Feb. 24, 1970 R. C. ENGLE 3,496,678

ROUGH AND FINISH HONING TOOL

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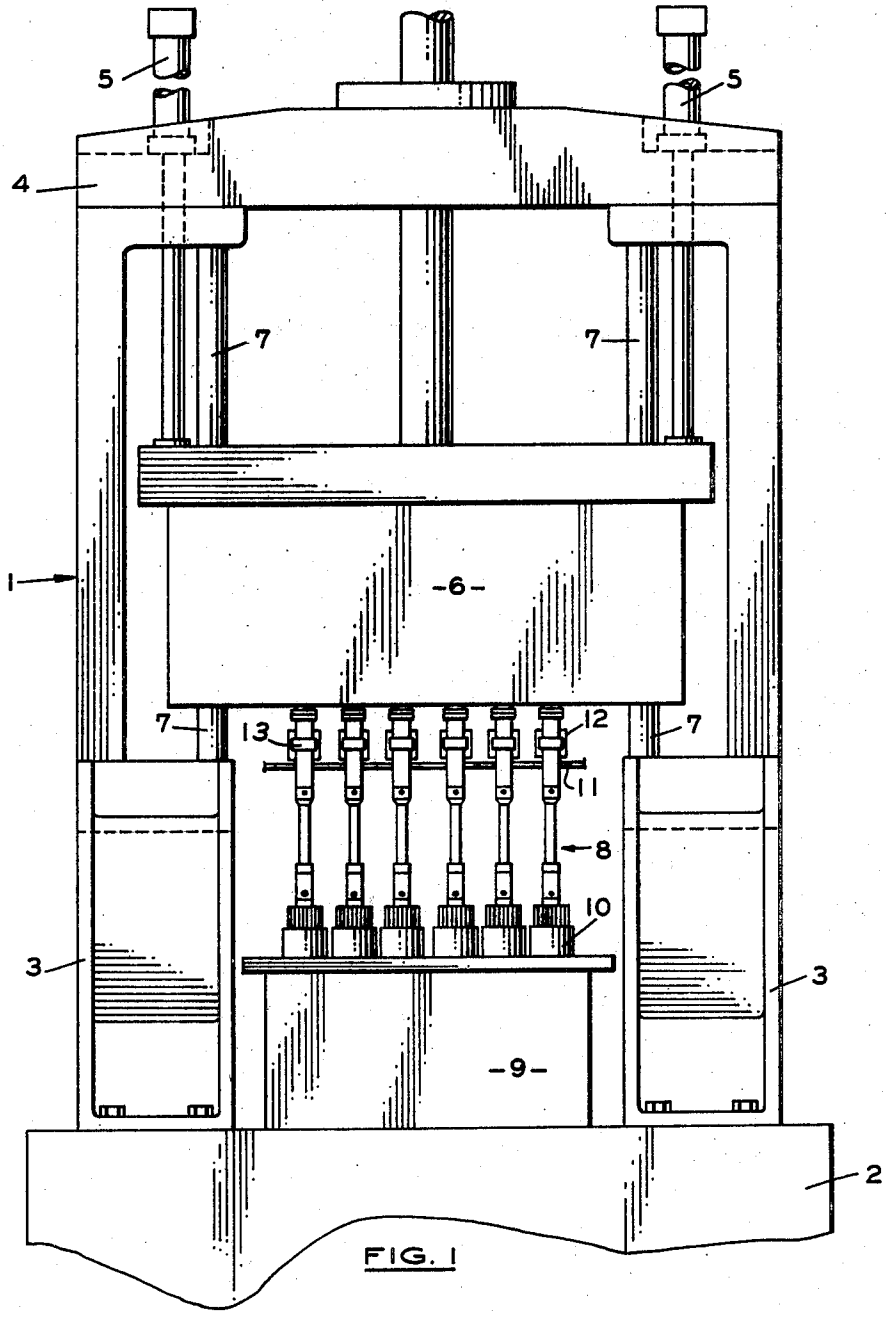

