mentioned.

Accordingly, the main objects of my invention are: to provide a method of honing whereby the scratch marks left on the cylindrical wall are disposed parallel to its axis; to provide a honing tool with abrading stones which overlap each other so that an operation may be performed by the tool in reciprocation while machining all points on the circumference of the cylindrical wall; to provide a honing tool with a plurality of overlapping abrading elements which are supported radially about the periphery of the tool head; to provide cam means for adjusting the overlapping abrading elements radially of the tool axis; to provide a control head for the abrading elements having an annular piston which is operated by fluid pressure for adjusting a cam element, and therefor the abrading elements; to provide an annular cylinder in the adjusting head of a honing tool having an annular piston therein which operates through collars to actuate a central adjusting cam of a honing head; to provide a machine which drives the honing tool in rotation and reciprocation for a predetermined length of time, after which the cycle of rotation is terminated to permit the final operation to be performed with a cycle of reciprocation only; to provide clutch means in a honing machine for interrupting the movement in rotation of the honing tool to permit the final operation in reciprocation only; and in general, to provide a method and device for machining cylindrical elements and bores which is simple in construction, positive in operation, and economical of manufacture.

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

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

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

Fig. 3 is an enlarged sectional view of the lower portion of the honing tool illustrated in Fig. 1;

Fig. 4 is a sectional view of the honing tool illustrated in Fig. 3, taken on the line 4—4 thereof;

Fig. 5 is a sectional view of the honing tool illustrated in Fig 3, taken on the line 5—5 thereof;

Fig. 6 is a plan view of one of the abrading elements illustrated in the lower end of the tool in Fig. 3;

Fig. 7 is a view of a honing head similar to that illustrated in Fig. 3, showing a modified form thereof;

Fig. 8 is a sectional view of the structure illustrated in Fig. 7, taken on the line 8—8 thereof;

Fig. 9 is a view of a honing head, similar to that illustrated in Fig. 8, showing a further form which the abrading head may assume;

Fig. 10 is an enlarged perspective view of a link employed in the honing head of Fig. 9;

Fig. 11 is a sectional view of the structure illustrated in Fig. 9, taken on the line 11—11 thereof; and,

Fig. 12 is a plan view of a honing machine which may be employed for operating the honing tool illustrated in the foregoing figures for producing a cycle of operation embodying my invention.

The honing tool of Fig. 1 embodies an adjusting head 13 and a honing head 14 driven in rotation and reciprocation by a machine 15, illustrated in Fig. 11. A shank 16 supports the honing tool in the machine, being connected by pins 17 to a block 18 and to ears 19 projecting from the holow cylindrical body portion 21. A sleeve 22 is disposed upon the cylindrical body portion 21 to be rotatable relative thereto against a thrust bearing 23. An outer sleeve 24 encompasses the sleeve 22 and forms therewith an annular cylinder 25. A conduit 26 is connected to the cylinder for introducting a fluid thereto. An annular piston 27 is disposed within the cylinder 25, sealed against fluid pressure in the cylinder by an annular cup 28 made of leather, composition material, or other substances known in the art as sealing material.

A second thrust bearing 29 abuts against the annular piston 27 being retained in contact therewith by the tension of a spring 31, one end of which is supported on a pin 32 which projects through the body portion 21, the other end of which is supported on a pin 33 projecting through a collar 34. The pin 33 operates within slots 35 provided diametrically opposite each other in the body 21. A set screw 36 is threaded in the piston 27 having a head projecting in a slot 37 of the sleeve 24 which prevents the piston from turning while limiting its degree of travel within the cylinder 25. It will be noted that the sleeves 22 and 24, the cylinder 25 and the piston 27 form a unit which is supported on the body portion 21 between thrust bearings 23 and 29 to be retained against rotation while the cylindrical body portion 21 is rotated.

