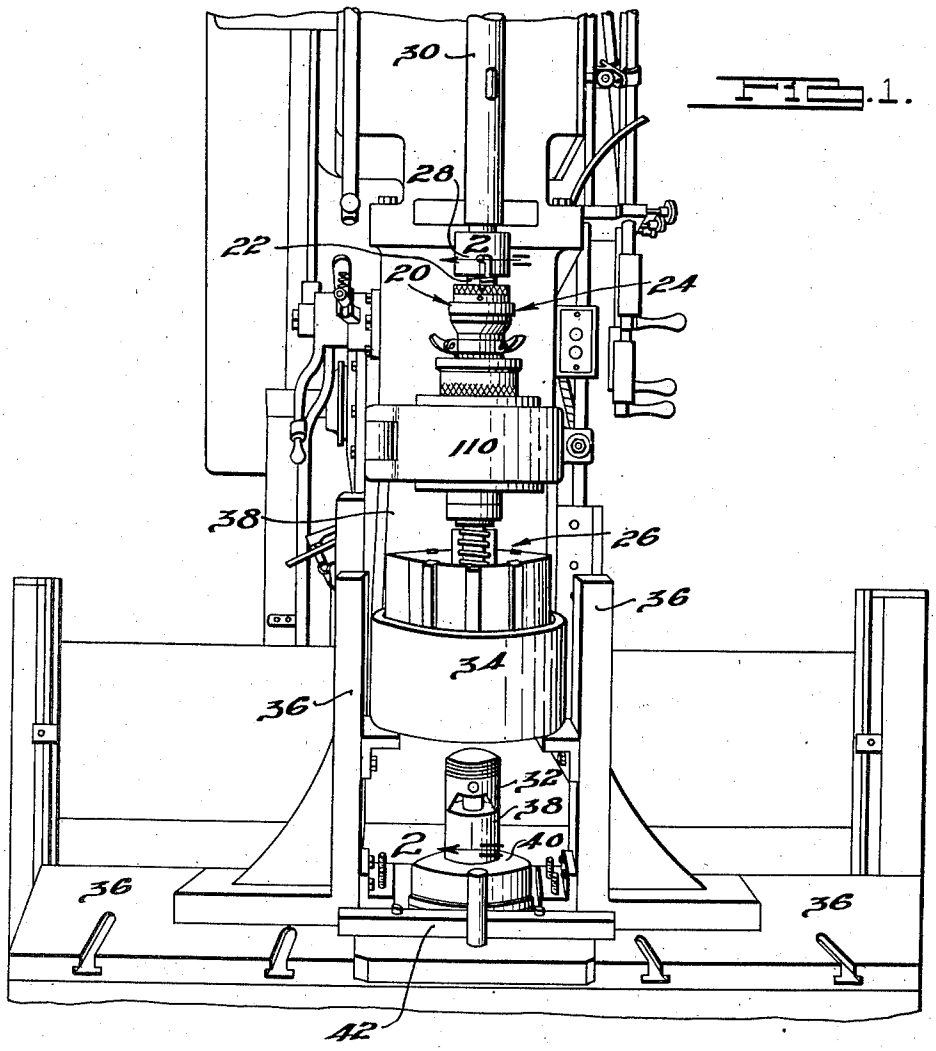
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MACHINE FOR GRINDING CYLINDRICAL AND EXTERNAL SURFACES

Filed Oct. 26, 1935 7 Sheets-Sheet 1

Fig. 1.



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Filed Oct. 26, 1935 7 Sheets-Sheet 2

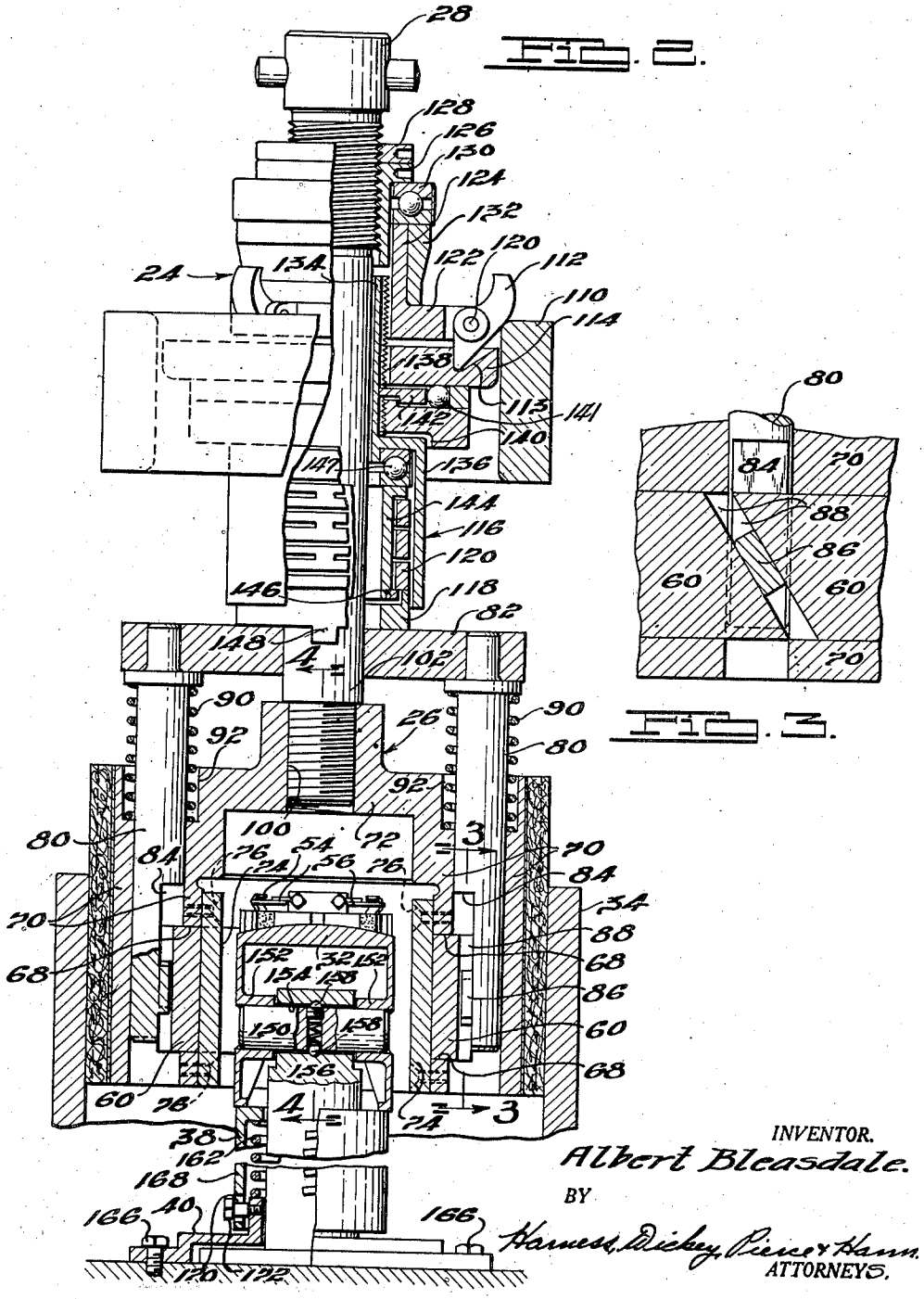


FIG. 2.

FIG. 3.

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MACHINE FOR GRINDING CYLINDRICAL AND EXTERNAL SURFACES

Filed Oct. 26, 1935 7 Sheets-Sheet 3

Fig. 4.

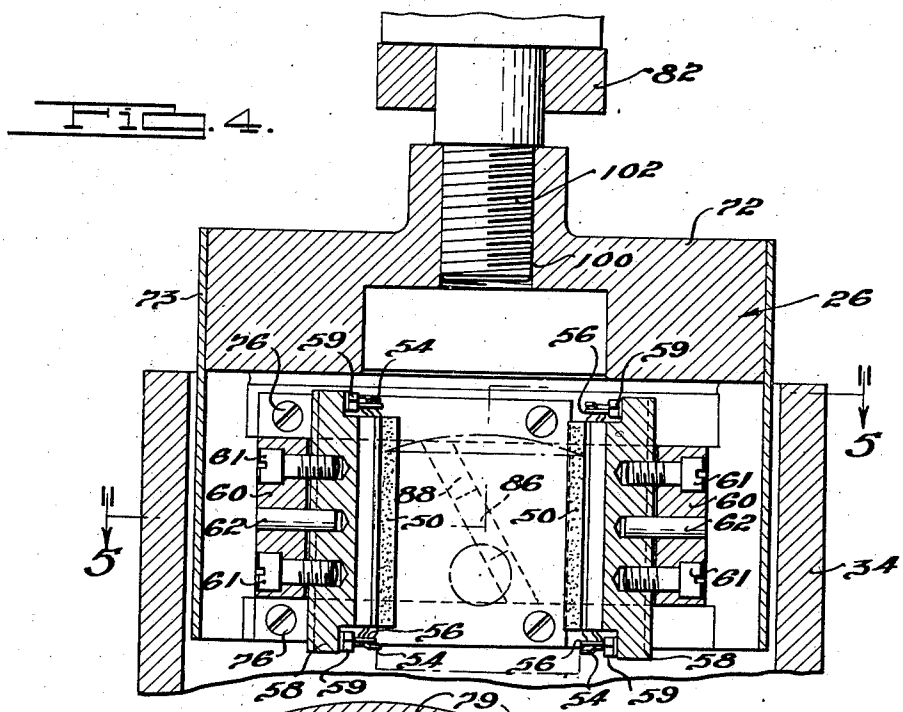
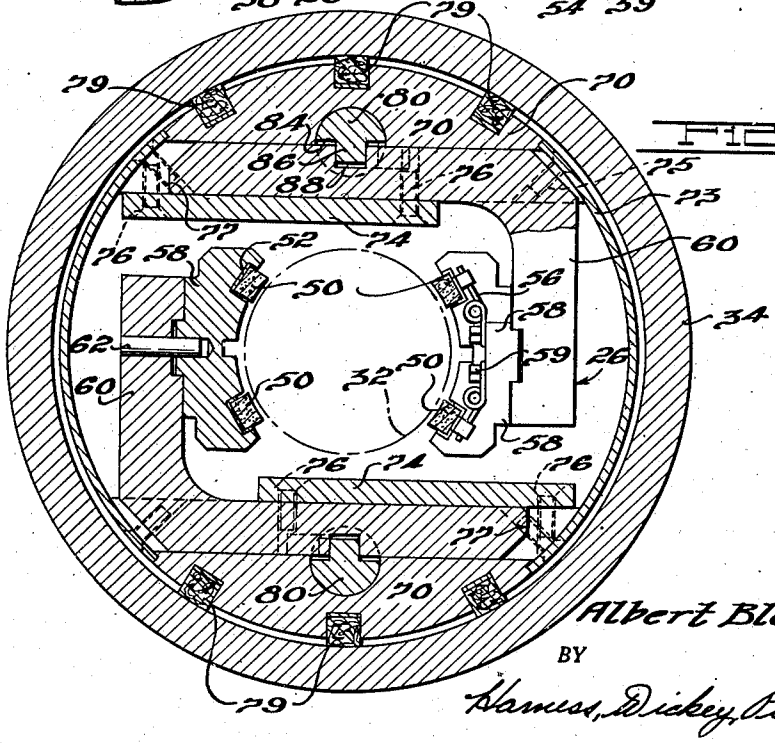


Fig. 5.