FIG. 1

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FIG. 2

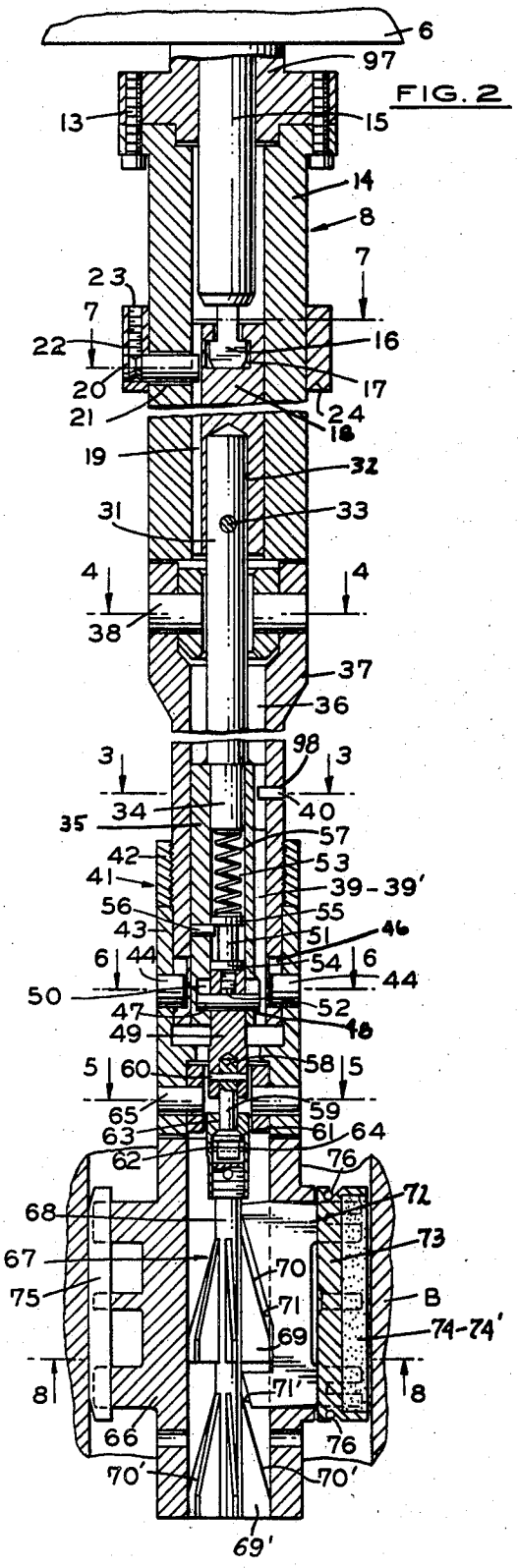

FIG. 3

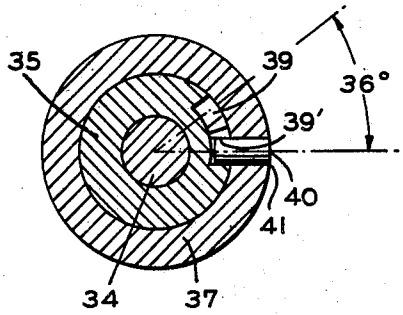

FIG. 4

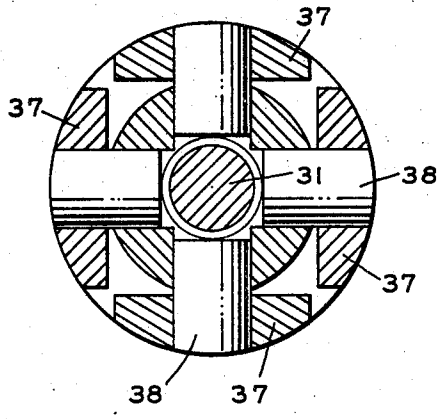

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FIG. 5

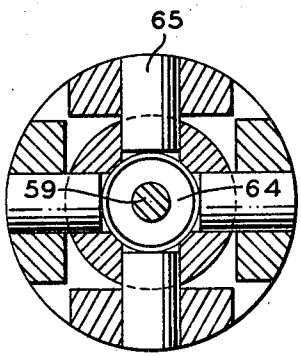

FIG. 6

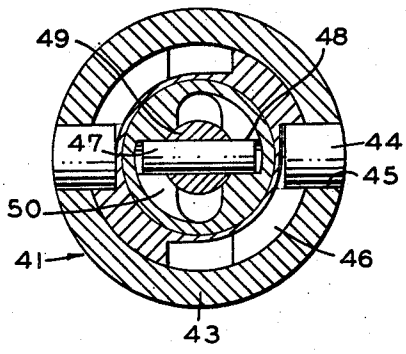

FIG. 7

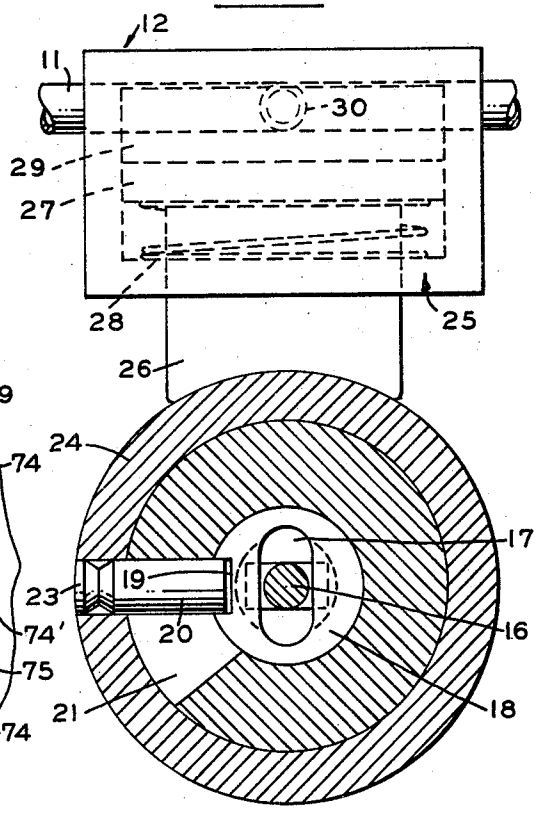

FIG. 8

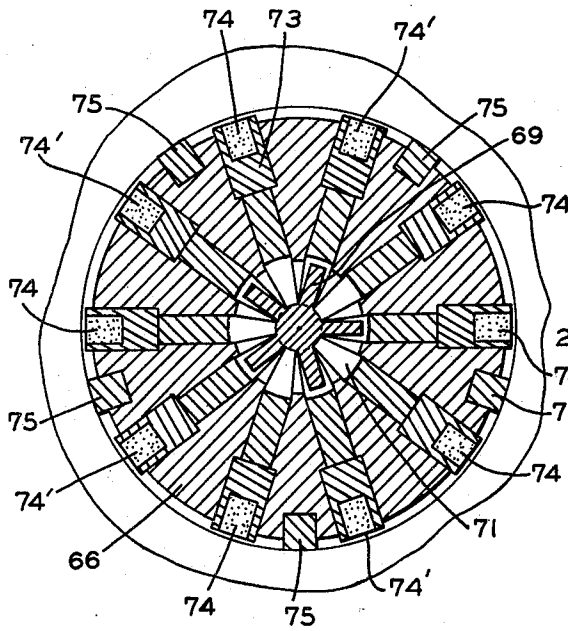

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FIG. 9

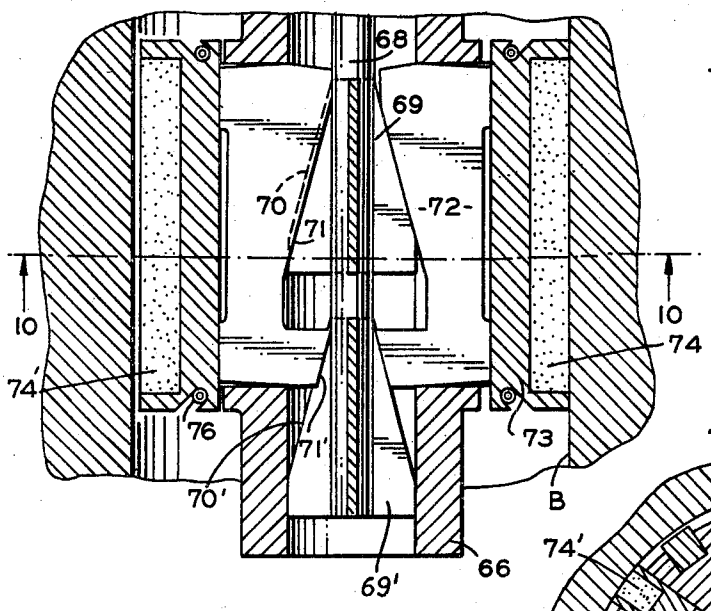


FIG. 10

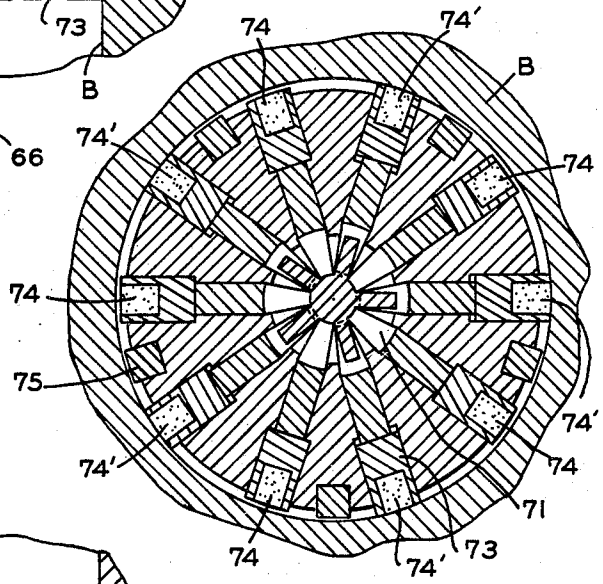
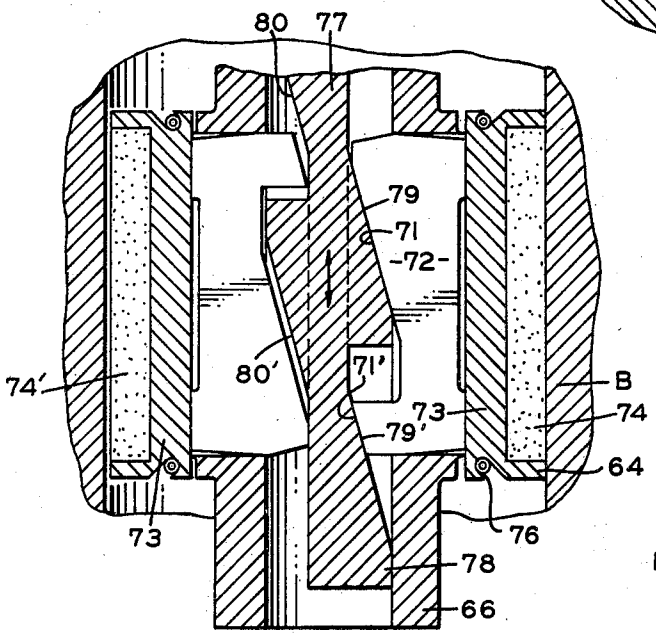


FIG. 11



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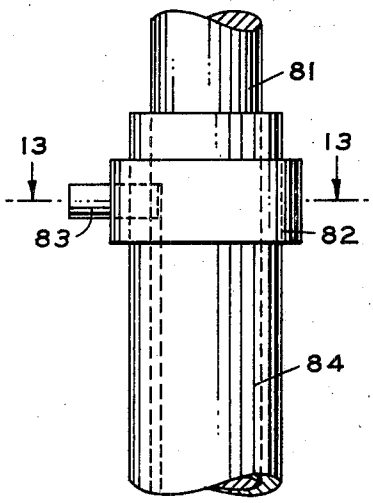


