July 29, 1958 G. M. CALVERT 2,844,920

HONING APPARATUS

Filed Aug. 13, 1956 3 Sheets-Sheet 1

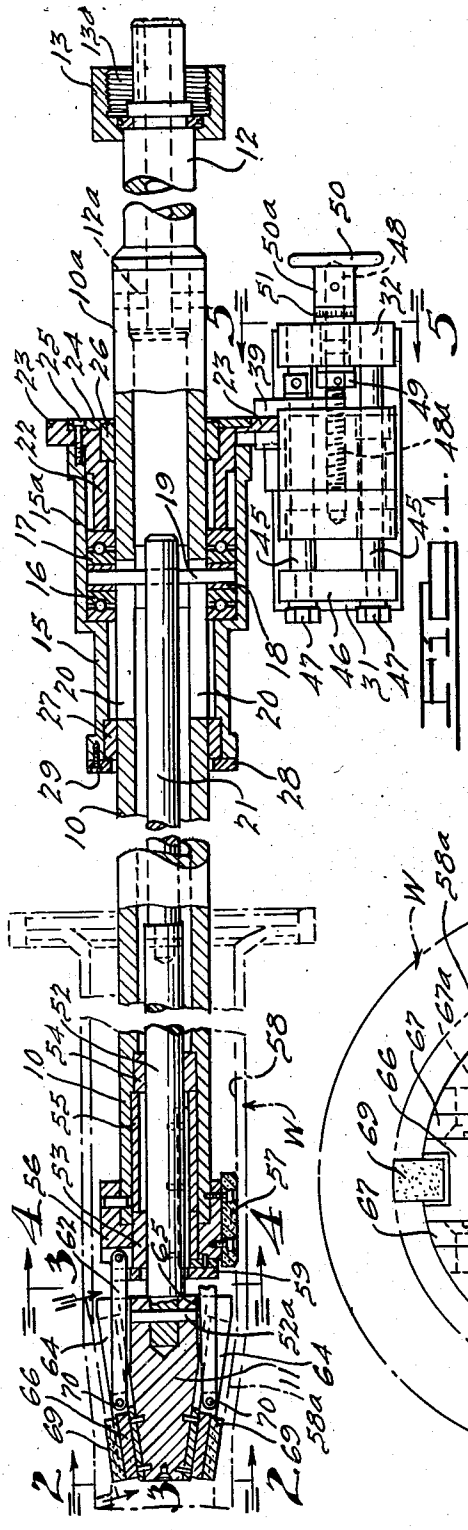


FIG. 1.

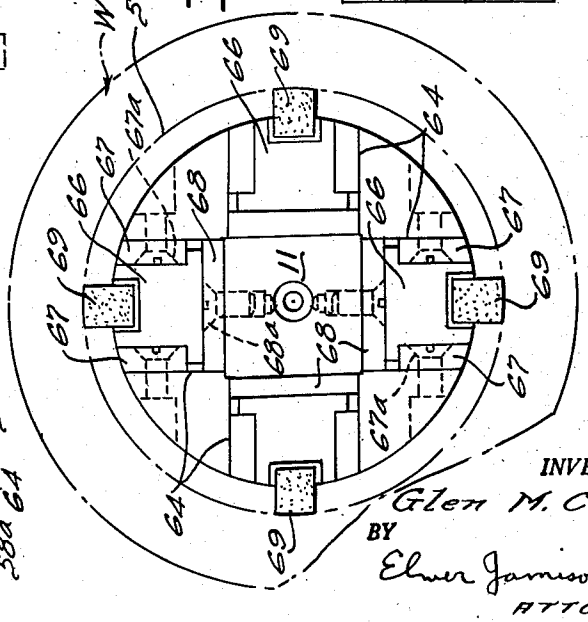


FIG. 2.

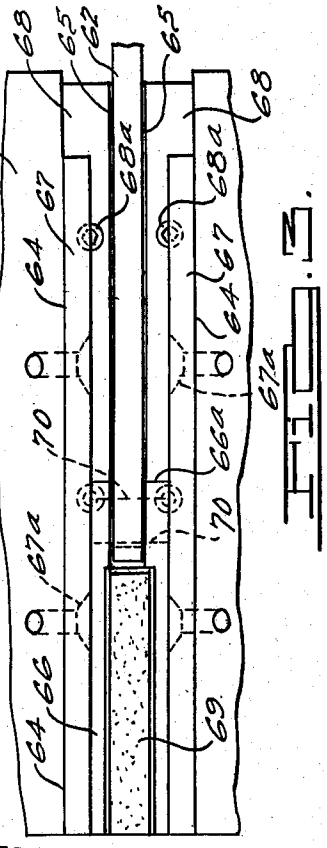


FIG. 3.