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MACHINE FOR GRINDING CYLINDRICAL AND EXTERNAL SURFACES

Filed Oct. 26, 1935 7 Sheets-Sheet 4

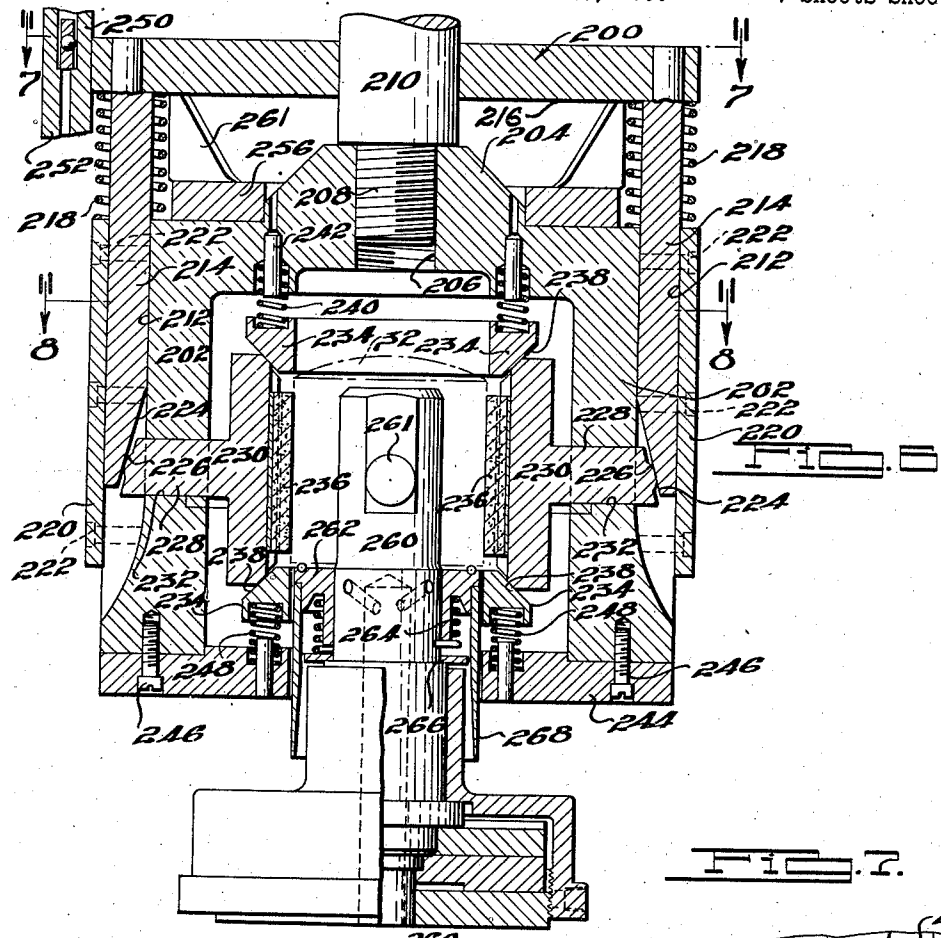


FIG. 7.

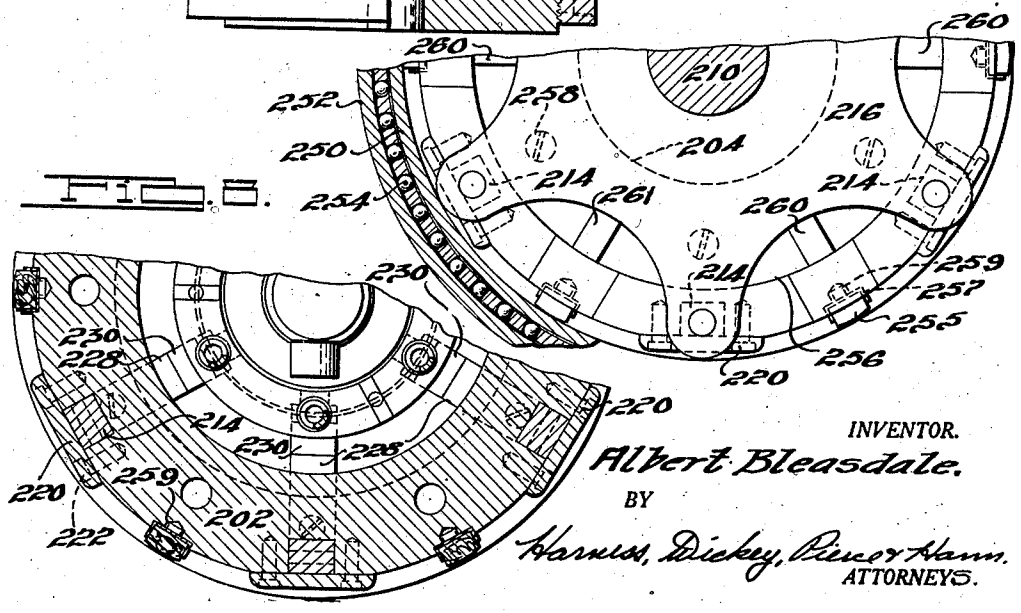


FIG. 8.

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MACHINE FOR GRINDING CYLINDRICAL AND EXTERNAL SURFACES

Filed Oct. 26, 1935 7 Sheets-Sheet 5

Fig. 9.

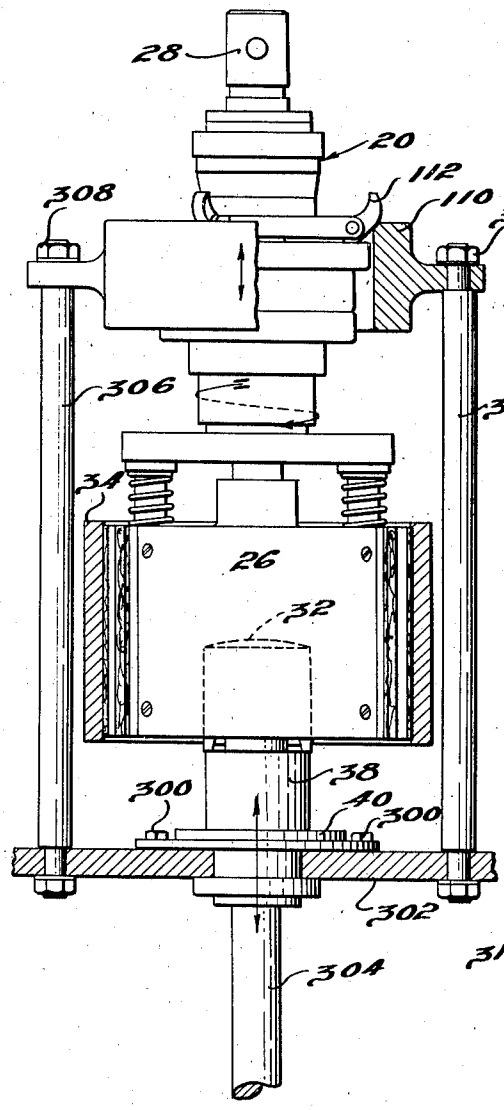
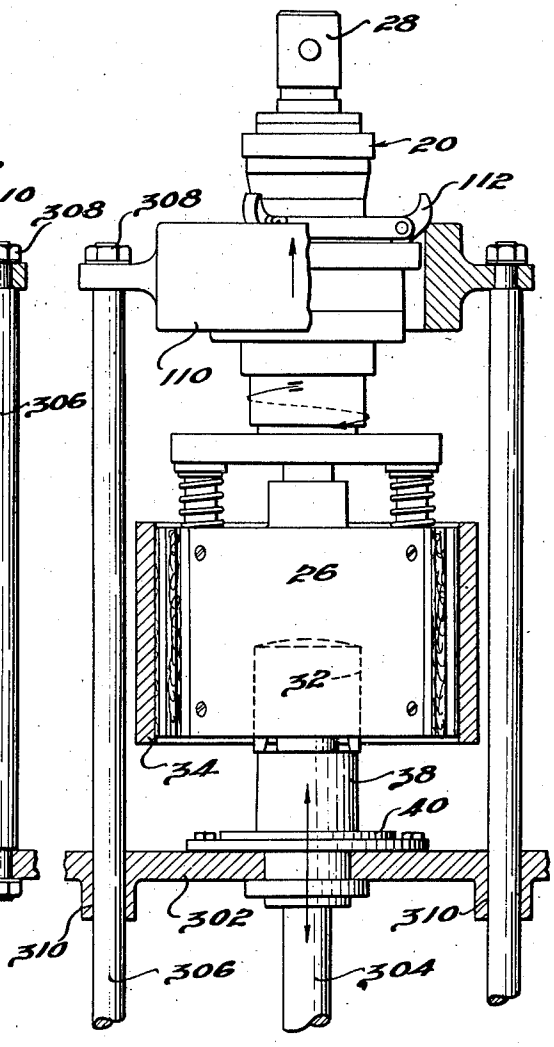


Fig. 10.