FIG. 12

FIG. 13

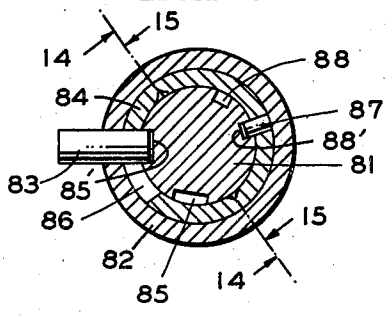


FIG. 14

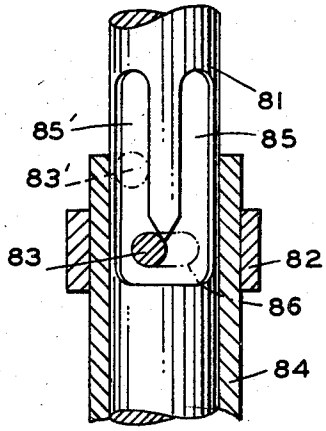


FIG. 15

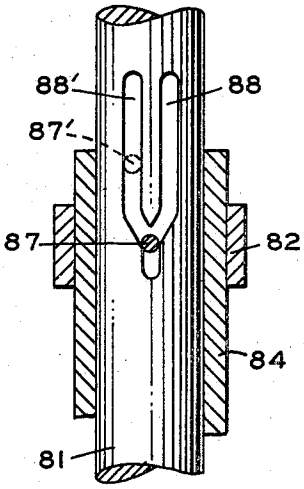
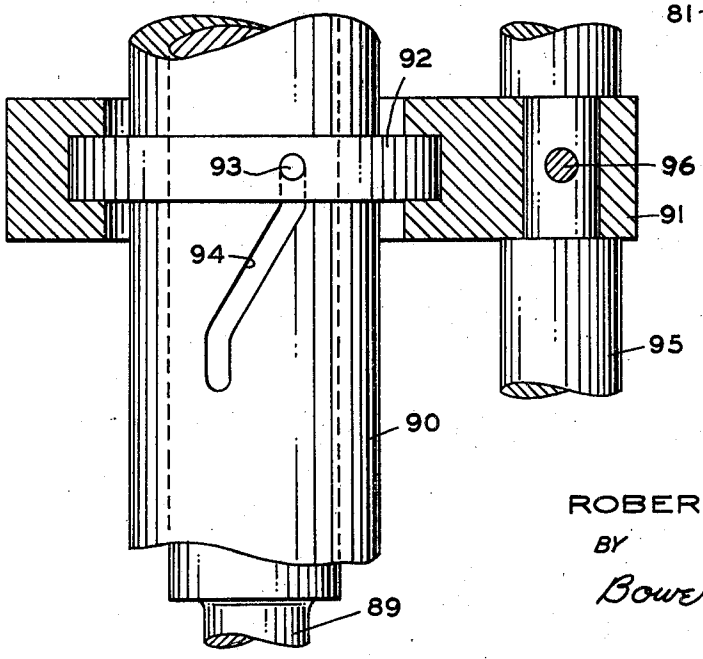


FIG. 16



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3,496,678

ROUGH AND FINISH HONING TOOL

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Int. Cl. B24b 7/00, 9/00, 9/02
U.S. Cl. 51—34 9 Claims

ABSTRACT OF THE DISCLOSURE

A honing tool having a bladed cone means mounted within the honing tool body, whereby movement of the cone means determines the expansion of a desired set of either rough abrasive honing stones or finish abrasive honing stones.

