Nov. 25, 1930. A. M. JOHNSON 1,783,019

HONING MACHINE

Filed Dec. 4, 1926 6 Sheets-Sheet 1

Fig. 1.

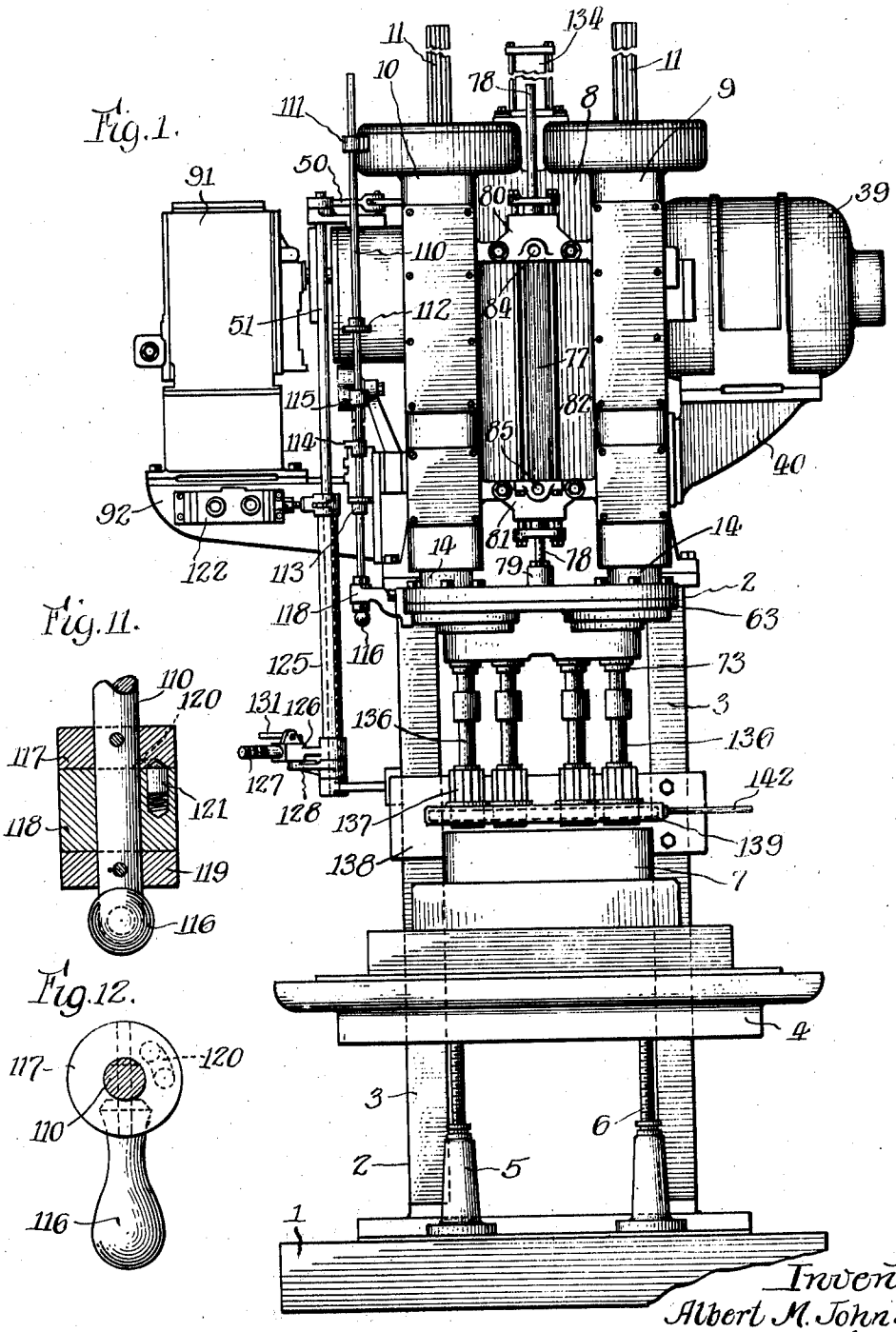


Fig. 11.

Fig. 12.