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HONING APPARATUS

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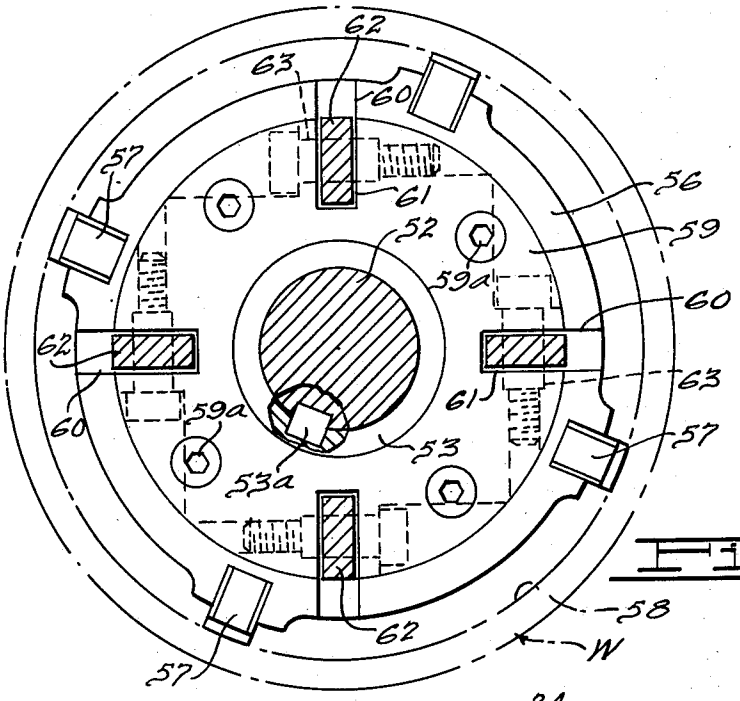


FIG. 4.

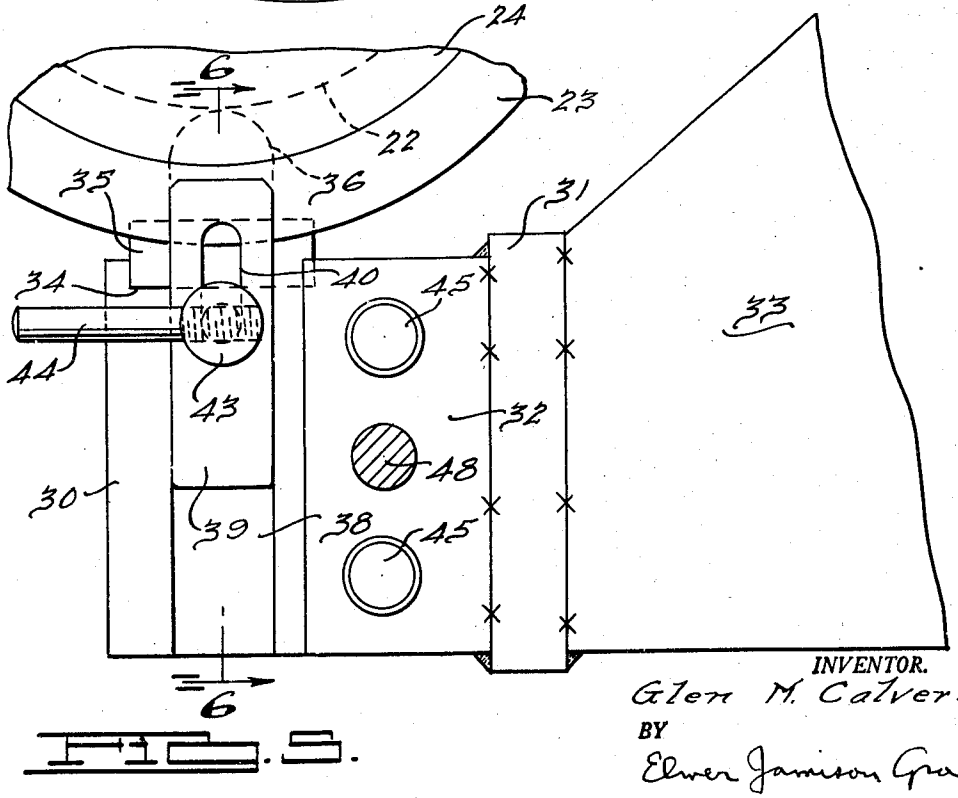


FIG. 5.