This invention relates to a unitary rough and finish honing tool, and especially for automatically or manually adjusting the position of the cone assembly to effect radial movement either of the rough honing stones or the finish honing stones.

The principal object of this invention is to provide a honing tool which will first expand and rotate the rough honing stones for a short period of time, retract the rough honing stones, then expand the finish honing stones until a preselected finish has been effected.

The object of this invention is to provide rough and finish honing with the use of one tool per bore in an integrated cycle.

Another object of this invention is to provide roughing and finishing a cylinder bore by first expanding coarse grit stones for high stock removal, and following, expanding fine grit stones for final bore size, finish and geometry.

Other objects, features and advantages become apparent from the following description taken in conjunction with the drawings, wherein:

FIG. 1 is a front elevational view of multiple spindle honing machine,

FIG. 2 is a cross-sectional view of one of the honing tools shown in FIG. 1,

FIG. 3 is a cross-sectional view taken along line **3—3** of FIG. 2,

FIG. 4 is a cross-sectional view taken along line **4—4** of FIG. 2,

FIG. 5 is a cross-sectional view taken along line **5—5** of FIG. 2,

FIG. 6 is a cross-sectional view taken along line **6—6** of FIG. 2,

FIG. 7 is a cross-sectional view taken along line **7—7** of FIG. 2,

FIG. 8 is a cross-sectional view taken along line **8—8** of FIG. 2, showing the honing stones in retracted position,

FIG. 9 is a cross-sectional view of the honing tool, showing one stone expanded by the cone and blade and the other stone being in its retracted position,

FIG. 10 is a cross-sectional view of the honing tool taken along line **10—10**, showing one set of honing stones expanded while the other set remains unexpanded,

FIG. 11 is a modification of the honing tool showing the honing stones being expandable by vertically adjusting the cone rod,

FIG. 12 is a front elevational view of another modification of the cone rod adjustment,

FIG. 13 is a cross-sectional view taken along line **13—13** of FIG. 12.

FIGS. 14 and 15 are cross-sectional views taken along lines **14—14** and **15—15**, respectively, and

FIG. 16 is a front elevational view of a further modification of the cone adjusting mechanism.

Previously rough and finish honing with two machines

was the accepted way to hone cylinder block bores. Next, improvements in honing equipment made it possible to do a satisfactory job with only one honing operation. As the cylinder bore walls got thinner and thinner, it became necessary to use softer stones and longer cycles to get the required accuracy of core size, finish and geometry. This type of operation increased the cost of honing to a point where many companies tried to limit the stock left by controlling previous grinding operation more closely. In a few cases, the automatic size control equipment was removed and "time cycle" or "stroke" honing was substituted.

Other honing tools included rough honing stones underneath a set of finish honing stones on the same shaft, and the finish honing would follow the rough honing by moving the shaft vertically; however, this became unfeasable for certain type of bores with bore length restrictions.

To overcome this difficulty, special honing tools have been developed which contain both "roughing" and "finishing" abrasive sticks, designed so that only one set is expanded at one time. The expansion is accomplished by several ways; by reverse direction of spindle rotation, by vertical movement of the cone push rod, or by manual adjustment which automatically presets the spindle blades. The preferred embodiment being the reversal of spindle rotation. The change in tool rotational direction presets a mechanism in the tool so that the finishing stones will be expanded as the feed rate is applied. As the bore size is reached, the finishing stones collapse, after which the tools are lifted out of the bore. This change is done automatically and occurs within a time limit of a few seconds.

The special tool, containing both rough- and finish-honing sticks, automatically expands either group (depending on the direction of the tool's rotation) at predetermined feed rates. Rotating clockwise during the roughing cycle, the tool collapses its set of "roughing" stones as soon as preliminary bore size is reached. Immediately, the rotation of the tool is reversed and the tool begins expanding the "finishing" set of abrasives. Automatic sizing takes place in both the roughing and finishing sequences, and incorporates bore gauging devices of the type disclosed and patented in U.S. Patents 3,059,381, issued Oct. 23, 1962, 2,821,049, issued Jan. 28, 1958, and 2,284,325, issued May 26, 1942.

The switchover from the roughing to the finishing sequence is immediate, that is, without an interruption in the tool's reciprocation, or the need to withdraw the tool from the workpiece. Initial expansion of the abrasives (in both roughing and finishing sequences) is rapid until the stones touch the work surface. At this instant, the expansion becomes controlled by the regular feed mechanism at pre-set roughing or finishing rates, respectively.

This invention is directed to a method of applying rough and finish honing on a single machine, incorporating automatic size control, which is shown by Patents Nos. 2,284,325 issued May 26, 1942; 2,777,257 issued Jan. 15, 1957; 2,777,321 issued Jan. 15, 1957; 2,821,049 issued Jan. 28, 1958; 3,059,381 issued Oct. 23, 1962. The honing tool is exemplified by Patents 2,383,657 issued Aug. 28, 1945, and 2,998,682 issued Sept. 5, 1961.