A hollow spindle 38 has its upper end telescoped within the lower end of the hollow cylindrical body portion 21, secured thereto by a plurality of balls 39. The balls are retained in position by a collar 41 which is moved down against a stop 42 after the balls have entered recesses provided in the spindle 38. One or more studs 43 threaded into the collar 41 project through apertures in a collar 44. Slots 45 are provided in the sleeve 34 through which the pins 43 project to permit the axial movement of the sleeve relative to the pins.

The sleeve 34 is secured to a collar 46 by a pin 47 which extends through diametrically disposed slots 48 in the driving spindle 38. Additional diametrically disposed slots 49 are provided in the driving spindle 38 through which a pin 51 extends disposed in apertures in a threaded sleeve 52 provided about the outer surface of the spindle 38 and projecting within the collar 46. A plug 53 is disposed within the drive spindle 38 supported by the pin 51. An adjusting sleeve 54 is threaded onto the threaded sleeve 52 and is secured to the collar 46 by a plurality of balls 55 disposed in an annular groove in a projecting portion 56 of the sleeve 54 retained by a collar 57 which is secured to the collar 46 by a pin 58.

To retain the sleeve 54 in adjusted position, the lower end of the collar 46 has a plurality of spaced apertures 59 engageable by a ball 61 which is urged therein by a spring 62 tensioned by a set screw 63. When the sleeve 54 is revolved on the threaded sleeve 52 the latter is moved axially of the collar 46 moving the pin 51 and the plug 53 axially of the driving spindle 38. The plug 53 has a threaded aperture 64 therein in which the ends of an adjusting shaft 65 is

threaded and secured in extension thereof. A spring-pressed ball 66 is urged into an aperture in the pin 50 to prevent the axial movement of the pin after assembly.

When fluid under pressure is introduced through the conduit 26 to the cylinder 25, the piston 27 will be moved downwardly carrying the thrust bearing 29 and collar 34 downwardly therewith against the bias of the spring 31. The downward movement of the collar 34 moves the collar 46 downwardly therewith because of the unit relation provided therebetween by the pin 47. The downward movement of the collar 46 moves the adjusting collar 54 and the sleeve 52 downwardly to likewise move the pin 51 and plug 53 downwardly to move the adjusting rod 65 axially of the tool. When the flow of fluid is reversed in the conduit 26 the tension of the spring 31 will return the adjusting rod 65, sleeve 52, collar 46, sleeve 34, bearing 29, and piston 27 to their original position.

Referring to Fig. 3, the honing head 14 of the tool embodies a hollow cylindrical body portion 67 having spaced slotted annular projections 68 and 69 thereon. An axially movable element 71 is disposed within the body portion 67 having sloping cam surfaces 72 and 73 and bearing surfaces 74, the latter of which contact the inner wall of the element 67 and accurately guide the element 71 therein. The element 71 has a ball connection 75 with the adjusting shaft 65 supported in the adjusting head 13 of the tool. A ball connection 76 is provided between the driving spindle 38 and the honing head body 67 to permit universal movement between the body portion 67 and spindle 38, a slight clearance being provided between balls 70 and their recesses to permit such universal movement while providing a driving connection between the body 67 and spindle 38.

A plurality of abrading stones 77 are mounted in carriers 78 which have their ends disposed in the slots in the annular projections 68 and 69 of the honing head body. The projections and ends have slots 79 for receiving garter springs 81 which urge the carriers 78 and stones 77 toward the axis of the tool. Pins 82 projecting through the body portion 67 into engagement with the inner side of the carriers 78, have sloping ends 83 which provide clearance for the pin ends so that they contact the cam surfaces 72 and 73 without interference.