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MACHINE FOR GRINDING CYLINDRICAL AND EXTERNAL SURFACES

Filed Oct. 26, 1935 7 Sheets-Sheet 6

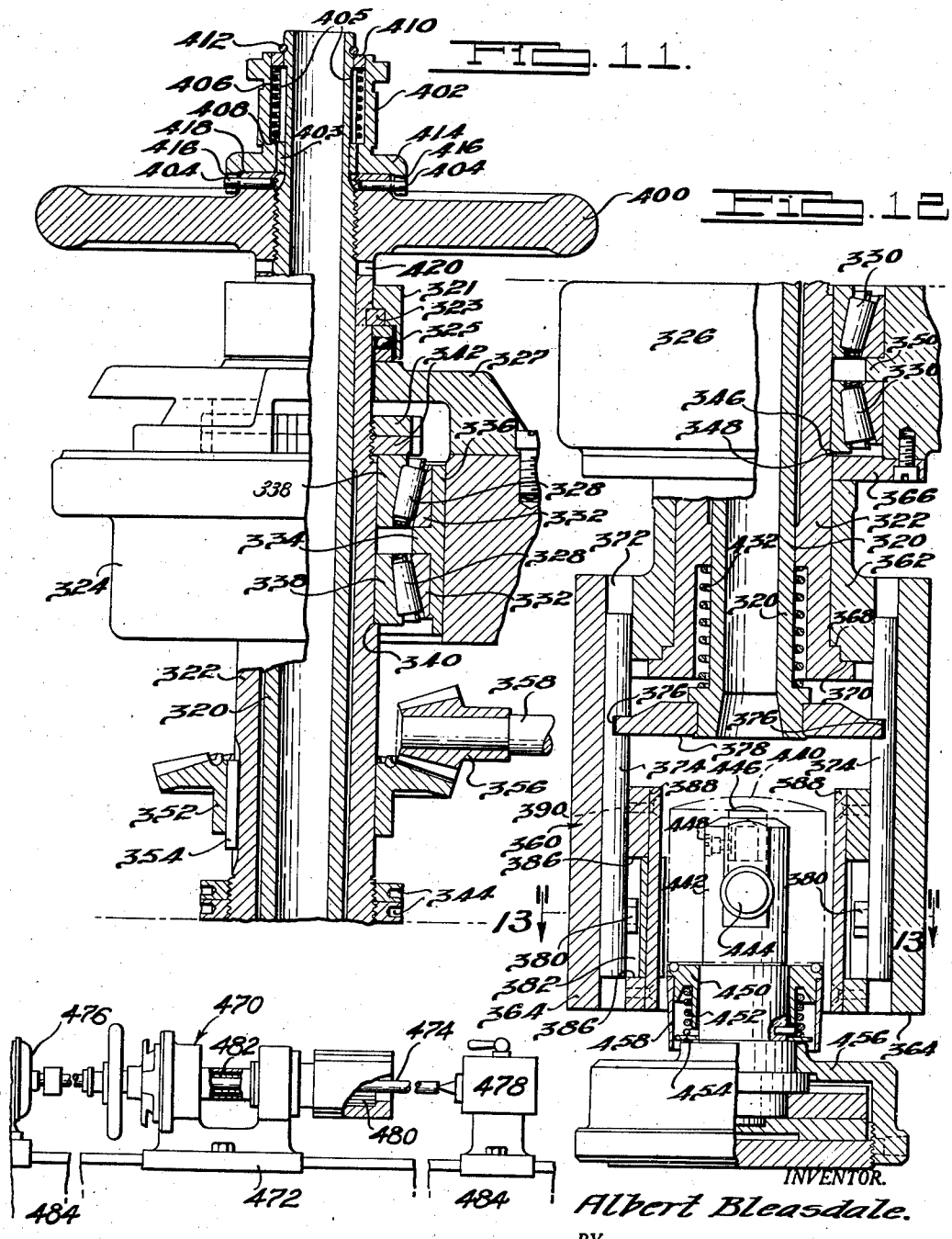


FIG. 11.

FIG. 12.

FIG. 13.

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MACHINE FOR GRINDING CYLINDRICAL AND EXTERNAL SURFACES

Filed Oct. 26, 1935 7 Sheets-Sheet 7

Fig. 13.

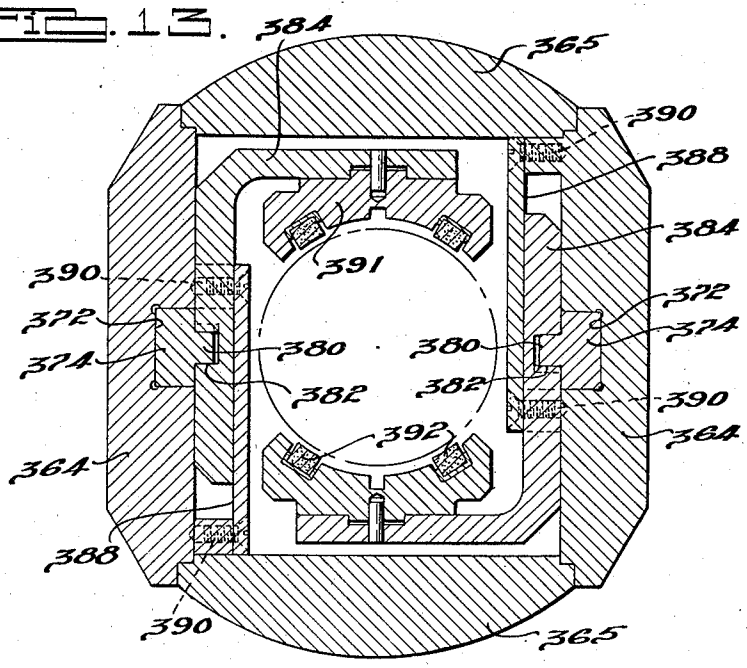


Fig. 15.

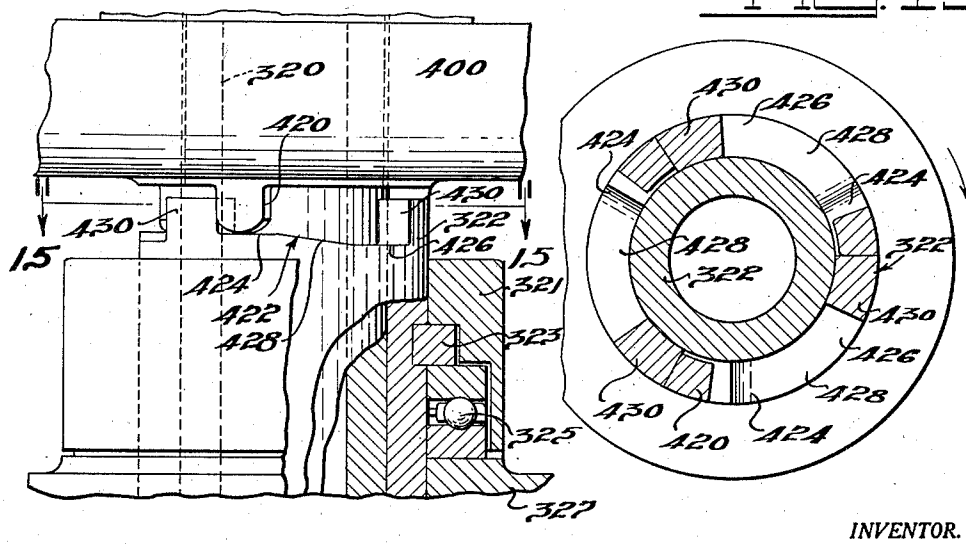


Fig. 14.

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Patented May 10, 1938 2,116,922

UNITED STATES PATENT OFFICE

2,116,922

MACHINE FOR GRINDING CYLINDRICAL AND EXTERNAL SURFACES

Albert Bleasdale, Detroit, Mich., assignor to Micromatic Hone Corporation, a corporation of Michigan

Application October 26, 1935, Serial No. 46,844

15 Claims. (Cl. 51—73)

The present invention relates to honing tools, and particularly to honing tools of the automatically controlled type.

A principal object of the present invention is to provide a honing tool for grinding and finishing external surfaces of objects, such as pistons or the like.

A further object of the present invention is to provide a honing tool for grinding and finishing surfaces in which the inertia of parts of the operating or control mechanism is utilized to control the grinding action.

It is a further object of the present invention to provide a method of and a honing tool for grinding or finishing external surfaces embodying means to rotatively drive the tool and to simultaneously move the work piece axially of the tool.

It is a further object of the present invention to provide a method of and a honing tool for grinding and finishing surfaces utilizing mechanism to rotatively drive the grinding head of the tool, and cooperative means to move the work piece axially of the tool and operate trip mechanism provided to effect a radial adjustment of the grinding stone within the grinding head of the tool.

It is a further object of the present invention to provide a method of and a honing tool for grinding and finishing surfaces utilizing mechanisms to rotatively drive the grinding head, mechanism to effect a reciprocating movement between the grinding head and the work piece, and independently driven means to operate trip mechanism to effect a radial adjustment of the grinding stone within the grinding head.

Further and more particular objects of the present invention are to provide a honing tool particularly adapted for the grinding and finishing of the external surfaces of objects, such as pistons or the like, embodying a rotatively driven grinding head, and a table for supporting a piston or the like in cooperative relation to the grinding head; to provide a tool as just stated, in which the grinding head accommodates a plurality of radially adjustable grinding stones or abrasives; in which the radial adjustment of the grinding stones or abrasives may be automatically controlled; in which the radial adjustment of the grinding stones or abrasives is effected by loading spring mechanism which acts to bias the stones or abrasives into engagement with the surface of the work piece, and in which the grinding action may continue until such spring mechanism is either partly or entirely unloaded; and in which the grinding stones or abrasives are carried upon and for rotation by a plurality of supporting arms, the radial adjustment of the abrasives being effected through a cam connection between the stones and the supporting arms.

Further objects of the present invention are to provide a method of and a tool for grinding and finishing external surfaces of objects, such as pistons or the like, in which the supporting relation between the tool and the work piece is adapted to accommodate itself to misalignment between the driving source and the work piece; in which the honing tool embodies flexible connections adapted to absorb misalignments between the driving source and the grinding head; in which the supporting table for the work piece is flexibly mounted, adapting the work piece to absorb finer misalignments between it and the grinding head; in which the connection between the work piece and the supporting table permits limited universal movement of the work piece with respect to the table.

Further objects of the present invention are to provide a honing tool particularly adapted for grinding and finishing external surfaces of objects such as pistons or the like embodying means to simultaneously reciprocate and rotate the grinding head with respect to the work piece, and in which the reciprocation of the grinding head operates trip mechanism to effect an initial adjustment of the radial positions of the grinding stones or abrasives; in which, alternatively, the grinding head is stationarily located, and the work piece is reciprocated, the reciprocation of the work piece controlling trip mechanism to effect the radial adjustment of the stones; in which, as a further alternative, the operation of the trip mechanism is operated independently of the rotative and reciprocatory movements between the grinding head and the work piece.