Referring now to the drawings, FIG. 1 shows an abrading machine **1**, having a base **2**, on which columns **3** are securely mounted thereon. The columns extend upwardly with a crosshead **4** mounted at the top. Stroke cylinders **5**, mounted on the crosshead **4**, extend downwardly to reciprocate spindle head or carriage **6**, which houses the spindle drive mechanism. The spindle drive mechanism controls the rotating drive to the honing tools **8**. Guide bars **7** maintain the spindle head **6** in proper alignment with the cylinder bores **10** of the workpiece **9**. A pneumatic line **11** extends rearwardly of the honing tools and

is connected with a friction device **12**, the purpose of which will be hereinafter described. FIG. 2 shows a sectional view of the honing tool **8** and illustrates the preferred embodiment of the invention. Honing tool **8** is connected to tool spindle **97** and, therefore, adapted to be drivingly connected to the rotating drive source (not shown) of the spindle drive mechanism. The tool spindle, therefore, is adapted for rotation about a longitudinally extending axis thereof and within a generally cylindrical bore **10** of the workpiece **9**. Honing tool **8** is connected to the spindle **97** by conventional means, as by threaded bolts **13** which mount the outer sleeve **14**, thereby providing for removal of the entire honing tool **8** from the spindle head. The vertical push rod **15** extending through the spindle head **6** has at its lower end a quick disconnect T-connector **16** which fits into T-slot recess **17** of center pivotal plug **18**. Movement of the vertical push rod causes the expansion of the honing stones in a manner as will be hereinafter described. Vertical movement of push rod **15** moves center pivotal plug **18** with respect to outer sleeve **14**. The center pivotal plug **18** has a vertical recess **19**, in which one end of pin **20** extending through the outer sleeve **14**, slides therein. As shown in FIG. 7, pin **20** slides horizontally a limited distance in opening **21** of outer sleeve **14**, but is retained in horizontal position by a threaded retaining screw **22** in circular opening **23** of ring **24** (see FIG. 2).

To effect slidable movement of ring **24**, and thereby select the proper honing stones to be expanded, a friction device **12** is mounted on the carriage **6**. Shown in FIG. 7, friction device **12** consists of a block **25** which houses a friction shoe **26** slidable in block **25** and includes an outer curved surface which abuts the outer curved surface of the ring **24**. The friction shoe **26** is retained in block **25** by an enlarged end **27** and restrained by spring **28**. It is apparent that fluid pressure through pneumatic line **11** will enter recess **29** through port **30**, causing the friction shoe to move and frictionally engage the outer ring **24** in a manner and for the purpose which will be described hereinafter.

As shown in FIG. 2, vertical movement of push rod **15** slides the center pivotal plug **18** vertically within the outer sleeve **14** for the purpose of expanding the honing stones against the surface of the bore by the following structural means. A cone push rod **31** is fitted into recess **32** of center pivotal plug **18** and is retained therein by pin **33**. Cone push rod **31** extends downwardly and terminates in a smaller diameter portion **34**. The junction between the smaller diameter portion and the larger diameter portion is connected to the blade orientation plug **35**. The blade orientation plug **35** is vertically slidable in longitudinal bore **36** of drive shaft **37**. The drive shaft **37** is connected to the outer sleeve **14** by means of a universal or trunnion **38** (shown in FIG. 4) in order to provide for universal movement and thereby effect proper rotation of the honing stones, irrespective of eccentric geometry of the bore of the workpiece.

The actuating pressure, is applied by push rod **15**, plug **18**, cone push rod **31** and through cone orientation plug **35** expands the proper type of honing stones selected by the direction of rotation of the ring **24**.

The cone orientation plug **35**, as best shown in FIGS. 2 and 3, comprises a pair of longitudinal recesses or slots **39** and **39'**, being offset with respect to each other by an angle of 36 degrees. A cone orientation pin **40** extends through an opening **41** of the drive shaft **37** and terminates in one of the slotted recesses or slots **39** and **39'**. With the pin **40** in either of the slotted recesses **39** and **39'**, either the rough honing stones or the finish honing stones will be selected for expansion.

To provide for quick removal of only the tool body portion of the honing tool **8**, there is provided a universal adapter assembly **41**, retained by a lock nut **42**. The universal adapter assembly **41** comprises an outer shell **43** having a pair of diametrically opposite torque pins **44** which fit through openings **45** of the outer shell **43** and extend inwardly to matingly engage the lower portion of the drive shaft **37** by fitting into arcuate recesses or bayonet slots **46**. To positively lock the universal adapter assembly **41** in the honing tool **8**, and as best seen in FIG. 6, the adapter assembly is rotated 90 degrees. The push rod moves vertically with respect to the drive shaft **37** and the outer shell **43** of the universal adapter assembly, and therefore must be provided with a separate but conjunctive positive lock connection. This is accomplished by providing a vertical thrust pin **47** pressed through an opening **48** of the connecting link **49**. The thrust pin **47** also moves 90 degrees in arcuate recess or bayonet slot **50** in conjunction with the torque pins to positively lock the tool body portion to the honing tool **8**. To maintain the pin **47** in the slot **50** the pressure of the cone push rod is applied through a spring **57** and a retaining plug **51** having a set screw **52** axially connected to the connecting link **49** and movable in axial opening **53** of cone orientation plug **35**. The retaining plug **51** has a lower shoulder **54** and an upper shoulder **55** which permits limited longitudinal travel of the connecting link **49**. Pin **56**, pressed into the wall of the cone orientation plug **35**, permits only limited longitudinal travel of the retaining plug **51** between the upper and lower shoulder portions **54** and **55** respectively. The spring **57** maintains a compressive force on the retaining plug to prevent accidental withdrawal during assembly or disassembly operations of the honing tool body **66**. The other end of the connecting link **49** has a recess **58** in which one end of a second connecting link **59** is fittingly engaged therein and held by a pin **60** extending through the first connecting links **49**. The lower end of the second link **59** has an enlarged portion **61** which fits loosely in axial recess **62**, but is prevented from withdrawal by a narrow restricted opening **63** in the cone rod holding plug **64**. A universal **65** provides for universal action of the honing tool body **66** with respect to the honing tool **8**. As shown in FIG. 2, the tool body **66** is connected to the universal adapter assembly **41** by the universal **65**. The universal adapter assembly **41** is further connected to the drive shaft **37** which is subsequently connected to the outer sleeve **14** and, thence, to spindle **97**. Independently thereof, the cone rod shaft **68** of the cone-rod assembly **67** is threadedly fastened to the cone-rod holding plug **64**. The holding plug **64** is thence fastened to the first connecting link **49** by the second connecting link **59**, which is then fastened to the cone-push rod **31** by means of cone orientation plug **35**. The cone-push rod **31** is joined to push rod **15** by means of center plug **18**.