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HONING APPARATUS

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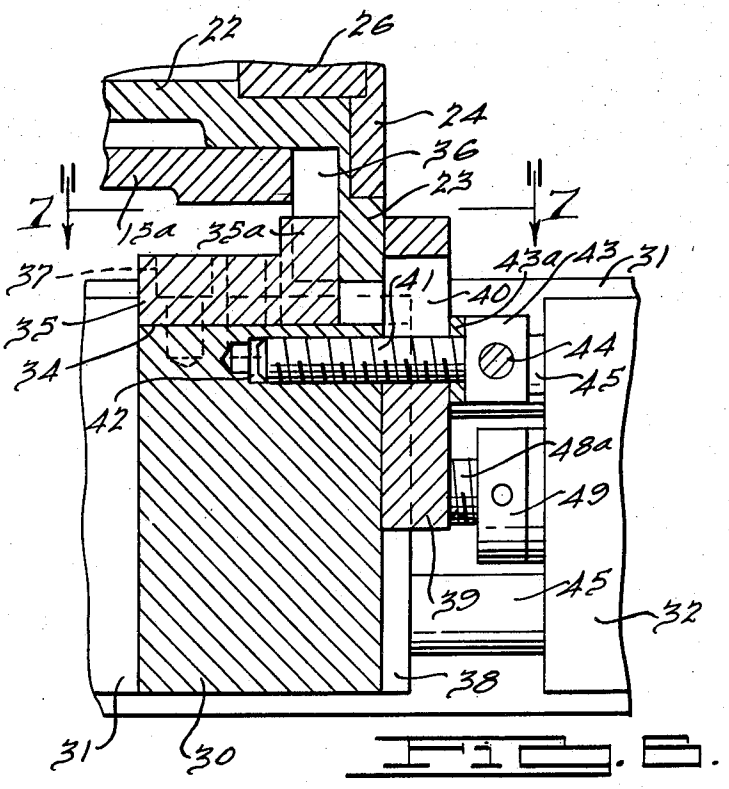


FIG. 1.

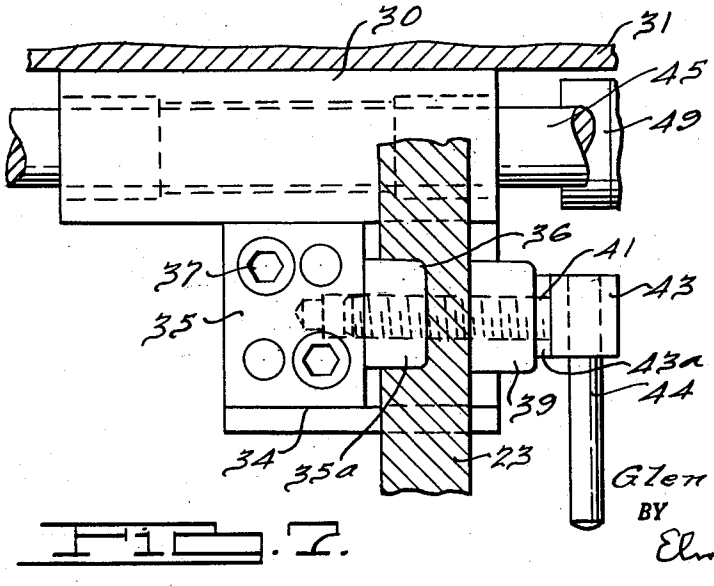


FIG. 2.

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HONING APPARATUS

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Application August 13, 1956, Serial No. 603,479

15 Claims. (Cl. 51—34)

This invention relates to honing apparatus and particularly to improvements and structural features adapted to be embodied in a honing tool for honing the tapered or cone shaped bore of a tubular workpiece.

An important object of the invention is to provide a honing apparatus or tool having rotatable spindle means guided for reciprocable travel in a straight line direction or in directions axially of the spindle means and in addition to provide honing means adapted to reciprocate and rotate with the spindle means, such honing means being so supported and connected to the spindle means as to enable the honing means to travel angularly with respect to the direction of travel of the spindle means so as to hone a tapered or cone shaped bore.

An additional object of the invention is to provide a honing apparatus or tool embodying, in addition to the foregoing features, means for imparting movement to or progressive displacement of the honing means in a direction axially of the spindle means thereby to cause the honing means to continue effective and uniform honing of the tapered bore and the removal of stock therefrom until the bore has been honed to a predetermined size.