Referring to Figs. 4, 5, and 6, the construction of the abrading element 77 and the carriers 78 are clearly illustrated. The abrading element 77 is preferably a single piece of abrading material having projecting side portions 84 on one edge and projecting side portions 85 on the other edge providing recesses 86 and 87 respectively, therebetween, for receiving like projections on adjacent abrading elements. The carrier 78 has the outline of the abrading stone 77 which is aligned by a key 88 embedded in the carrier and stone and which provides additional anchoring means when the stone is glued, babbitted, or otherwise secured to the carrier. The projecting portions 84 and 85 and the recesses 86 and 87 are of sufficient extent to overlap at all times within the degree of expansion of the abrading head 14. Therefore, all portions of the cylinder wall or element will be machined when the tool is moved only in reciprocation during the final machine operation. The radial movement of the stones 77 is effected through the axial movement of the element 71, the stones being expanded when the element is moved downwardly and being retracted by the garter spring 81 when the element is moved upwardly. In the tool illustrated, the downward movement is effected through the introduction of fluid under pressure through the conduit 26 into the cylinder 25 while the reverse movement is produced by the spring 31 when the pressure on the piston 27 is removed.

In Figs. 7 and 8 I have illustrated a modified form of tool, one employed for blind end honing. The tool 90 is similar to the tool illustrated in the foregoing figures with the exception that the abrading elements extend to the bottom of the honing head. Such a tool is employed for machining engine cylinders or any other type of cylindrical structure which is open only at one end. In this type of tool, a body portion 91 has annular projections 92 and 93, the former of which is slotted to receive the top projecting end of the stone carriers 94. The stone carriers 94 are provided with abrading stones 77 similar to the stones above described with relation to the structure of Figs. 1 to 6 inclusive. The stones overlap vertically and are provided with a plurality of annular recesses 89 which collect the abraded material from the cylinder wall as well as the material of the stones which break down during the honing operation.

The carriers 94 are provided with apertures 96 near their top ends in which project pins 97 which extend through the projection 92 and which have flat surfaces 98 which pervent the pins from turning. Pins 99 extend through the lower projection 93 of the body portion 91 into recesses 101 in the lower end of the carriers 94 having similar flat sides 98 which prevent the pins from turning. The opposite ends of the pins are sloped to engage the cam surfaces 72 and 73 on the axially movable element 71. A garter spring 102 is disposed in slots in the end of the carriers 94 intermediate the pins 97 and 99 to provide an inward bias at both ends of the carriers and stones. The carriers 94 are supported on pins 103 which project through slightly tapered holes in the carriers to permit the carriers to tilt longitudinally of the tool axis. A spring 104 may be employed about the tool body 91 in engagement with the sleeve 52 to provide additional spring tension for returning the element 71 to its initial position after pressure has been removed from the cylinder 25. The operation of the tool is the same as that of the tool illustrated in Figs. 1 to 6 and is employed primarily when blind holes are to be honed.

A tool similar to that shown in Figs. 7 and 8 is illustrated in Figs. 9, 10, and 11. In this construction, a pin 106 operates against a link 107 to apply pressure at the very end of the carrier 108. The links are pivoted on the projection 92 by pins 109. The lower end of the link has a bifurcated projection 110 which extends in recesses in the stone holders 108 and which receives the material therebetween. This retains the stone parallel to the axis of the tool while transmitting the pressure from the conical element 73 directly to the end of the stones so that the pressure from both of the conical elements will be applied to the abrading stick at their ends.

In Fig. 12, I have illustrated a honing machine 115 having a hydraulically actuated reciprocating piston and cylinder 116 which reciprocates in a driving head 117. The driving head contains gears 118 for operating the spindle 119 in rotation. Power is applied through suitable means herein illustrated as a spline shaft 120 for rotating the gears. The shaft 120 has a clutch 122

therein by which the operation in rotation may be interrupted during the time the tool is being reciprocated. Suitable means, herein illustrated as timing devices 123 and 124 may be utilized for timing the operation of the cycle of rotation and reciprocation. A solenoid 125 operates the clutch 122 after a predetermined time of operation and thereafter the time switch 124 operates to energize a solenoid 126 for operating the valve 127 which interrupts the cycle of reciprocation.