As described above, and as shown in FIG. 2, there is an independent relationship between the drive shaft means **14**, **37** and push rod means **15**, **31**. The push rod controls the expansion and contraction of the honing stones by means of vertical movement within the drive shafts **14**, **37** and, consequently, within the tool body **66**. The tool body, which is connected to the spindle head through universals **65** and **38**, rotates with the honing stones **74–74'**.

The cone rod assembly comprises a shaft **68** and an expander, the expander comprising two sets of wedge-shaped expander cams or cone-rod blades **69** and **69'** separated by longitudinally extending grooves and having inclined cam surfaces **70** and **70'** which engage the inclined cam surfaces **71** and **71'** respectively of the stone, expanding plates **72**. Mounted on the expanding plates **72** are stone holders **73**, see FIG. 8. Mounted within each stone holder is a honing stone **74** or **74'**. The honing stones are interspaced alternately around the cone rod, that is, for example **74**, denoting a rough grinding honing stone, **74'** denoting a finish grinding honing stone. Mounted on the tool body **66** are guides **75** which are interspaced around the periphery of the tool body to prevent abuse to the honing stone as it is being inserted and retracted from the bore **10** of a workpiece. As shown in FIGS. 8,

9 and 10, the cone surfaces of the wedge-shaped expander cams or cone-rod blades **69** and **69'** expand only one set of plates for each operation, thereby providing either a rough honing operation or a finish honing operation. During the actual honing operation, the transfer from one set of honing stones to the other set is accomplished automatically within a few seconds. As one set of expanded stones completes the initial honing operation, either through a timed cycle or by manual control, the cone push rod is retracted to its normal position, thereby retracting the one set of honing stones. After the cone orientation plug **35** is turned by means of ring **24** either automatically or manually, the other set of honing stones are expanded by vertical movement of the cone push rod. This is accomplished while the tool body is rotating at its operational speed. It is, therefore apparent that changing from the rough honing operation to the finish honing operation is done automatically in a matter of seconds.

For a modification of the combined rough and finish honing tool, FIG. 11 shows a modification of the cone rod assembly, showing the similar tool body **66** having expanding plates **72** with cam surfaces **71** and **71'**. Mounted on the expanding plates **72**, are holders **73** which contain honing stones **74** and **74'**. As with the preferred embodiment shown in FIGS. 2 through 10, the honing stones are retracted upon return of the cone rod to its normal position by means of retaining springs **76**. The modification which will expand either set of honing stones is directed to the push rod **77** with cone rod blades **78** having cam surfaces **79** and **79'** to engage the surfaces **71** and **71'**, respectively, of the expanding plates for the expansion of the rough honing stones, for example **74**, and having cam surfaces **80** and **80'** to engage the surfaces **71** and **71'** of the expanding plates for finish honing stones, for example **74'**. The expansion of either of the honing stones is accomplished by vertical movement of the cone push rod **77**. As readily seen from FIG. 11, upward movement of the cone push rod will expand one set of honing stones, and downward movement of the cone push rod will effect retraction of these honing stones and expansion of the other set.

FIGS. 12 through 15 show another embodiment of the cone-rod blade orientation, in which the cone push rod **81** is oriented by manually moving the ring **82** when the tool body **84** is stationary. Movement of the ring **82** causes pin **83**, which extends through slotted opening **86** of the tool body **84** into either of respective vertical orienting slots **85** and **85'** in the push rod **81**, to orient the cone rod blades to either the rough honing or finish honing blade position. The circumferential length of slot **86** is less than the distance between the center lines of the slots **85** and **85'**. As shown in dotted line of FIG. 14, pin **84'** extends into slotted recess **85'** of the cone push rod **31**. To provide proper orientation of the cone push rod **81** with respect to the tool body **84**, and to prevent eccentric or unbalanced forces in movement of the cone push rod, there is provided diametrically opposite to the first pin and slot arrangement, a second pin **87** slidable in either of the vertical slotted recess **88**, **88'** in the push rod **81**. As shown in FIG. 15 in dotted line, pin **87'** extends in slotted recess **88'** in conjunction with the pin **83'** extending in slotted recess **85'** of the cone push rod shown in FIG. 14.

Another embodiment is shown in FIG. 16 in which orientation of the cone push rod **89** with respect to the tool body **90** is accomplished by vertical movement of the bracket **91**. The bracket **91** is connected with an annular washer **92** in which pin **93** extends therethrough and slides within S-shaped slot **94** of the tool body **90** and in a vertical slot, not shown, in the cone push rod **89**. A rod **95** may be connected by pin **96** to the bracket **91** to provide an extensible handle if, for example, the honing tool stands too high for the operator to reach. The operator can grasp the handle of the rod **95** and move it vertically, either up or down, and thus effect the cone orientation to the desired blade position; however, the rod **95** may be moved by other means, for example, a motor.

The honing stones may be of any suitable type, for example, bonded abrasive consisting of any of the usual abrasives, such as silicon carbide or aluminum in its various forms, also diamonds, and the bond may be of any desired type, for example, vitrified ceramic bond, resinoid bond, including nautral and synthetic resins, rubber, or metal bond.

It will be apparent from the foregoing that the invention provides an improved method of honing workpieces which permits the work to be finished precisely to desired dimensions without interrupting the honing operation; that is, both rough honing and finish honing cycles are accomplished on the same tool. The improved apparatus is simple and rugged in construction, and yet adapted to provide extremely accurate measure of the work size. If desired, gauging apparatus may be incorporated giving a continuous indication of size available, thus providing for accurate gauging of a bore or the like during the entire operation. Moreover, a cylindrical workpiece may be gauged accurately throughout its length with a minimum of effort on the part of the operator and without loss of time. As a matter of convenience, the gauging apparatus may be incorporated directly into the tool, such as described in Patent 2,284,325, issued May 26, 1942.