In accordance with the embodiment of the invention herein illustrated there is provided reciprocable and rotatable spindle means together with honing means rotatable with the spindle means. The honing means preferably includes a honing head held against reciprocable travel with the spindle means and having annularly spaced abrading elements actuated by the spindle means so as to enter first the end of the tapered bore having the largest diameter, travel therefrom in one direction to the end of the tapered bore having the smallest diameter, and thereupon travel in the reverse direction through the bore. In accomplishing the foregoing the abrading or honing head is provided with taper guide means conforming to the taper of the workpiece bore and adapted to shiftably support the abrading elements so that the working or abrading surfaces thereof also conform to the shape of the tapered or cone shaped workpiece bore thereby causing the abrading elements to have uniform contact with the bore at all times during reciprocation and rotation thereof by the spindle means.

The honing devices or abrading elements are drivingly connected to the tool spindle means for rotation and reciprocation therewith through the medium of longitudinal push and pull link means pivotally connecting each honing device to the tool spindle means. These link connections enable the angularly related abrading elements or honing devices, shiftably carried by the cone shaped honing head, to travel along the tapered or cone shaped bore of the workpiece while at the same time the honing tool spindle travels in a rectilinear path. In order to control the path of travel of the honing tool there is mounted adjacent the outer end of the tool an annular guide support carrying outwardly and radially projecting guide members formed, for example, of carbide material. These guide members rotatably engage and travel along

the inner surface of the rectilinearly disposed cylindrical bore of a giude. In the illustrated embodiment the cylindrical guide for the tool spindle comprises an integral extension of the cone shaped or tapered workpiece which is to be honed by the tool. It will be understood, however, that the cylindrical guide may be separate from the workpiece to be honed, and in such case the guide would be supported so as to terminate proximate to the enlarged tapered or cone shaped end of the workpiece.

For the purpose of enabling the abrading elements or honing stones to maintain effective honing action on the tapered workpiece bore during the period that removal of stock from the bore continues, there is connected to the honing head one end of a shaft or rod extending axially within the tubular spindle means. The opposite end of this shaft or rod is connected to improved mechanism which may be adjustably operated to move the shaft or rod axially of the spindle means thereby adjustably moving the honing head axially of the workpiece bore. Such axial adjustment or movement of the shaft or rod in one direction maintains effective honing action by the honing stones or abrading means, whereas axial adjustment or shifting of the shaft or rod together with the honing head in the opposite direction frees the abrading means from the workpiece bore and thereby terminates the honing operation.

In the illustrated embodiment there is provided stationary manually operable mechanism for dimensionally adjusting the honing or abrading head axially of the workpiece bore, such mechanism being adapted to have operative connection with the adjusting shaft or rod which in turn is connected to the honing head. This operative connection is such as to enable it to be released or disconnected from the adjusting shaft whereby the entire honing mechanism may be withdrawn from the workpiece or shifted in a direction entirely away from the operating zone of the honing tool. It will be understood that power controlled means may be utilized to axially adjust the honing head and that termination of the honing operation may be initiated or controlled by actuation of a limit switch thereby resulting in freeing the abrading means from the workpiece bore.

Other objects of this invention will appear in the following description and appended claims, reference being had to the accompanying drawings forming a part of this specification wherein like reference characters designate corresponding parts in the several views.

Fig. 1 is a fragmentary view, mainly in longitudinal mid-section, illustrating a honing apparatus constructed in accordance with the present invention.

Fig. 2 is an enlarged front end elevation taken from lines 2—2 of Fig. 1 looking in the direction of the arrows.

Fig. 3 is an enlarged fragmentary plan view taken from lines 3—3 of Fig. 1 looking in the direction of the arrows.

Fig. 4 is an enlarged sectional view taken substantially through lines 4—4 of Fig. 1 looking in the direction of the arrows.

Fig. 5 is an enlarged fragmentary sectional view taken substantially through lines 5—5 of Fig. 1 looking in the direction of the arrows.

Fig. 6 is an enlarged fragmentary sectional view taken substantially through lines 6—6 of Fig. 5 looking in the direction of the arrows.

Fig. 7 is a sectional view taken substantially through lines 7—7 of Fig. 6 looking in the direction of the arrows.

Before explaining in detail the present invention it is to be understood that the invention is not limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawings, since the invention is capable of other embodiments and of being practiced or carried out in various ways. Also

it is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation.

In the drawings there is illustrated a honing tool or apparatus which is attachable at its upper or inner end to the conventional machine spindle. The honing tool, depending upon the type of machine with which it is used, may extend either vertically, or at an angle such as 45°, or horizontally. In the present instance the tool operates in a vertical position, although it is understood that this is merely for illustrative purposes.

In accordance with the present embodiment the honing mechanism is provided with a tubular honing tool spindle or drive shaft **10** at the outer end of which is supported a tapered or cone shaped abrading or honing head **11** forming a taper guide for the honing devices as hereinafter described. A tool spindle driving sleeve **12** has one end thereof fitting into the end **10***a* of the spindle and attached thereto by locking pins **12***a*. Secured to the driving sleeve **12** is an attaching collar **13** provided with internal threads **13***a* through the medium of which the collar **13** may be screwed onto the end of the machine spindle (not shown) which is operated in conventional manner to both reciprocate and rotate the honing tool spindle or drive shaft **10**.