When commencing a honing operation, both switches are opened to permit the reciprocation and rotation of the honing tool. After a predetermined cycle of combined operation, the switch 123 closes, energizing the solenoid 125 and opening the clutch 122 which stops the movement in rotation permitting the honing operation to continue the cycle of reciprocation. After a predetermined length of time, the switch 124 closes to actuate the solenoid 126 which operates valve 127 to stop the cycle of reciprocation and complete the honing operation. As pointed out hereinabove, under certain conditions it is desirable to operate the hone with combined movement of rotation and reciprocation and finish the honing operation with a movement in reciprocation only. By employing a suitable type of abrading stones, the surfaces are worn to the exact contour of the cylindrical surface desired, so that the final operation in reciprocation finishes the entire circumference of the cylindrical wall with abrading marks parallel to the cylinder axis.

While I have described and illustrated several embodiments of my invention, it will be apparent to those skilled in the art that various changes, omissions, additions, and substitutions may be made therein without departing from the spirit and scope of my invention, as set forth in the accompanying claims.

What is claimed is:

1. A honing tool embodying an abrading head, a plurality of abrading stones, means for radially moving said stones, said stones having edge projected and recessed portions which nest within those of adjacent stones.

2. A honing tool embodying an abrading head, a plurality of abrading stones, means for radially moving said stones, said stones having edge projected and recessed portions which nest within those of adjacent stones, the surface of said stones being circumferentially grooved.

3. An abrading tool including, in combination, an abrading head, a plurality of stones of greater length than width disposed on the periphery of said head for radial adjustment, said stones having projected and recessed portions along their side edges which nest within those of adjacent stones so as to have portions overlap in all radial planes through said stones.

4. A honing tool including, in combination, an adjusting head, an abrading head supported thereon, abrading stones provided on the periphery of said head for radial movement, means for moving said abrading stones radially, said abrading stones having recessed and projected portions on the side edges which nest with those of adjacent stones.

5. An abrading stone for a honing tool having a curved outer surface and side edges which are alternately projected and indented, said curved outer surface being grooved normal to the edges.

6. An abrading stone for a honing tool having a curved outer surface and side edges which are alternately projected and indented, a projected portion on one edge having the portion on the opposite edge indented and the portion projecting on the second said edge being indented on the opposite side.

7. An abrading stone for a honing tool having a curved outer surface and side edges which are alternately projected and indented, a projected portion on one edge having the portion on the opposite edge indented and the portion projecting on the second said edge being indented on the opposite side, said curved outer surface being grooved at spaced points between the side edges.

8. In an abrading tool, an abrading head having circumferentially spaced annular projections, pins having tapered sides extending through said projections disposed radially of the axis of the head with the tapered sides of the pins in juxtaposition to each other, means for simultaneously adjusting said pins radially and abrading stones carried by the ends of said pins and interrelated to be disposed in overlapping relation in the various positions of adjustment by said pins.

9. In an abrading tool, an abrading head having circumferentially spaced annular projections, pins extending through said projections disposed radially of the axis of the head in juxtaposition to each other, abrading stones carried by the ends of said pins disposed in abutting relation, and abrading stones having projecing and recessed portions which nest within each other to provide continuous abrading surfaces parallel to the tool axes within the degree of expansion of the abrading head.

10. In an abrading tool, an abrading head having circumferentially spaced annular projections, pins extending through said projections disposed radially of the axis of the head in juxtaposition to each other, abrading stones carried by the ends of said pins disposed in abutting relation, said abrading stones having projecting and recessed portions which nest within each other to provide continuous abrading surfaces parallel to the tool axes within the degree of expansion of the abrading head, and cam means within the abrading head engaging said pins for adjusting said pins radially.