OPERATION

In placing the machine in operation, the work is secured in place on the work support and limit stops (not shown) are set to define the desired working stroke of the tools. After the machine has been preliminarily set in the above manner, it is started by the operator by pressing the start button (not shown). The spindle head moves downwardly until it reaches the preliminary limit stop when the tools have fully entered into the work. The honing operation commences when the motor is energized, thus causing rotation of the honing tool. The cone rod shaft is then moved upwardly to expand first the rough honing stones. During the initial rough honing cycle the tools are traversed repeatedly from one end of the work to the other. After a preselected time interval in which the rough honing stones have removed a portion of the bore surface, the cone rod shaft is lowered, thereby effecting retraction of the rough honing stones. At this instant, energization of the valve (not shown) allows pneumatic fluid to effect movement of the friction shoe against the cone orientation pin into the other of the two longitusure of the friction shoe sliding against the outer ring causes the outer ring to drag behind the outer sleeve when the direction is reversed, thus effectively orienting the cone orientation pin into the other of the two longitudinal slots of the orientation plug. While the spindle is now rotating in the reverse direction, the cone push rod shaft is moved upwardly. Since the cone orientation pin is now sliding in the other longitudinal slot of the orientation plug, the finish honing stones will thus be expanded. After a preselected time interval of the finish honing cycle, the cone rod shaft is lowered, thereby rectracing the finish honing stones. The tools are then raised from the bores of the workpiece by the spindle head in preparation for the next workpiece.

While the invention may be performed in various ways, the preferred embodiment is one in which the expansion from rough to finish honing stones is accomplished by a reverse direction of spindle operation. The change in tool rotational direction presets the mechanism in the tool so that the finishing stones will be expanded after the rough honing stones have been applied.

The following are some advantages in using the rough and finish tool with programmed hydraulic feed:

(1) Closer size control
(2) Improved bore roundness and straightness
(3) Reduced heat distortion

(4) Controlled surface finish
(5) Longer stone life (the stock-removal-to-stone-wear factor is improved 20%)
(6) Eliminates double handling and/or locating work part
(7) Eliminates need for additional machine and operator
(8) Conserves floor space
(9) Makes possible higher production rates
(10) Stone change is fast and simple.

The roughing and finishing tool performs very well and demonstrates the following capabilities:

(a) Better bore geometry is obtained with the rough and finish process than with a standard honing cycle, when each removes stock at the same rate. Roundness accuracies of .0004–.0006 are obtained with the rough and finish tool compared to .0009–.0012 for a single honing cycle (both removing stock at the rate of .005 per 30 seconds). Straightness is also improved with the rough and finish tool.

(b) Higher production rates are achieved with the rough-and-finish tool without sacrificing geometry. For example, the conventional honing cycle had to be reduced to a stock removal rate of .0025 in 30 seconds in order to achieve .0004–.0006 roundness accuracies (½ the rate that is obtained with the rough-and-finish tool).

(c) Stone selection is less critical with the rough-and-finish tool. Since free cutting, rough honing stones can be used until the bore reaches a predetermined size, the finishing stones can be selected to remove a constant amount of stock, and can be tailored more easily to achieve the desired surface finish and bore geometry.

(d) Less heat is generated in the rough and finish process. For example, in removing .005 in 30 seconds, the rough and finish operation produced a bore temperature of about 100° F., while conventional honing at the same rate produced a 140° F. bore.

(e) Stone economy of the rough and finish process is considerably improved over that obtained in a comparative test of a conventional honing cycle. The volume ratio obtained with the five roughing stones was about 58/1, and the five finishing stones was approximately 30/1 compared to a ratio of 25/1 for the conventional cycle when the stock removal rate was set at .005/30 seconds for the combined rough and finish sequence, as well as the conventional cycle.

It will be apparent from the foregoing that the invention described provides a honing tool of novel and advantageous character. The honing tool embodies novel means for expanding a plurality of rough honing stones while effectively maintaining a plurality of finish honing stones in reserve for the next cycle of operations; that is, after the rough honing cycle, the rough honing stones are retracted, and the finish honing stones are expanded.

It is to be emphasized that various equivalent changes may be made in the various elements which comprise the device and that these various elements may be integrated or separated without departing from the spirit of the invention or the scope of the appended claims, so long as the novel results are attained. In all cases, the drawings and descriptive material are to be interpreted as illustrative rather than limiting, and for a determination of the scope of the invention, attention is directed to the appended claims.

What I claim is:

1. A honing machine having, in combination, a hollow rotary body having a plurality of angularly spaced longitudinal slots, first and second sets of honing elements having abrasive surfaces of different characteristics disposed in said slots and alternating with each other around said body with said abrasive surfaces facing outwardly for engagement with a bore wall to be honed, each of said elements having a follower on its inner side, an expander disposed within and movable axially of said body through a preselected range of feed motion from a first position to a second position, said expander having a set of angularly spaced wedge-shaped cams selectively alineable with the followers of either set of honing elements and operable upon axial movement of said expander in one direction to feed the alined set of elements outwardly relative to said body, from a collapsed condition in said first position to a fully expanded condition in said second position, said cams being separated by longitudinal grooves for receiving the followers of the other set of elements during said feed motion, a section on said expander of circular cross-section merging smoothly with the smaller ends of said cams and level with the bottoms of said grooves, said followers engaging said section when said expander is in said first position, means for selectively turning said expander to bring said cams into alinement with the followers of either set of honing elements in said first position, and mechanism for moving said expander axially of said body in alinement with each selected set of elements.

2. A honing machine having, in combination, a hollow rotary body having a plurality of equally spaced longitudinal slots, first and second sets of honing elements having abrasive surfaces of different characteristics disposed in said slots and alternating with each other around said body with said abrasive surfaces facing outwardly for engagement with a bore wall, an expander disposed within and movable axially of said body and having a series of wedge-shaped cams angularly spaced apart for engagement with the inner sides of alternating elements around said body, said expander also having a plurality of angularly spaced longitudinal grooves separating said cams and adapted to be alined with the inner sides of alternating elements around said body, mechanism for selectively turning said expander in one longitudinal position thereof back and forth between a first angular position in which said cams are alined with the elements of said first set and a second angular position in which the cams are alined with the elements of said second set, and means for moving said expander axially relative to said body in both of said angular positions to feed said elements outwardly relative to said body.

3. A honing machine having, in combination, a rotary spindle, a hollow tool body on said spindle having a plurality of angularly spaced radial slots, first and second sets of honing elements having abrasive surfaces of different characteristics disposed in said slots and alternating with each other around said body, an expansion rod disposed within and reciprocable longitudinally of said spindle, an expander disposed within said body and movable with said rod, said expander having a plurality of angularly spaced cams thereon, mechanism for turning said rod and said expander selectively between two angularly spaced positions to aline said cams selectively with the respective sets of honing elements, and means for moving said rod and said expander axially back and forth relative to said body in each of said positions to control the feeding and retracting of the selected set of honing elements.