Further objects of the present invention are to provide a method of and a honing tool for grinding and finishing the external surfaces of objects such as pistons or the like, embodying a rotatively driven grinding head, and an inertia controlled member adapted to control the radial adjustment of the grinding stones or abrasives; in which the inertia member is connected to the grinding stones or abrasives through spring mechanism disposed to be loaded by the inertia member, and to bias the grinding stones or abrasives into engagement with the work piece; in which the inertia member is disposed to be rotated bodily with the grinding head during

operation of the tool, and in which, in starting, the inertia drag of the inertia member effects a corresponding movement of an adjusting member which in turn loads the above stated spring mechanism; in which, as an incident to stopping the tool, the energy stored in the inertia member effects an automatic resetting of the tool, withdrawing the grinding stones or abrasives from engagement with the work piece.

Further objects of the present invention are to provide a method of and honing tool for grinding and finishing surfaces as stated generally in the previous paragraph, and in which the tool comprises generally an inner sleeve and a rotatively driven outer sleeve, the inner sleeve being relatively movable with respect to the outer sleeve under the influence of the inertia member to effect the radial adjustment of the grinding stones or abrasives; in which the outer sleeve is disposed for connection to a suitable external source of power and effects the rotation of the grinding head in which are carried the grinding stones or abrasives; in which the adjusting motion between the inner and outer sleeves occurs longitudinally of the tool, and effects a radial movement of the grinding stones with respect to the grinding head and the work piece; in which the inner and outer sleeves are connected together to rotate simultaneously and in which the driving connection between the inner and outer sleeves is effected through the inertia member, the inertia member being rigidly connected to the inner sleeve and being connected to the outer sleeve through a cam and cam track relationship.

Further objects of the present invention are to provide a honing tool adapted for connection at a point intermediate its ends to a source of power for driving the same; and to provide a honing tool as just stated, embodying an outer or driving sleeve and adjusting mechanism positioned interiorly of said driving sleeve.

Further objects of the present invention are to provide a honing tool embodying driving and grinding elements, adapted to operate upon work pieces of substantially greater length than the length of the grinding elements; to provide a tool of this character embodying grinding and driving elements positioned in relatively spaced axial relation, in which the driving elements are of tubular construction and permit a work piece to be slipped longitudinally therethrough.

With the above and other objects, which appear in the following description and in the appended claims, illustrative embodiments of the present invention are shown in the accompanying drawings, throughout the several views of which corresponding reference characters are used to designate corresponding parts, and in which:

Figure 1 is a perspective view in front elevation of an external grinding tool embodying the present invention;

Fig. 2 is a detail view in front elevation, partly in section, of the tool shown in Fig. 1;

Fig. 3 is a fragmentary detail view, in vertical section, taken along the line 3—3 of Fig. 2;

Fig. 4 is a fragmentary view in vertical section, taken along the line 4—4 of Fig. 2;

Fig. 5 is a detail view in horizontal section taken along the line 5—5 of Fig. 4;

Fig. 6 is a view in vertical central section of a modified construction of grinding head;

Fig. 7 is a fragmentary view in horizontal section, taken along the line 7—7 of Fig. 6;

Fig. 8 is a fragmentary view in horizontal section, taken along the line 8—8 of Fig. 6;

Fig. 9 is a partial view in elevation, illustrating a modification of the structure shown in the preceding figures;

Fig. 10 is a partial view in front elevation, illustrating a further modification of the structure shown in the preceding figures;

Figs. 11 and 12, taken together, constitute a view in vertical central section of an inertia controlled grinding tool, Fig. 11 representing the upper portion of the tool, and Fig. 12 representing the lower portion of the tool;

Fig. 13 is a detail view in horizontal section, taken along the line 13—13 of Fig. 12;

Fig. 14 is a partial perspective view based upon Fig. 11 and illustrating the connection between the inertia member and a part of the driving mechanism for the tool;

Fig. 15 is a view in horizontal section, taken along the line 15—15 of Fig. 14; and

Fig. 16 is a fragmentary view illustrating the application of the improved honing tool to the grinding and finishing of relatively long objects.

In certain of its broader aspects, the present invention is directed particularly to extending the field of application of honing tools of the general type heretofore used in the grinding and polishing of internal surfaces of objects, such as cylinders and the like, to the grinding and polishing of external surfaces of objects, such as pistons or the like. Concerning these aspects of the present invention, an important feature thereof is the provision of an improved honing tool grinding head, embodying a plurality of expansible and contractible grinding stones or abrasives, which are carried upon one or more radially adjustable arms and are movable thereby from between contracted or working positions in engagement with the surface of the work piece and expanded or released positions out of engagement with the work piece. Several alternative external grinding head structures are shown in the drawings to illustrate the invention.

In the use of the improved grinding head of the present invention, the relative motion between the grinding head and the work piece may be effected in various ways. In accordance with one illustrated embodiment, the work piece is stationarily supported and the grinding head is both rotated and reciprocated with respect to the work piece. In another embodiment the grinding head is rotated and the work piece is reciprocated with respect to the grinding head during rotation of the latter.

Similarly, in accordance with the present invention, the control mechanism for moving the grinding stones or abrasives from between the working and released positions, preferably automatic, is controlled in various ways. In accordance with certain of the illustrated embodiments, mechanism is used similar to that described and claimed in the patent to Jeschke No. 1,944,660, granted January 23, 1934, and assigned to the assignee of the present application.

In other illustrated embodiments of the present invention, the movements of the grinding stones or abrasives between the grinding or released positions are automatically controlled in accordance with an inertia principle and the adaptation of this principle to honing tools in general is of itself regarded as one of the broader features of the present invention. In the form illustrated, the honing tool is provided with what may be called an inertia wheel, which effects the movement of the grinding stones between the working and released positions through an inter-

mediate sleeve to which it is secured and which extends through the tool to the grinding head. The inertia member is connected to an outer or driving sleeve of the driving head of the tool through a cam and cam track relationship. In starting the tool, the inertia of the inertia member causes it and the adjusting sleeve to drag or lag behind the movement of the driving sleeve. This drag or lag, through the cam and cam track relation, causes a longitudinal movement of the adjusting sleeve within the driving sleeve and effects a corresponding movement of the grinding stones. In stopping the tool, the energy stored in the inertia member tends to continue it in motion and this tendency is utilized to reset the stones to the released position by effecting an opposite longitudinal movement of the adjusting sleeve.

The last mentioned embodiment of the present invention is further advantageous in that it is readily adaptable to the grinding of objects having lengths greater than the length of the grinding head, such as shafts and the like. The tool body is made tubular in form and the driving power is applied at a point intermediate the ends of the tool and to an outer or driving sleeve. With this arrangement, the tool may either be fixed in position axially and rotated or may be both rotated and reciprocated, the shaft or other relatively long objects being operated upon being slipped entirely through the driving parts of the tool as well as through the grinding head of the tool.

Considering the above mentioned elements in more detail, and referring first to Figs. 1, 2, 3, 4 and 5, a specific embodiment of the present invention is shown which may be characterized as a honing tool embodying interconnected driving and grinding parts, the driving head effecting a rotation and reciprocation of the grinding head with respect to a stationarily supported work piece. The grinding head may be characterized as comprising a plurality of grinding stones or abrasives carried upon a pair of adjusting arms which are radially adjustable to thereby move the grinding stones from extended or released positions to contracted or work engaging positions. The contraction and expansion of the grinding stones is illustrated as controlled by mechanism similar to that described and claimed in the above identified Jeschke patent and comprising tripping fingers carried by the driving head for cooperation with a tripping plate. The cooperation between these members causes the adjusting arms to be moved through a suitable loading spring to a contracted or working position, or to be released to an expanded or released position.

General construction—Figure 1

Referring first to Fig. 1, representing a general elevational view of the just mentioned embodiment, the honing tool designated generally as **20** comprises a driving head **22**, intermediately positioned adjusting elements designated generally as **24**, and a grinding head designated generally as **26**. The driving head **22** is adapted for connection, through a readily detachable bayonet type joint, to a suitable external source of power represented by the spindle **30** and which, it is to be understood, is effective to simultaneously rotate and reciprocate the entire tool **20** with respect to the illustrative work piece **32**, the reciprocatory movement including a working range throughout which the grinding stones within head **26** are continuously in engagement with the work piece **32**, as well as a starting position illustrated in Fig. 1, outside of such working range. In its rotary and reciprocating movement the head **26** is guided within a sleeve **34**, suitably secured upon the main machine frame **36**.

The illustrative work piece **32**, representing a conventional piston of an internal combustion engine, is carried upon a support **38** and table **40**, the connection between these elements being such as to permit a certain amount of universal movement of piston **32** and thus compensate for any minor misalignment between it and the grinding head **26**. The supporting structure for piston **32** is illustrated as carried upon a bed plate **42**, adjustable transversely of the main machine frame **36**, to facilitate the insertion and removal of work pieces from the machine.

As illustrated, the grinding mechanism is of the machine type, which may, as will be evident, be arranged to maintain correct alignment between the tool **20** and the power source. Alternatively, it will be understood that suitable universal joint mechanism, including the joint **28**, may be provided to absorb any misalignment that may develop between the tool **20** and the power source.

Grinding head—Figs. 2, 3, 4 and 5

Considering the feature of the grinding head in more detail and referring particularly to Figs. 2, 3, 4 and 5, a plurality of grinding stones or abrasives **50** are individually and suitably secured within backing members **52**. The grinding stones themselves may be of conventional construction and composition and though only four of them are illustrated, it will be obvious that other numbers of them may be utilized in practice. The upper and lower ends of the backs **52** are provided with hooklike extensions **54**, each of which receives one end of a spring **56**. The other ends of springs **56** in turn are secured upon blocks or stone holders **58** which may be formed integrally with or suitably secured to a pair of similar and oppositely disposed adjusting arms **60**. It will be understood that the springs **56** act in a direction to retain the stones and the backing members within the stone holders **58**. Where the stone holders **58** are formed separately from the adjusting arms **60**, they may be secured thereto by studs **61** and one or more centering pins, such as **62**, are preferably provided which extend through the arms **60** and into the stone holders **58** to properly position the members with respect to each other.

Each of the adjusting arms **60** is of generally right angle shape and the relatively longer leg of each arm **60** is guided for limited movement transversely of the grinding head within a corresponding recess **68**. The recesses **68** are formed in the downwardly extending legs **70** of a drive yoke **72**. The arms **60** are retained within the recesses **68** by plates **74** which are secured upon the inner faces of the legs **70** by the countersunk screws **76**.