11. In an abrading tool, an abrading head having circumferentially spaced annular projections, pins extending through said projections disposed radially of the axis of the head in juxtaposition to each other, abrading stones carried by the ends of said pins disposed in abutting relation, said abrading stones having projecting and recessed portions which nest within each other to provide continuous abrading surfaces parallel to the tool axes within the degree of expansion of the abrading head, cam means within the abrading head engaging said pins for adjusting said pins radially, and garter springs encompassing projections on said stones for biasing them toward the abrading head axis.

12. An abrading tool including, in combination, an abrading body having circumferential annular projections, fixed pins on one of said annular projections, slidable pins extending through said projections on either side of said fixed pins, abrading stones carried by said fixed pins for tilting movement and engageable with the ends of said slidable pins, and a garter spring encompassing a projection on said stones between said slidable pins.

13. An abrading tool including, in combination, an abrading body having circumferential annular projections, fixed pins on one of said annular

projections, slidable pins extending through said projections on either side of said fixed pins, abrading stones carried by said fixed pins for tilting movement and engageable with the ends of said slidable pins, and a garter spring encompassing a projection on said stones between said slidable pins, said stones having projecting and recessed projections along the side edges which nest in each other to provide a substantially continuous abrading surface.

14. An abrading tool including, in combination, an abrading body having circumferential annular projections, fixed pins on one of said annular projections, slidable pins extending through said projections on either side of said fixed pins, abrading stones carried by said fixed pins for tilting movement and engageable with the ends of said slidable pins, a garter spring encompassing a projection on said stones between said slidable pins, said stones having projecting and recessed projections along the side edges which nest in each other to provide a substantially continuous abrading surface, an adjusting head supporting said abrading body for movements in rotation and reciprocation, a hollow sleeve rotatable relative to said adjusting head, an annular piston in said sleeve adjustable therein by fluid pressure axially of the tool, camming means engaging the slidable pins, and means interconnecting said piston with said camming means for transmitting movement from the piston thereto.

15. An adjusting head for a honing tool embodying a hollow shank, a hollow sleeve on said shank forming an annular cylinder, an annular piston within said sleeve, said sleeve and piston being rotatable relative to said shank, and means on said shank movable axially of said tool by said piston under the control of fluid delivered to said cylinder for adjusting the diameter of said head.

16. A honing tool, including in combination, an abrading head embodying a plurality of radially movable abrading stones, means on said head for adjusting the expansive position of said stones, and an actuating head to which said honing head is releasably attachable, said actuating head having a fluid operated piston for additionally controlling the expansion and contraction of said abrading elements.

17. In a honing tool having an adjusting head embodying a hollow shank, a hollow sleeve on said shank forming an annular cylinder, an annular piston within said sleeve, said sleeve and piston being rotatable relative to said shank, a honing head embodying a plurality of radially movable abrading stones, adjusting mechanism on said abrading head for positioning said stones, releasable means for connecting said abrading head to said adjusting head, and means on said shank movable axially of said tool by said piston for expanding and contracting said abrading elements.

18. In a blind end abrading tool, an abrading head including a support, a plurality of abrading stones carried by said support, upper and lower pins projecting through said support, the upper pins engaging the abrading elements near the upper ends thereof, a pivoted arm having an end portion engaging the lower ends of said abrading elements and being engaged by the lower of said pins interjacent the ends of the arms.

19. In an abrading tool, an abrading body having a plurality of pivoted arms, abrading stones, stone carriers supported by said body with the lower end of said carriers in contact with pins projecting through the body in engagement with said arms interjacent their ends, additional pins projecting through the body in engagement with the upper ends of said carriers, and means for adjusting said pins radially.

JOHN E. KLINE.

CERTIFICATE OF CORRECTION.

Patent No. 2,313,442. March 9, 1943.

JOHN E. KLINE.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, second column, line 9, for "holow" read --hollow--; page 3, second column, line 32, for "pervent" read --prevent--; page 4, second column, line 30, for "and" first occurrence, read --said--; same line for "projecing" read --projecting--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 20th day of April, A. D. 1943.

Henry Van Arsdale,

(Seal) Acting Commissioner of Patents.