Embracing the spindle **10** is a non-rotatable cylindrical sleeve **15** having a cylindrical section or portion **15***a* of enlarged diameter. Mounted within the sleeve portion **15***a* are longitudinally spaced ball bearing races **16** and **17**. A bearing ring **18** is interposed between the ball bearing races **16** and **17**, this bearing ring being free to rotate within the sleeve portion **15***a*. A transverse driving or adjusting pin **19** has opposite ends press fitted into holes in the bearing ring **18**. This driving or adjusting pin **19** passes freely through opposed longitudinal guide slots **20** in the spindle **10**, this construction enabling the spindle to be reciprocated relatively to the pin **19** and also enabling this pin to be adjusted along the slots **20** longitudinally of the spindle **10**. A honing or abrading head adjusting rod or draw bar **21** is connected at its rear or upper end to the pin **19**, this pin extending through a hole in the rod **21** and having a press fit therein.

A cylindrical spacer member **22** is interposed between the portion **15***a* of the sleeve **15** and the spindle **10**, this member being spaced from the spindle and terminating at its rear end in an enlarged diameter flange **23**. A retainer ring **24** is seated in an annular depression formed at the end face of the flange **23**, this retainer ring being attached to the flange **23** and also to the end of the sleeve portion **15***a* by attaching screws **25**. A bearing ring **26** is mounted between the spacer member **22** and the spindle **10**, this bearing ring being held in position by means of the retainer ring **24** and the edge of an annular recess formed in the spacer member **22**. A forward bearing ring **27** is disposed between the forward end of the sleeve **15** and the tool spindle **10**. This bearing ring is disposed within an annular recess in the sleeve **15** and is held in place by means of a retainer ring **28** freely embracing the spindle **10** and attached to the end of the sleeve **15** by screws **29**. It will be noted that the sleeve **15** and spacer member **22**, which are attached together, are non-rotatable. However, they are connected to the rotatable spindle **10** for longitudinal adjustment relative thereto by the adjusting or driving pin **19** and bearing ring **18** which rotate with the spindle. Adjustment of pin **19** longitudinally within the guide slots **20** results in adjusting the draw bar **21** longitudinally.

The honing head adjusting rod or draw bar **21** is adjusted axially and within the spindle **10** by means of an adjusting slide **30**, Figs. 5 to 7, this slide being disposed in face to face relation to a bracket member or plate **31**. The bracket plate **31** terminates in a bracket extension member **32**, Figs. 5 and 6, these members **31** and **32** being welded together and the bracket member **31** being welded to a fixed frame riser **33**, see Fig. 5. The slide **30** is formed with an upper longitudinal channel or recess **34** within which a locating block **35** is fitted and secured. It will be noted that the lower arcuate edge of the spacer member flange **23**, see Fig. 5, terminates somewhat above the upper face of the adjusting slide **30**. The locating block **35**, see Figs. 6 and 7, is integrally formed with a projecting clamping member or block **35***a* of reduced width. This clamping member **35***a* is adapted to fit within a slot **36** in the spacer member flange **23**. The locating block is attached to the adjusting slide **30** within the channel **34** through the medium of anchor screws **37**. The slide **30** is provided at its rear face with a vertical channel or groove **38**, Figs. 5 and 6, adapted to receive a clamping member **39** which is vertically adjustable within the channel **38**. This clamp member is provided with a vertical slot **40** through which freely extends a clamping screw **41** adapted to be screwed into a threaded hole **42** in the slide **30**, see Fig. 6. The clamping screw **41** terminates integrally in an annular head **43** which, through a bushing **43***a*, overlies the slot **40** and is engageable with the clamp member **39** at opposite sides of the slot.

Attached to the screw head **43** is an adjusting rod **44**, Figs. 6 and 7, which is adapted to be manually grasped for the purpose of turning the clamping screw **41** and its head **43** so as either to tighten the clamp member **39** within the slot **38** or loosen it. When tightened the clamp member **39** in cooperation with the clamping member or block **35***a* operate to clamp therebetween the spacer member flange **23**, see Figs. 6 and 7. Upon loosening the clamping screw through the medium of the adjusting rod **44** the clamp member **39** may be shifted downwardly within the guide slot **38** so as to free it from abutting relation to the flange **23**. This operation results in releasing the operative connection between adjusting slide **30** and the spacer member **22**, **23** thereby enabling the entire honing mechanism to be withdrawn from the workpiece and shifted rearwardly relative to the adjusting slide in a direction away from the operating zone of the honing tool.