The adjusting movements of the arms **60**, transversely of the legs **70**, is controlled by a pair of similarly formed adjusting rods **80** which are interconnected at their upper ends by a cross bar **82** and the adjacent lower faces of which are cut away to provide recesses **84** into which the outer faces of the arms **60** extend. Rods **80** are positively guided but freely slidable within corresponding openings formed in the legs **70**, which openings communicate with the previously mentioned recesses **68**. Generally rectangular but

angularly disposed cams extend from the bases of the recesses 84 and may either be formed integrally with the rods 80 or suitably secured thereto, as will be understood. The cams 86 are slidably received in correspondingly angled grooves or keyways 88 formed in the outer faces of the arms 60. The rods 80, and thus the stones and their supporting mechanism, are biased to and normally retained in their retracted or released positions by compression springs 90 which surround rods 80 and are seated between cross bar 82 and recesses 92 in yoke 72.

With this arrangement, and with reference to Fig. 2, it will be understood that downward movement of the rods 80 with respect to the drive yoke 72, causes the adjusting cams 86 to move downwardly within their associated grooves 88 and effect a corresponding horizontal or transverse movement of the arms 60. The relation of the parts is such that downward movement of the arms 80 causes a contracting movement of the arms 60, bringing the stones 50 into a contracted or work engaging position. Similarly, an upward movement of the rods 80 with respect to the yoke 72 effects an opposite movement of the adjusting arms 60, causing the latter to expand or retract the stones 50 out of engagement with the work.

Arcuate plates 73 are secured by countersunk screws 75 to the edges of the legs 70 of yoke 72 and act to generally enclose the grinding head, as well as to form stops which positively limit the stone contracting movements of the arms 60 when engaged by the outer ends 77 of the latter. As previously mentioned, the grinding head 26 is guided within a circular sleeve 34 suitably secured to the machine frame. Preferably, a plurality of cork guide strips, such as 79, of the type described and claimed in the patent to Kirke W. Connor, No. 1,939,205, issued December 12, 1933, and assigned to the assignee of the present application, are secured to the outer faces of the legs 70 and extend slightly therefrom into engagement with the inner surface of the sleeve 34.

Referring particularly to Figs. 2 and 4, the driving yoke 72 is provided at its upper end with a centrally disposed internally threaded opening 100 which receives the correspondingly threaded lower end of the main drive shaft 102 to form a positive driving action between the grinding head and the drive shaft. The grinding stones 50 and supporting parts, though movable axially of yoke 72, as above described, are driven in rotation thereby through the driving connection afforded between the rods 80 and the legs 70 of the yoke 72. The shaft 102 extends directly upwardly through the tool and terminates in the previously mentioned bayonet type drive connection 28.

The automatic control mechanism 24 for rods 80, illustrated as similar to that described and claimed in the above described Jeschke Patent No. 1,944,660, comprises generally the cam plate 110, the trip fingers 112, the cam ring 114, sleeve 116, collar 118 and the caged spring 120. The trip plate 110 is suitably supported upon the main machine frame 36, as best shown in Fig. 1. The trip fingers 112, a plurality of which are spaced around the tool, are pivotally supported by pins 120 upon a collar 122, the tubular shank 124 of which is freely fitted over the downwardly extending shank of an adjusting collar 126. The lower ends of the fingers 112 are supported in an annular recess cut in the surface of ring 114 and having the sloping cam side 113. Collar 126 is threaded onto shaft 102 and may be locked in a selected position of adjustment axially of shaft 102 by the lock nut 128. A ball bearing unit 130 seated between collar 126 and the upper edges of collar 122 and a strengthening sleeve 132, forms a freely rotatable connection between shaft 102 and the collar 122, which also limits relative axial movement in one direction therebetween.

Sleeve 116 is provided with an upper restricted portion 134 and a lower enlarged skirt portion 136. Portion 134 freely fits over shaft 102, is externally threaded and is provided with an axially extending external keyway 138. Cam ring 114 is supported upon portion 134 in a selected position of adjustment through collar 140 and balls 141, collar 140 being threaded upon portion 134 and balls 141 forming a detent type connection between ring 114 and collar 140. Balls 141 are retained in place by a member 142 having a finger which enters the keyway 138. By retaining ring 114 stationary with respect to portion 134 and rotating collar 140, an adjustment is effected which is conveniently measured by the snapping of the balls 141 from one recess within collar 140 to another.

Spring 120 is caged between a collar 144 and the upwardly extending rim of the previously mentioned collar 118 and is freely received within the skirt portion 136. A supplementary limit to compressive movements of spring 120 is afforded by a ring 146 secured upon the bottom of collar 144. A freely rotatable connection between collar 144 (and hence spring 120) and sleeve 116 is afforded by the ball bearing unit 147. A non-rotatable connection between collar 118 (and hence spring 120) and cross bar 82 is afforded by the tongue 148 which extends downwardly from collar 118 into a corresponding recess within bar 82.

With the above arrangement, it will be understood that the adjusting mechanism comprising the fingers 112, cam ring 114, sleeve 116, spring 120 and collar 118 is supported in axial position upon the tool between the previously mentioned stop collar 126 and the cross bar 82, which, as previously stated, is urged upwardly with respect to shaft 102 by the compression springs 90 which surround the rods 80. The position of the just mentioned assembly axially of shaft 102 is determined by the adjustment of stop collar 126. The effective length thereof is determined by the adjustment of sleeve 116. Sleeve 116 and collar 126 may thus be set to provide any desired initial diametral spacing between the grinding stones 50.

It will also be understood that a downward movement of the tool with respect to the cam plate 110 causes the upper end of the tripping fingers 112 to move inwardly with respect to the tool and the lower end thereof to move outwardly with respect to the tool along the cam surface 113 of the cam ring 114. This camming movement causes cam ring 114, sleeve 116 and the collar 144 to move downwardly with respect to shaft 102. This movement is transmitted to collar 118, cross bar 82 and consequently the adjusting rods 80, through the caged spring 120. In operation, when the grinding stones associated with the rod 80 engage the surface of the work piece, their inward movement is thereby interrupted and continued downward adjusting movement as above stated is absorbed in compressing the caged spring 120 between the collar 118 and the collar 144. During the grinding action, accordingly, the grinding stones are continuously urged into engagement with the surface of the work piece

by the force exerted by the compressed caged spring 120. The grinding action ceases automatically when the stones have moved inwardly far enough, as a consequence of the grinding away of the surface of the work piece, to release spring 120 to its free position. The final diametral spacing between the stones 50 is determined by the degree of movement of the fingers 112 by the plate 110, proper proportioning of which last mentioned elements permits grinding to precise dimensions.

It will also be understood that of the adjusting elements, the caged spring 120, collar 144 and collar 118 rotate with the shaft 102 but the cam fingers 122, cam ring 114 and sleeve 116 remain stationary. This arrangement avoids any relative rotative movement between the cam plate 110 and the tripping fingers 112 and in this respect the adjusting mechanism of the present invention is regarded as an improvement over the corresponding mechanism shown in the above identified Jeschke patent.

Support for work piece—Fig. 2

Considering the mounting for the work piece 32 and referring particularly to Fig. 2, a transverse pin 150 passes relatively freely through the wrist pin openings 152 in the side walls of piston 32 and also extends through a transverse opening 154 formed near the upper end of a standard 156 and is retained in place therein by the spring pressed detents 158, which are received within a transverse opening therein and seat against corresponding recesses formed in the walls of the opening 154. Opening 154 is somewhat larger than the outside diameter of pin 150 and permits a certain amount of universal movement between piston 32 and standard 156. The base of piston 32 rests upon the previously mentioned supporting collar 38 which surrounds standard 156 and is supported thereon by a spring 162. Spring 162 is seated between collar 38 and the rim of the previously mentioned table 40, which is stationarily secured to the machine frame by the studs 166. The downwardly extending apron 168 of collar 38 is provided with an elongated opening 170 which receives a stud 172 secured to table 40. Stud 172 permits relative movement between support 38 and table 40, but imposes a limit on such movement. It will be noted that the inner edges of the wrist pin openings 152 are spaced slightly from the outer edges of the standard 156, thus permitting a limited amount of transverse movement between piston 32 and standard 156, but imposing a positive limit upon such movement.

With the general arrangement as just described, it will be apparent that piston 32 is resiliently supported upon the table 40 through the spring 162 and is retained in general axial alignment therewith through the standard 156. The resilient mounting, which permits piston 32 to tilt somewhat, as well as to move transversely somewhat with respect to the table 40, enables it to adjust itself to any minor misalignment which may exist between table 40 and the axis of the honing tool.

Operation as a whole—Figs. 1 through 5

Considering the operation of the above described embodiment of the present invention as a whole, it will be understood that a work piece may be introduced into working position by raising the tool so that the lower limit of the grinding head 26 is above the upper limit of the work piece 32 or by correspondingly lowering the work table 40. Arrangements for alternatively accomplishing these functions are well known and form no part of the present invention. The grinding stones 50 normally occupy the expanded or released positions, as previously stated, and so do not interfere with the initial positioning operations.

Depending upon the type of drive for the tool, the rotative and reciprocatory movements thereof may be started simultaneously. In moving downwardly over the work piece 32 the tripping fingers 112 are brought into engagement with the tripping plate 110 and are cammed thereby in a direction to move the lower ends thereof outwardly of the tool. This camming movement effects corresponding downward movement of the cam ring 114 with respect to the shaft 102 carrying with it the sleeve 116 and the spring cage 144 into engagement with the load spring 120. This movement is transmitted through spring 120, to rods 80, stone supporting arms 60, and stones 50. When stones 50 engage the work piece, continued camming movement compresses spring 120, loading it to a predetermined degree.

It will be understood that during the grinding action, the tripping fingers 112 move between the upper and lower limits of the cam plate 110 and so continually retain the cam ring 114 and associated parts in the tripped position.

As the grinding action continues and the diameter of the work piece 32 is gradually reduced, the grinding stones 50 are continuously urged into contact with the work by the force exerted by spring 120. When such force is expended or is balanced by the forces of the supporting springs 90, the grinding action is complete.

Upon withdrawal of tool 20 upwardly, fingers 112 are released from plate 110 and are cammed along surface 113 to their illustrated positions under the influence of springs 90 which carry with them rods 80 and thus expand the stones 50 out of engagement with the work piece 32.