4. A honing machine having, in combination, a hollow rotary body having a plurality of angularly spaced longitudinal slots, first and second sets of honing elements disposed in said slots and alternating with each other around said body and having abrasive surfaces of different characteristics facing outwardly for engagement with a bore wall, an expander disposed within and movable axially of said body and having a single set of cams spaced angularly apart for engagement with the inner sides of each set of honing elements, said cams being operable upon movement of said expander in one direction to feed the alined set of elements outwardly relative to said body, means for turning said expander selectively between two angularly spaced positions in which said cams are alined with the inner sides of the respective sets of elements, mechanism for moving said expander axially of said body in both of said positions to feed the

selected set of elements, and means on said expander for disabling each set of elements when said cams are alined with the other set.

5. In an abrading machine, the combination of, an abrading tool, a pair of spaced abrading elements mounted on said tool for independent feeding and retracting movement, each of said elements having an outer abrading surface and an inner follower, an expander having a cam selectively alineable with either of said followers and shaped to move the alined follower outwardly upon movement of the expander in one direction and to permit retraction of the follower upon movement of the expander in the opposite direction, mechanism for selectively moving said cam into alinement with either of said followers, and means for moving said expander back and forth in alinement with each follower to control the feeding and retracting movement of said elements.

6. A honing machine having, in combination, a hollow rotary body having a plurality of angularly spaced longitudinal slots, first and second sets of honing elements disposed in said slots and alternating with each other around said body with abrasive surfaces facing outwardly for engagement with a bore wall to be honed, an expander disposed within said body and having a set of cams spaced apart for engagement with the inner sides of either set of honing elements, said expander being movable relative to said body through a preselected range of motion to feed said elements outwardly relative to said body, means for bringing said cams selectively into operative association with either of said sets of honing elements by a selecting motion transverse to said feed motion while disassociating said cams from the other set of honing elements, and mechanism for effecting said feed motion with said cams in operative association with each set of cams.

7. In an abrading device comprising:

(a) a rotatable honing tool;

(b) said honing tool including an outer sleeve terminating at its lower end in a honing tool body;

(c) said honing tool body having a longitudinal opening extending therethrough and including longitudinally extending circumferentially spaced slots;

(d) a plurality of abrasive honing stones, said honing stones including a set of rough abrasive honing stones and a set of finish abrasive honing stones;

(e) a plurality of plates for holding said abrasive honing stones, each of said plates holding each of said abrasive honing stones extending through said slots and terminating inwardly radially in inclined cam surfaces;

(f) unitary cone means extending within said longitudinal opening of said honing tool body, said unitary cone means including circumferentially spaced radially extending wedge-shaped blades;

(g) each of said wedge-shaped blades on said unitary cone means having inclined cam surfaces engaging corresponding inclined cam surfaces on each of said plates;

(h) a cone push rod extending longitudinally axially through said outer sleeve and honing tool body, and terminating at its lower end at said unitary cone means, said cone push rod adapted to be moved longitudinally axially within said outer sleeve and honing tool body; and

(i) means for partial rotation of said unitary cone means, relative to said honing tool body, whereby partial rotation of said unitary cone means determines the selective expansion of a desired set of abrasive honing stones.

8. In an abrading machine, comprising:

(a) a tool support means;

(b) a rotatable honing tool journaled on said tool support means;

(c) said honing tool including an outer sleeve terminating at its lower end in a honing tool body;

(d) said honing tool body having a longitudinal opening extending therethrough and including longitudinally extending circumferentially spaced slots;

(e) a plurality of abrasive honing stones, said honing stones including a set of rough abrasive honing stones and a set of finish abrasive honing stones;

(f) a plurality of plates for holding said abrasive honing stones, each of said plates holding each of said abrasive honing stones extending through said slots and terminating inwardly radially in cone engaging means;

(g) cone means extending within said longitudinal opening, said cone means including circumferentially spaced radially extending blades;

(h) said blades having inclined cam surfaces engaging corresponding inclined cam surfaces on said plates;

(i) a cone push rod extending centrally through said outer sleeve and terminating at its lower end at said cone means, said cone means being entirely within said honing tool body, and said cone push rod adapted to be moved within said outer sleeve; and

(j) means for moving said cone means, whereby movement of said cone means determines the expansion of a desired set of abrasive honing stones, said means for moving said cone means comprises:

(1) at least one pair of slotted recesses extending parallel to the longitudinal axis of said cone push rod; and

(2) a pin extending into said cone push rod and adapted to slide in either one of said pair of slotted recesses, whereby movement of said cone push rod determines the expansion of a desired set of abrasive honing stones.

9. In an abrading machine, comprising:

(a) a tool support means;

(b) a rotatable honing tool journaled on said tool support means;

(c) said honing tool including an outer sleeve terminating at its lower end in a honing tool body;

(d) said honing tool body having a longitudinal opening extending therethrough and including longitudinally extending circumferentially spaced slots;

(e) a plurality of abrasive honing stones, said honing stones including a set of rough abrasive honing stones and a set of finish abrasive honing stones;

(f) a plurality of plates for holding said abrasive honing stones, each of said plates holding each of said abrasive honing stones extending through said slots and terminating inwardly radially in cone engaging means;

(g) cone means extending within said longitudinal opening, said cone means including circumferentially spaced radially extending blades;

(h) said blades having inclined cam surfaces engaging corresponding inclined cam surfaces on said plates;

(i) a cone push rod extending centrally through said outer sleeve and terminating at its lower end at said cone means, said cone means being entirely within said honing tool body, and said cone push rod adapted to be moved within said outer sleeve; and

(j) means for moving said cone means, whereby movement of said cone means determines the expansion of a desired set of abrasive honing stones, said means for moving said cone comprises:

(1) an S-shaped slot in said tool body;

(2) an annular ring around said tool body;

(3) a pin extending through said slot and into said cone push rod, connected to said annular ring; and

(4) a bracket connected to said annular ring whereby movement of said bracket causes movement of said pin to slide in said S-shaped slot

and effect movement of said cone and determine the expansion of a desired set of abrasive honing stones.

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