The slide **30** is adjustably supported on a pair of upper and lower longitudinal guide rods **45**, the rear ends of these rods being anchored in the frame bracket member **32**, Figs. 1 and 5. These guide rods are formed with reduced front ends projecting through holes in a front bracket **46** secured to the bracket member **31**. Clamping nuts **47** are attached to the threaded ends of the guide rods **45** and serve the purpose of clamping them in fixed positions to the front bracket **46**. Interposed between the guide rods **45** is a shaft **48**, this shaft extending through bracket member **32** and having a bearing therein, see Figs. 1 and 5. A stop collar **49**, Figs. 1 and 6, is pinned to the shaft **48** and is adapted to abut the stationary bracket **32**. The shaft **48** has a threaded extension **48***a* extending into a tapped hole in the adjusting slide **30**. For the purpose of turning the shaft **48** in order to adjust the slide **30** along the guide rods **45** there is provided a hand knob **50** having a shank **50***a* embracing the end portion of shaft **48** and pinned thereto. Secured to the end of the shank **50***a* is an annular thimble or ring **51** which is dimensionally marked. By turning the hand knob **50** to adjust the slide **30** toward or from the bracket or abutment **46** the extent of this adjustment may be determined accurately by the dimensional markings on thimble **51** and a fixed arrow or pointer.

In the present embodiment the adjusting rod or draw bar **21** is attached at its forward end to the rear end of a cone shaft **52**. The opposite reduced end of the cone shaft fits within a hole in the abrading head **11** and is pinned thereto at **52***a*. The cone shaft is mounted within front and rear bearings **53** and **54**, these bearings being interposed between the cone shaft and the spindle **10**. The front bearing **53** is keyed at **53***a*, see Fig. 4, to cone shaft **52**. The rear bearing **54** is held between

a shoulder on spindle **10** and a cylindrical bushing **55**. This bushing or bearing spacer engages at opposite ends thereof the bearing members **53** and **54**. Embracing the bearing **53** and also the forward end of the spindle **10** is an annular guide support **56**. This support has a bearing on the bearing member **53** and is counterbored to receive and fit over the forward end of the spindle **10** to which it is pinned. The guide support **56**, as shown in Figs. 1 and 4, carries four annularly spaced carbide guide inserts **57**, these inserts fitting into and being secured within slots in the guide support **56**. The guide inserts project outwardly and radially from the supporting member **56** and are adapted to engage the inner surface of the cylindrical bore portion **58** of the workpiece W. In the present instance this cylindrical bore **58** of the workpiece terminates in a tapered or cone shaped bore **58***a*. The front bearing **53** is held in position on the cone shaft **52** by means of a retainer plate or disk **59** secured at **59***a* to the forward end of the guide support **56**, see Fig. 4.

The guide support **56** is provided with four equally and annularly spaced radial slots **60** which mate with slots **61** in the retainer plate **59**, see Figs. 1 and 4. A series of four equally and annularly spaced push and pull links **62** have their rear ends disposed in the slots **60**, **61**. These links are pivoted at their rear ends to the guide support **56** through the medium of bearing screws **63** which enable the rear ends of the links **62** to have pivotal motion relative to the guide support **56**. The cone shaped abrading or honing head **11** is provided with four equally spaced tapering guide slots **64** which communicate at their rear ends thereof with rectilinear slots **65** extending into the abrading head **11** to receive the links **62**, see Figs. 1 and 3. The links **62** extend freely through the slots **64**, **65** and are pivoted at their forward ends by pins **70** to the rear ends **66***a* of stone holders **66**. As shown in Figs. 2 and 3, each stone holder **66** is disposed within a radial slot **64** in abrading head **11** and has a bearing at opposite sides thereof on a pair of side wear strips **67** attached by means of screws **67***a* to the abrading head **11**. Each stone holder engages and has a bearing on a bottom wear strip **68** also attached by screws **68***a* to the abrading head. Mounted and secured within slots in the stone holder **66** are four equally spaced radially extending abrading elements or honing stones **69**. These stones, as illustrated in Fig. 2, project outwardly from the abrading head **11** and terminate in arcuate working surfaces engageable with the inner surface of the tapered bore **58***a* of the workpiece. It will be understood that the base of each tapering slot **64** is parallel to the tapered bore **58***a* of the workpiece and in like manner the outer working surfaces of the abrading elements or honing stones **69** are inclined or tapered so as to correspond to the taper of the bore **58***a* of the workpiece. Accordingly, during reciprocation and rotation of the honing tool spindle **10** the abrading elements **69** will uniformly contact the tapered bore of the workpiece. This reciprocation and rotation of the honing tool spindle **10** is transmitted to the stone holders **66** and thence to the abrading elements or honing stones **69** through the medium of the push and pull links **62** which have articulate connections **63** and **70** at opposite ends thereby enabling the honing means to travel angularly in guide slots **64** with respect to the direction of travel of the spindle means so as to hone uniformly the tapered or cone shaped bore **58***a* of the workpiece.