Modified grinding head—Figs. 6, 7 and 8

Figs. 6, 7 and 8 illustrate a modified construction of grinding head in which the contracting and expanding movements of the grinding stones occur in directions respectively normal to the surface of the work piece, and in which the adjusting rods act to move the grinding stones into work engaging position, and additional mechanism is provided to continuously urge the stones to work releasing position, and in certain cases, to also permit limited flexibility of the stones within the grinding head.

In Figs. 6, 7 and 8 the grinding head, designated generally as 200, comprises a cylindrical driving yoke having the downwardly extending skirt portion 202 and substantially enclosed upper end 204, which is apertured at 206 to threadably receive the correspondingly threaded shank 208 of the main drive shaft 210. Shaft 210 may correspond in all respects to the previously described drive shaft 102 and be similarly connected to a source of power. The surface of the downwardly extending skirt 202 is provided with a plurality of equally spaced rectangular recesses 212, which correspond in number to the number of grinding stones for which the head is designed and which slidably receive the adjusting rods 214. Rods 214 are connected at their upper ends by a spider plate 216 which corresponds in function to the previously described

cross bar 82 and may be connected to the adjusting control mechanism in the manner described in connection with cross bar 82 (Figs. 1 through 5). Compression springs 218 are interposed between the underside of plate 200 and the upper surface 204 of the yoke and act to continuously urge the adjusting rods 214 to positions corresponding to released or retracted positions of the grinding stones. The adjusting rods 214 are retained within the recesses 212 by plates 220 which are suitably secured to the outer face of the skirt 202 by the countersunk studs 222.

The inner faces of the adjusting rods 214 are angled at the lower ends thereof to provide cam surfaces 224 which cooperate with correspondingly formed ends 226 of the shanks 228 of stone holders 230. The shanks 228 are slidably received within corresponding transverse recesses 232 formed in the skirt 202 and which communicate with the previously described recesses 212. The grinding stones or abrading elements 236 which may be of conventional construction and composition, are suitably secured upon the inner faces of the stone holders 230.

In certain instances it is considered desirable that shanks 228 fit snugly within recesses 232, to thus afford a positive aligning connection between the stone holders 230 and the yoke. In certain other instances it is considered desirable to provide a relatively loose fit between shanks 228 and openings 232, thus permitting a certain amount of relative aligning motion between the stone holders 230 and the yoke, and to control this motion by the spring pressed plungers 234 which are described in more detail below.

The stone holders 230 and consequently the grinding stones 236 are continuously urged to expanded or work releasing positions by a series of spring pressed plungers 234, the outer surfaces 238 of which are angled to have a camming action upon the upper and lower ends of the inner faces of the stone holders. The upper plungers 234 are connected to the underside of the surface 204 of the driving yoke through compression springs 240 which are seated between recesses formed in the plungers and corresponding recesses formed in the surface 204. Guide pins 242 are preferably provided to guide the springs 240. The lower plungers 234 are correspondingly supported upon a base plate 244 which is secured to the lower edge of the skirt 202 by studs 246 through compression springs 248 which are seated between recesses formed in the plate 244 and in the plungers 234 respectively.

The springs 240 and 248 preferably have similar characteristics and are given the same initial compressions so that, even though the fit between shanks 228 of the stone holders and the skirt 202 is relatively loose to permit motion between these parts, the springs act to maintain the stones 236 in proper alignment with respect to the work piece.

Preferably and as illustrated, the grinding head 200 is guided within a sleeve having inner and outer concentric members 250 and 252. The inner and outer members 250 and 252 are connected together through one or more sets of radial ball bearings 254 and the outer member 252 is adapted to be stationarily secured in the manner described in connection with the sleeve 34 of Figs. 1 through 5. The inner member 250 is adapted to rotate with the grinding head 200 but is preferably secured against axial movement. The connection between the grinding head 200 and the inner sleeve 250 is preferably effected through a series of vertically disposed guide strips 255 of the type described and claimed in the above identified patent to Kirke W. Connor, No. 1,939,205. The guide strips 255 are secured within shells 257, and the outer surfaces thereof frictionally engage the inner surface of the sleeve 250. The connection thus afforded permits relative axial movement between the grinding head 200 and the sleeve 250 in cases where the grinding head is reciprocated and also forms a resilient connection between the two which resists radial movement of the grinding head within the supporting sleeve structure. The upper and lower ends of the backing shells 257 are provided with upper and lower inwardly extending similar pins 259. The upper pins of each shell are received in recesses in the outer faces of the fingers 261 of a spider, the base 256 of which is generally circular and fits over the upper edge 204 of the drive yoke. The spider may be secured in place by the studs 258. The lower pins 259 are received in recesses formed in the outer surface of the skirt 202. It will be noted that the number of the guide strips 255 corresponds to the number of the abrading stones and that the abrading stones and guide strips are disposed in alternate relation around the grinding head.

The work piece 32, illustrated as a conventional piston, may be supported upon a standard 260 through a pin 261 in the manner previously described. In this instance the base of the piston 32 is supported upon a collar 262 which in turn is supported through a spring 264 upon a plate 266 which surrounds the base of the standard 260. Collar 262 is preferably provided with a downwardly extending skirt 268 which acts to enclose the movable parts of the supporting structure. Standard 260 may be either stationarily supported or may be connected to mechanism to effect reciprocation thereof with respect to the grinding head 200. As in the previously described embodiment, the supporting structure for piston 32 permits a certain amount of universal movement of the piston 32 with respect to the support, thus allowing it to take up any minor misalignment which may occur between the support and the honing tool.

In operation the grinding head 200 may either be rotated through shaft 210, or both reciprocated and rotated therethrough. In the former case, the grinding head 200 and the inner guiding sleeve 250 are relatively stationary and the rotation between these members and the outer guiding sleeve 252 occurs through the ball bearing units 254. In the latter case the grinding head and the inner guiding sleeve 250 reciprocate with respect to each other, the movement being taken up through the guide strip 255, the rotation again being through the ball bearings 254.

As in the previously described embodiment, the placing in operation of the tool results in the downward movement of the adjusting rods 214 with respect to the drive yoke. Through the cam surfaces 224 and 226, this movement results in an inward or work engaging movement of the grinding stones, bringing the latter members into engagement with the surface of the work piece. This latter movement also pushes the upper plungers 234 upwardly and the lower plungers 234 downwardly against the force of the associated compression springs 240 and 248.

At the completion of the grinding operation, the adjusting rods 214 are released and permitted

to rise to their original positions under the influence of their supporting springs 218. The upward movement of adjusting rods 214 is accompanied by an outward movement of the stone holders 230 under the influence of the plungers 234.

Modified embodiments—Figs. 9 and 10

Referring particularly to Figs. 9 and 10, modified embodiments of the present invention are illustrated, which distinguish from the previously described embodiments in that while the tool is driven in rotation as before, it is fixed axially, and the relative reciprocation between the tool and the work piece is effected by reciprocating the work piece.

In Fig. 9, the tripping plate, which actuates the previously described tripping fingers to control the expansion and contraction of the grinding stones, and the mechanism for reciprocating the work piece, are interconnected and so move as a unit. As an alternative, in Fig. 10, the mechanism for reciprocating the work and the mechanism for actuating the trip plate are independently movable, thus adapting the structure to the improvement disclosed and claimed in the copending application of Kirke W. Connor, and the present applicant, Serial No. 43,932, filed October 7, 1935 and assigned to the assignee of the present application. In certain of its aspects, the Connor et al. structure may be characterized as providing for the contraction and expansion of the grinding stones between the work engaging and released position only while the tool is within the working range with respect to the work piece.

Fig. 9, a honing tool 20, which may and preferably does correspond in all respects to the corresponding honing tool described in connection with Figs. 1 through 5, and having a grinding head 26 guided within sleeve 34, is provided with a driving head 28, through which it may be connected to a suitable external source. An illustrative work piece 32 is carried upon a support 38 and table 40, and may be associated therewith as described in connection with Figs. 1 through 5. Table 40 is secured by studs 300 upon a base 302, which, in turn, is connected to a drive member 304 by which it may be reciprocated with respect to the grinding head 26 in any suitable manner. The machine portion 302 also carries standards 306 to the upper ends of which the previously described trip plate 110 is secured by nut 308.

In operation, after starting the tool 20 in rotation, the work piece 32 may be moved upwardly with respect thereto, bringing work piece 32 and the grinding head into the relative working range thereof. Prior to the arrival of work piece 32 within the working range, with respect to grinding head 26, the upper edge of the upwardly moving trip plate 110 engages the fingers 112, and this effects the contraction of the grinding stones within head 26 to work engaging position in the manner described in connection with Figs. 1, 2, 3, 4 and 5. Also in the manner described in connection with the earlier figures, fingers 112 are continuously engaged by trip plate 110 throughout the operation of the tool.

Referring particularly to Fig. 10, the rods 306, which support the trip plate 110, are freely slidable through openings 310 provided therefor in the frame portion 302. With this arrangement, it will be evident that the upward movement of the work piece 32 with respect to the grinding head 26 may occur independently of the movement of the trip plate 110 into tripping engagement with the fingers 112. A preferred mode of using the structure of Fig. 10 is to delay the engagement between the trip plate 110 and the fingers 112 until after the work piece 32 is within its working range with respect to grinding head 26, to withdraw the trip plate 110 from engagement with the fingers 112 before the work piece 32 is withdrawn from such working range. As stated above, certain of the broader aspects of thus independently controlling the tripping action are claimed in the above identified co-pending Connor and Bleasdale application.

Modified embodiments—Figs. 11 through 15

The embodiment of the present invention illustrated in detail in Figs. 11 through 15 distinguishes principally from the previously described embodiment in that an inertia principle is utilized in controlling the expansion and contraction of the grinding stones between the work engaging and released positions, and also in that the tool is arranged for connection at an intermediate point along its length to an external source of power. The latter feature is of general advantage, but is particularly useful in that it permits the use of a tubular or hollow tool construction which may readily be adapted to the grinding and polishing of objects which are relatively long in comparison to the length of the grinding head. This feature is described in more detail in connection with Fig. 16.

Referring particularly to Figs. 11 and 12, the improved honing tool comprises generally inner and outer concentrically positioned and telescopically related sleeves 320 and 322. The outer or driving sleeve 322 is suitably rotatably supported in bearings 324 and 326, which may form part of or be suitably secured in stationary relation upon the machine frame. Roller bearing units 328 and 330, of the combined radial and thrust type, are preferably interposed between the bearings 324 and 326 and the outer sleeve 322. The outer rings 332 of the roller bearing unit 328 are retained in spaced relation by a rib 334 which extends inwardly from a bushing 336 which is preferably press fitted within the bearing 324. The inner rings 338 of the roller bearing unit 328 are secured in place axially of the outer or driving sleeve 322 by the engagement between the lower end of one of the rings with the shoulder 340 formed in sleeve 322, the previously mentioned rib 334, and a pair of lock nuts 342, which are threaded upon the sleeve 322. The roller bearing units 330 are correspondingly secured in position axially of the outer sleeve 322 and the bearing 326 by the pair of lock nuts 344, the recess 346, the base of which supports a shoulder 348 formed in the inner ring of the lower ball bearing ring, and the rib 350 which extends inwardly from the bearing 326. An additional thrust bearing unit 325 secured between a snap ring 323 fitted in sleeve 322 and a protective cover 327 secured to bearing 324, is preferably provided to supplement bearings 328 and 330. A protective collar 321 is preferably fitted over snap ring 323 and the bearing unit 325.

Preferably and as illustrated, the power for rotating the outer or driving sleeve 322 is applied thereto at a point intermediate the two bearing supports 324 and 326 and may be of various types such, for example, as V-sheaves driven by suitable belts. In the drawings a bevel gear 352 is illustrated as suitably keyed by key 354 to driving sleeve 322 in driving relation to a bevel gear 356. The latter gear is carried upon a shaft 358

which may be rotated from any suitable external source.

As illustrated, the driving head illustrated generally as 360, comprises a bifurcated driving yoke 362 and having the downwardly extending diametrically opposed legs 364 connected by segmental members 365. The yoke 362 is provided with a central opening in the top thereof through which the outer driving sleeve 322 may be slipped. In assembled relation the yoke 362 is fixed in position axially of sleeve 322 by the engagement between the stepped shoulders 368 thereof with the correspondingly stepped shoulders 370 formed at the lower end of sleeve 322. The upper edge of yoke 362 is slightly spaced from a cover plate 366 suitably secured to the under side of the bearing 326.

The legs 364 are provided with similarly disposed rectangular openings 372 which extend throughout the length thereof, and which slidably receive the correspondingly positioned rectangular adjusting rods 374. The adjusting rods 374 are provided with oppositely directed, transversely aligned recesses 376 which receive the opposite ends of a cross bar 378 which is suitably and rigidly secured upon the lower end of the inner or adjusting sleeve 320.

With the construction as thus far described, it is evident that the adjusting rods 374 are driven in rotation with the outer or driving sleeve 322 through the guide openings 372 and that the axial position of the adjusting rods 374 with respect to the outer or driving sleeve 322 is controlled by the cross bar 378 and the inner or adjusting sleeve 320. Movement of these latter members is effected in the manner described below.

The adjusting rods 374 are each provided with generally rectangular but angularly disposed cams 380 which enter correspondingly angled recesses 382 which are formed in the pair of generally right angled supporting arms 384. The arms 384 correspond in all respects to the arms 60 described in connection with Figs. 1 to 5 and are slidable transversely of the legs 364 within the rectangular recess defined by the edges 386 in legs 364 and the enclosing plates 388 which are suitably secured by the countersunk studs 390 to the legs 364. As also described in connection with Figs. 1 to 5, the arms 384 carry stone holders 391 to which the grinding stones or abrasives 392 are suitably secured.

With reference to the mechanism for effecting an axial adjusting movement betwen the inner and outer sleeves 320 and 322 to correspondingly actuate the abrading stones 392 between the work engaging and release positions, a relatively heavy or inertia member 400, illustrated as in the form of a hand wheel, is secured in readily adjustable axial position upon the upper end of the inner sleeve 320 by the sleeve 402 and the locking pins 404. Sleeve 402 is freely slidable upon the upper end of sleeve 320 but is biased to the illustrated position by a spring 406 which is seated between an inwardly extending shoulder 408 formed in sleeve 402 and a ring 410 which slidably fits within the upper end of sleeve 402 and is secured in place axially of sleeve 320 by a conventional snap ring 412. Rotation between sleeves 402 and 320 is prevented by tongues 403 formed in sleeve 402 which enter keyways 405 formed in sleeve 320.

The lower or skirt portion 414 of sleeve 402 is provided with diametrically opposed notches 416 through which the locking pins 404 extend. Pins 404 also extend through corresponding openings formed in the upwardly extending hub 418 of the inertia member 400.

With the construction as just described, it will be understood that sleeve 402 may be raised axially of sleeve 320 against the force of the compression spring 406, bringing the notches 416 above the level of the pins 404 and thus releasing the inertia member 400 and permitting rotation thereof upon sleeve 320 to a position above or below that illustrated in the figures. Depending upon the spacing and number of the notches 416 in the sleeve 402, it will be evident that inertia member 400 may be locked in position in any one of a plurality of rotative positions with respect to sleeve 320, each of which rotative positions provides a different axial position thereof on sleeve 320. At the completion of an adjusting operation the pins 404 may be brought into alignment with a pair of notches 416 permitting the sleeve 402 to be dropped thereover, locking member 400 into place through the key 403 and keyway 405.

Referring particularly to Figs. 14 and 15, the lower face of inertia member 400 is formed as a plurality of circumferential, spaced cam projections 420, the lower face of each of which is adapted to ride in a corresponding cam track 422 recessed into the upper end of the outer or driving sleeve 322. Each such cam track includes horizontal end portions 424 and 426, separated by a sloping intermediate portion 428. Vertical abutments 430 separate the several cam tracks and limit the movement with respect thereto of the cam members 420.

The parts normally occupy the positions indicated in Fig. 14 in which the lower face of each cam member 420 engages and is supported upon the upper or raised horizontal portion 424 of the associated cam track. The parts are retained in this relative engaging position by the weight of sleeve 320 and connected parts, and also by the force exerted by a biasing spring 432, which, as best seen in Fig. 12, is seated between an annular shoulder formed at the base of the adjusting sleeve 320 and a corresponding shoulder formed near the base of the outer or driving sleeve 322. Spring 432 is preferably continuously under compression.

If the outer or driving sleeve 322 is started in rotation in a clockwise direction, as viewed in Fig. 15, a force is applied tending to cause corresponding rotation of the inner sleeve 320 at a corresponding rate, this force being transmitted between them at their points of relative sliding engagement. The weight of the sleeve 320, however, and the parts connected thereto, particularly the relatively heavy inertia member 400, causes a drag or lag in the starting of the inner sleeve 320, as an incident to which there is relative rotation between sleeve 322 and the inner sleeve 320. This relative rotation between the two sleeves is effective to cause the cam members 420 to move off the raised cam track portion 424 to positions at least partially down the sloping cam track portions 428. A limit to such movement is afforded, of course, by the vertical abutments 430 and it has been found in the practice of the present invention that the member 400 is initially brought to rest at an intermediate point on the sloping surfaces 428.

The movement of the cam portions 420 off the raised supporting cam track portions 424 permits downward movement of the adjusting sleeve 320 with respect to the driving sleeve 322 under the

influence of the weight of sleeve 320 and connecting parts and also under the influence of the previously mentioned compression spring 432.

This downward movement, as best shown in Fig. 12, causes the cross bar 378 to move downwardly, carrying with it the adjusting rods 374. The downward movement of the adjusting rods, in turn, causes a corresponding transverse movement across the grinding head of the supporting arms 384, thus moving the abrading stones 392 into engagement with the surface of the work piece 440. It may happen in practice that the engagement of the abrading stones with the surface of the work piece occurs before adjusting sleeve 320 has moved downwardly far enough to take up all the movement made possible by the sloping character of the intermediate cam track portions 428. In such instance, the cam portions 420 may be maintained in vertical spaced relation to the sloping cam track portions 428 until such a time as sufficient material is removed from the surface of the work piece to permit the abrading stones to move inwardly to positions in which the cam portions 420 engage the associated cam track portions. During such grinding action it will be understood that the stones are resiliently urged into engagement with the surface of the work piece by a force determined by the weight of sleeve 320 and the connected parts and also by the force exerted by the lower compression spring 432.

Throughout the grinding operation the lower compression spring 432, supplemented by the weight of sleeve 320 and connected parts, exerts a downward force on the adjusting sleeve 320. In the initial positions of the tool when the cam portions 420 are in engagement with horizontal portions of the associated cam track, the downward force just identified is at right angles to the direction of possible relative movement between sleeve 320 and sleeve 322, and thus does not tend to cause such movement. If, in starting the tool, the relative rotation between sleeves 320 and 322 is sufficient only to bring the cam portions 420 into position in vertical alignment with the sloping portions of the associated cam tracks, the downward vertical force of spring 432 and the weight of sleeve 320 and connected parts have a component tending to cause the cam portions 420 to slide further along the sloping cam track portions onto the horizontal cam track portions. This continuously acting force imposes a continual drag on the inertia member 400 and the sleeve 320 throughout the grinding operations, and in practice is found to retard the rotation of sleeve 320 enough to ultimately bring the cam portions 420 onto the lower horizontal portions 426 of the associated cam tracks. When this position is reached, the spring 432 and the weight of sleeve 320 and connected parts again have no component in the direction of possible movement between sleeve 320 and sleeve 322. Such final position, accordingly, represents a completion of the grinding operation.

Considering now the supporting structure for the work piece 440, these elements may be arranged as described in connection with Figs. 1 through 5. In Fig. 12, however, a slightly different construction is illustrated comprising a standard 442 over which the illustrative work piece 440, representing a piston, is slipped. As previously described, the standard 442 freely and somewhat loosely supports a pin 444, the opposite ends of which are received in the wrist pin openings formed in the side walls of the piston 440 and the loose connection thus supported permits a certain amount of tilting between piston 440 and standard 442. As illustrated, standard 442 is also provided with an adjustable extension 446 slidable in a corresponding opening formed at the upper end thereof and adapted to be locked in place by a set screw 448. Extension 446 is normally extended into engagement with the center of under side of the top of the piston 440 and thus acts to provide a positive force against vertical movement thereof. The lower edge of the work piece 440 is supported upon a collar 450. Collar 450 in turn is resiliently supported through a spring 452 upon a plate 454 which surrounds the base of standard 442 and rests upon the upper rim of the supporting member 456. Preferably, and as illustrated, collar 450 is provided with a downward extending skirt 458 which surrounds and encloses spring 452 and the plate 454. The assembly comprising support 456 may be connected in any suitable manner to suitable reciprocatory mechanism effective to move the work piece 440 upwardly and downwardly with respect to the grinding head throughout the previously described work range of the tool.