The abrading or honing head **11** is adjustable longitudinally by means of the cone shaft **52** so as to progressively displace or shift the honing head in a direction axially of the spindle thereby enabling the stone holders **66** and the abrading elements or honing stones **69** carried thereby to continue uniform honing of the tapered bore **58***a* and the removal of stock therefrom until the bore has been honed to a predetermined size. For illustrative purposes the workpiece in the present instance comprises the cylindrical guide section **58** and the tapered section **58***a* which is to be honed. Thus, it will be seen that the section **58** serves as a guide for the honing tool spindle which is guided rectilinearly by guide members **57** adapted to reciprocate in guiding engagement with the cylindrical section **58** of the workpiece. In the event the workpiece is tapered as at **58***a* from end to end it will be understood that the workpiece and the cylindrical guide section **58** will be supported end to end and the guide section, which is separate from the workpiece, will serve the same purposes as in the embodiment herein illustrated.

I claim:

1. Honing apparatus for honing the tapered bore of a workpiece, comprising reciprocable and rotatable spindle means, guide means carried by said spindle means exteriorly of said bore for guiding the spindle means in a rectilinear path, said guide means being reciprocable and rotatable with the spindle means, honing means adapted to be disposed in the workpiece bore and rotatable with said spindle means, said honing means including a honing head held against reciprocable travel with said spindle means and provided with taper guide means conforming to the taper of the workpiece bore, and honing devices connected to said spindle means and shiftable thereby along said taper guide means for honing said bore.

2. Honing apparatus according to claim 1 including means for adjusting said honing head axially relative to said spindle means.

3. Honing apparatus for honing the tapered bore of a workpiece, comprising reciprocable and rotatable spindle means, guide means carried by said spindle means exteriorly of said bore for guiding the spindle means in axial alignment with the axis of the workpiece bore, said guide means being reciprocable and rotatable with the spindle means, honing means adapted to be disposed in the workpiece bore and rotatable with said spindle means, said honing means including a honing head held against reciprocable travel with said spindle means and provided with taper guide means conforming to the taper of the workpiece bore, honing devices shiftable along said taper guide means for honing said bore, and means for pivotally connecting said honing devices to said spindle means for reciprocable travel therewith relative to the honing head.

4. Honing apparatus according to claim 3 including means for axially adjusting said honing head relative to the workpiece.

5. Honing apparatus for honing the tapered bore of a workpiece, comprising reciprocable and rotatable spindle means, a honing head, shiftable rod means extending axially within said spindle means and connected at one end to said honing head, connecting means for connecting the opposite end of said rod means to said spindle means to provide for relative shiftable movement thereof axially of the spindle means together with rotation of the honing head with the spindle means, said honing head having annularly spaced tapered guide means conforming to the taper of the workpiece bore, annularly spaced honing devices shiftable along said tapered guide means for honing said bore, and means for pivotally connecting said honing devices to said spindle means for reciprocation and rotation therewith.

6. Honing apparatus for honing the tapered bore of a workpiece, comprising reciprocable and rotatable spindle means, a honing head, shiftable rod means extending axially within said spindle means and connected at one end to said honing head, connecting means for connecting the opposite end of said rod means to said spindle means to provide for relative shiftable movement thereof axially of the spindle means together with rotation of the honing head with the spindle means, said honing head having annularly spaced tapered guide means conforming to the taper of the workpiece bore, annularly spaced honing devices shiftable along said tapered guide means for honing said bore, and annularly spaced links pivotally

connected at opposite ends to said honing devices and spindle means for transmitting reciprocable and rotatable motion of the spindle means to said honing devices.

7. Honing apparatus for honing the tapered bore of a workpiece, comprising reciprocable and rotatable spindle means, a honing head, shiftable rod means extending axially within said spindle means and connected at one end to said honing head, connecting means for connecting the opposite end of said rod means to said spindle means to provide for relative shiftable movement thereof axially of the spindle means together with rotation of the honing head with the spindle means, said honing head having annularly spaced tapered guide means conforming to the taper of the workpiece bore, annularly spaced honing devices shiftable along said tapered guide means for honing said bore, means for pivotally connecting said honing devices to said spindle means for reciprocation and rotation therewith, and means for adjusting said connecting means thereby to adjust said rod means and honing head axially of the spindle means.