Reviewing the operation of the above described embodiment as a whole, it will be understood that the supporting structure, comprising standard 442 associated with the work piece 440, may be lowered away from the grinding head sufficiently to permit the placing thereover of a work piece. As a preliminary to such placing, the extension 446 may be suitably adjusted so that when the work piece is placed thereover, the mid-point of the underside of the top thereof is supported by such extension.

Depending also upon the size of the object to be operated upon, the grinding stones 392 may be given an initial predetermined spacing by correspondingly adjusting the position of the inertia member 400 upon the inner or adjusting sleeve 320. This adjustment, as previously described, may be effected by raising sleeve 402 sufficiently to release the pin 404 from the notches 416 and results in moving sleeve 320 axially of the outer or driving sleeve 322. This axial movement is transmitted to the grinding stones 392 through the cross bar 378, the adjusting rods 374 and the supporting arms 384.

The initiation of the reciprocatory movement of the work piece 440 and the rotative movement of the honing tool may and preferably do occur simultaneously. The beginning of the rotative movements of the honing tool results in a rotative displacement between the inner and outer sleeves 320 and 322 respectively, due to the inertia drag of the member 400 and other parts connected to sleeve 320. This rotative displacement permits a downward movement of sleeve 320 with respect to sleeve 322 influenced by the compression spring 432 and by the weight of sleeve 320 and connected parts. The latter movement results in a movement of the grinding stones into engagement with the work piece 440 and is interrupted at the point of such engagement. As the grinding action continues and the outside diameter of the work piece is gradually reduced, the inward movement of the grinding stone is correspondingly continued, as influenced by the spring 432 and the weight of sleeve 320 and connected parts. This downward movement of sleeve 320 and the inward movement of the stones 392 are interrupted when the lower edges of the cam portions 420 ultimately engage the horizontal lower portions 426 of the associated cam tracks, at which time

the diametral spacing of the stones equals the desired outside diameter of the work piece.

Referring particularly to Fig. 16, the adaptation of the tool construction described with reference to Figs. 11 through 15 to the honing of relatively long objects, is illustrated. In Fig. 16, the tool 470, which may correspond in all respects to the construction described with reference to Figs. 11 through 15, is horizontally disposed, and is supported upon a bed 472. The object 474, to be operated upon, is illustrated as extending axially entirely through tool 470 and as supported at its opposite ends upon head and tail stocks 476 and 478 respectively. It will be understood that in operation, the abrading elements 480 engage the surface of the object 474, and the inside diameter of the adjusting sleeve 482, which corresponds in all respects to the previously described adjusting sleeve 320, is somewhat in excess of the outside diameter of the object 474. It will also be understood that a drive connection may be applied to the tool 470 as described with reference to Figs. 11 through 15, or that alternatively, tool 470 may be stationary and the object 474 driven in rotation through the head stock 476. It will also be understood that relative reciprocation between the object 474 and the tool 470 may be accomplished either by reciprocating the bed 472, or by reciprocating the bed 484 upon which the head and tail stocks 476 and 478 are supported.

Although specific embodiments of the present invention have been described in detail, it will be evident that various modifications in the form, number and arrangement of the parts may be made, within the spirit and scope of the present invention.

What is claimed is:

1. A honing tool embodying a grinding head, a plurality of abrading elements carried by said head, means for driving said grinding head in rotation, an adjusting element concentric with said driving means, driving connections between said driving means and said adjusting element adapted to permit limited relative axial movement therebetween, an inertia member associated with said tool for effecting said relative movement and means responsive to said relative movement for adjusting the positions of said abrading elements.

2. In a honing tool embodying a grinding head, a plurality of abrading elements carried by said head, a driving sleeve for driving said grinding head in rotation, an adjusting element positioned within said driving sleeve to be driven thereby, driving connections between said driving means and said adjusting element permitting relative axial and rotative movement therebetween, the inertia of said adjusting element effecting said relative movement, and means responsive to said relative axial movement for adjusting the positions of said abrading elements.

3. A honing tool adapted to operate upon the external surface of an object comprising an abrading head having an axially extending body portion; an abrading element having an inwardly directed face positioned within and supported by said body for bodily movement with said body about the axis of said body, a rod extending parallel to said body portion; selectively actuable means for moving said rod parallel to the axis of said body portion; and means forming a connection between said rod and said abrading element for translating axial movement of said rod into movement of said abrading element radially of said head to thereby effect a radial adjustment of the position of said abrading element.

4. A honing tool adapted to operate upon the external surface of a work piece, comprising in combination a head having an axially extending body portion provided with a plurality of axially extending recesses therein; a plurality of inwardly presented stone holders positioned within and supported by said body portion; a plurality of adjusting rods slidably received within said recesses for axial movement therein; and means forming a connection between said stoneholders and said rods for translating axial movements of said rods into radial movements of said stoneholders.

5. A honing tool adapted to operate upon the external surface of a work piece comprising, in combination, a head having an axially extending body portion provided with a plurality of axially extending recesses therein; a plurality of inwardly presenting stoneholders positioned within said body portion and supported thereby; a plurality of rods slidably received within said recesses for movement therein between retracted and abrading positions; spring means acting between said rods and said body portion for urging said rods to a retracted position; and means forming a connection between said stoneholders and said rods for translating axial movements of said rods into radial movements of said stoneholders.

6. A honing tool adapted to operate upon the external surface of a work piece, comprising in combination a head having an axially extending body portion; a radially adjustable stoneholder carried by said head and adapted to support an abrading element for bodily movement with said body portion about the axis of said body portion; an adjusting member movable axially of said head for causing movement of said stoneholder radially of said head; and a connecting member between said adjusting member and said stoneholder for causing positive movement of said stoneholder in one direction in response to movement of said adjusting member in one direction, and for causing positive movement of said stoneholder in an opposite direction in response to an opposite direction of movement of said adjusting member.

7. A honing tool adapted to operate upon the external surface of a work piece comprising, in combination, a head having an axially extended body portion provided with a plurality of axially extending recesses therein; a plurality of inwardly presenting stoneholders positioned within said head and supported thereby; a plurality of adjusting rods slidably received within said recesses for movement between retracted and abrading positions; spring means acting between said rods and said head for urging said rods to said retracted position; and means connecting said stoneholders and said rods for causing movement of said rods to said abrading position to effect positive movement of said stoneholders to abrading position and for causing movement of said rods to said retracted position to effect positive movement of said stoneholders to said retracted position.

8. A honing tool adapted to operate upon the external surface of a work piece comprising, in combination, a head having an axially extended body portion provided with a plurality of axially extending recesses therein; a plurality of inwardly presenting stoneholders positioned within said head and supported thereby; a plurality of

adjusting rods slidably received within said recesses for movement between retracted and abrading positions; spring means acting between said rods and said head for urging said rods to said retracted position; means connecting said rods and said stoneholders for translating movement of said rods to projected position into inward radial movement of said stoneholders; and additional means acting between said head and said stoneholders for causing radially outward movement of said stoneholders.

9. A honing tool adapted to operate upon the external surface of a work piece comprising, in combination, a head having an axially extended body portion provided with a plurality of axially extending recesses therein; a plurality of inwardly presenting stoneholders positioned within said head and supported thereby; a plurality of adjusting rods slidably received within said recesses for movement between retracted and abrading positions; spring means acting between said rods and said head for urging said rods to said retracted position; means connecting said rods and said stoneholders for translating movement of said rods to projected position into inward radial movement of said stoneholders; and additional means acting between said head and said stoneholders for urging said stoneholders radially outwardly and for permitting limited rocking movement of said stoneholders axially of said body portion.

10. A honing tool adapted to operate upon the external surface of a work piece comprising, in combination, a head having an axially extended body portion provided with a plurality of axially extending recesses therein; a plurality of inwardly presenting stoneholders positioned within said head and supported thereby; a plurality of adjusting rods slidably received within said recesses for movement between retracted and abrading positions; spring means acting between said rods and said head for urging said rods to said retracted position; means connecting said rods and said stoneholders for translating movement of said rods to projected position into inward radial movement of said stoneholders; additional means comprising collars associated with the respective ends of said stoneholders for urging said stoneholders radially outwardly and for permitting limited rocking of said stoneholders axially of said body portion; and means resiliently connecting said collars to said body portion.

11. A honing tool adapted to operate upon the external surface of a work piece comprising, in combination, an abrading head having an axially extending hollow body portion disposed for axial rotation; an inwardly presented stoneholder positioned within and supported by said body for rotation therewith; means acting between said body and said stoneholder for effecting radial adjustments of said stoneholder; a non-rotatably supported guide sleeve to receive said head; and means adapting the external surface of said head for rotation within said guide sleeve.

12. A honing tool adapted to operate upon the external surface of a work piece comprising, in combination, a rotatable and reciprocable head having an axially extending body portion; a plurality of inwardly presenting stoneholders positioned within said head and supported thereby; selectively actuable means for effecting radial adjustments of said stoneholders; a guide sleeve surrounding said head and having axially fixed inner and outer relatively rotatable elements; and means adapting the exterior of said head for sliding engagement with the inner of said two sleeve members.

13. A work support for an internal combustion engine piston having diametrically opposed wrist pin bearing openings in the skirt thereof, comprising, in combination, a standard adapted to be received in said piston in axially extending relation, said standard having a transversely extended passage adjacent one end thereof; a pin adapted to be received within said passage and to have its ends received in said wrist pin openings; detent means acting between said pin and said standard for retaining said pin within said transverse opening; and a sleeve-like member surrounding said standard and resiliently connected thereto for universal movement relative thereto and adapted to resiliently support the base of the skirt of said piston.

14. A honing tool adapted to operate upon the external surface of an object comprising a grinding head, a radially adjustable abrading element, means movably supporting said abrading element within said head, a drive member for said head connected in axially spaced relation thereto, an adjusting member for said abrading element, said driving and adjusting members being telescopically related, and the inner of said members having a bore sufficiently large to permit said object to be passed axially therethrough.

15. A honing tool embodying a grinding head, abrading means carried by said grinding head, driving means for said grinding head, an adjusting element including an inertia member driven by said driving means, connections between the adjusting element and the driving means so that movement of the driving means applies positive driving force to said adjusting element, said connections permitting relative movement between the adjusting element and the driving means, the inertia of said member being effective to cause said relative movement against the said force, and means responsive to said relative movement for adjusting the position of said abrading means.

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