8. Honing apparatus for honing the tapered bore of a workpiece, comprising reciprocable and rotatable spindle means, a honing head, shiftable rod means extending axially within said spindle means and connected at one end to said honing head, connecting means for connecting the opposite end of said rod means to said spindle means to provide for relative shiftable movement thereof axially of the spindle means together with rotation of the honing head with the spindle means, said honing head having annularly spaced tapered guide means conforming to the taper of the workpiece bore, annularly spaced honing devices shiftable along said tapered guide means for honing said bore, means for pivotally connecting said honing devices to said spindle means for reciprocation and rotation therewith, and manually operable means supported laterally of the spindle means against movement therewith and having means engageable with said connecting means for adjusting the same thereby to adjust said rod means and honing head axially of the spindle means.

9. Honing apparatus for honing the tapered bore of a workpiece, comprising reciprocable and rotatable spindle means, a honing head, shiftable rod means extending axially within said spindle means and connected at one end to said honing head, connecting means for connecting the opposite end of said rod means to said spindle means to provide for relative shiftable movement thereof axially of the spindle means together with rotation of the honing head with the spindle means, said honing head having annularly spaced tapered guide means conforming to the taper of the workpiece bore, annularly spaced honing devices shiftable along said tapered guide means for honing said bore, means for pivotally connecting said honing devices to said spindle means for reciprocation and rotation therewith, manually operable means supported laterally of the spindle means against movement therewith and having means engageable with said connecting means for adjusting the same thereby to adjust said rod means and honing head axially of the spindle means, and means for disengaging said manually operable means and connecting means to permit axial movement of the spindle means, honing head and rod means relative to said manually operable means.

10. Honing apparatus for honing the tapered bore of a workpiece, comprising reciprocable and rotatable spindle means, honing means adapted to be disposed in the tapered workpiece bore and including a honing head disposed adjacent to but beyond one end of said spindle means, means for connecting said honing head to the spindle means for rotation therewith and also for holding the honing head against reciprocable travel with the spindle means, said honing head having taper guide means conforming to the taper of the workpiece bore and said honing means including a honing device, and means for pivotally connecting said honing device to said spindle means for travel along said guide means angularly with respect to the travel of the spindle means.

11. Honing apparatus for honing the tapered bore of a workpiece, comprising reciprocable and rotatable spindle means, a honing head, shiftable means connecting said honing head and spindle means to provide for relative shiftable movement of the honing head and spindle means together with simultaneous rotation thereof, said honing head having annularly spaced tapered guide means conforming to the taper of the workpiece bore, annularly spaced honing devices shiftable along said tapered guide means for honing said bore, and means for pivotally connecting said honing devices to said spindle means for reciprocation and rotation therewith.

12. Honing apparatus for honing the tapered bore of a workpiece, comprising reciprocable and rotatable spindle means, honing means adapted to be disposed in the workpiece bore and rotatable with said spindle means, said honing means including a honing head held against reciprocable travel with said spindle means and provided with annularly spaced taper guide means conforming to the taper of the workpiece bore, annularly spaced honing devices shiftable along said guide means for honing said bore, annularly spaced guide devices connected to the spindle means for rectilinear travel therewith, and link means pivotally connecting each honing device to a guide device for reciprocable travel therewith.

13. Honing apparatus according to claim 12 including means for axially adjusting said honing head relative to said honing devices.

14. Honing apparatus for honing the tapered bore of a workpiece, comprising reciprocable and rotatable spindle means, honing means adapted to be disposed in the tapered workpiece bore and including a honing head, interengaging means for connecting said honing head to said spindle means for rotation therewith, means for holding said honing head against reciprocable travel with said spindle means, said honing head having taper guide means conforming to the taper of the workpiece bore and said honing means including honing device means shiftable along said guide means for honing said bore, guide means connected to the spindle means for rectilinear travel therewith, and means for pivotally connecting said honing device means to said last named guide means.

15. Honing apparatus for honing the tapered bore of a workpiece, comprising reciprocable and rotatable spindle means, a honing head, shiftable rod means extending axially within said spindle means and connected at one end to said honing head, connecting means for connecting the opposite end of said rod means to said spindle means to provide for relative shiftable movement thereof axially of the spindle means together with rotation of the honing head with the spindle means, said honing head having tapered guide means conforming to the taper of the workpiece bore, honing device means shiftable along said tapered guide means for honing said bore, link means pivotally connected at opposite ends to said honing device means and spindle means for transmitting reciprocable and rotatable motion of the spindle means to said honing device means.

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