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HONING MACHINE

Filed Dec. 4, 1926 6 Sheets-Sheet 2

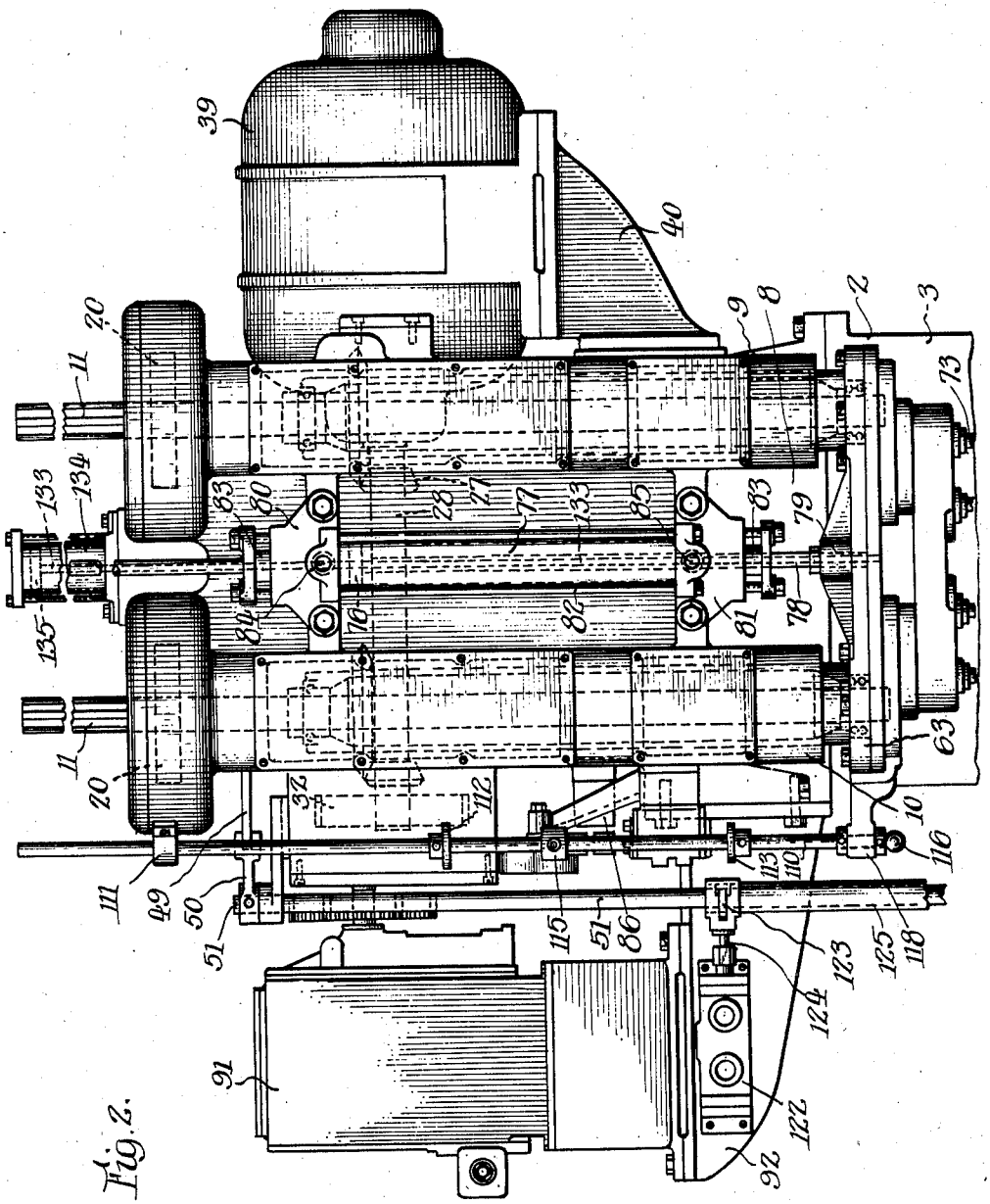


Fig. 2.

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HONING MACHINE

Filed Dec. 4, 1926 6 Sheets-Sheet 3

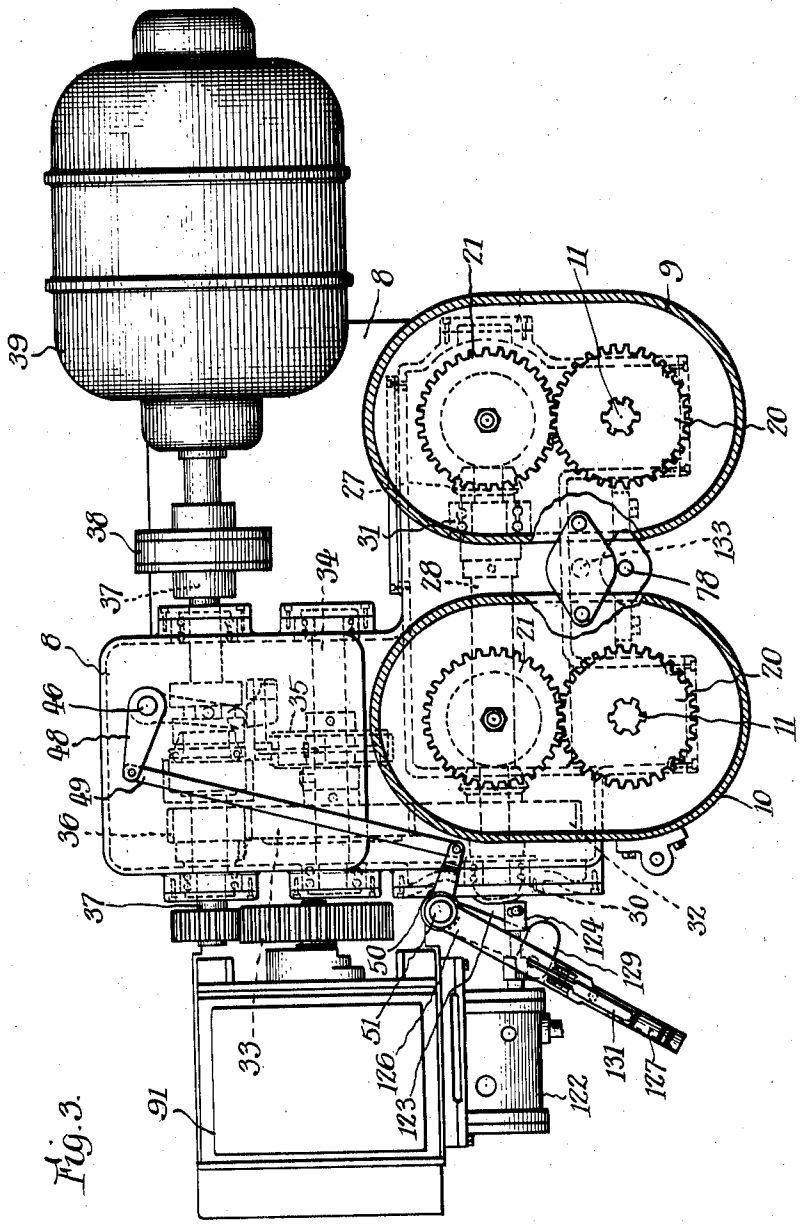


Fig. 3.

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HONING MACHINE

Filed Dec. 4, 1926 6 Sheets-Sheet 4

Fig. 4.

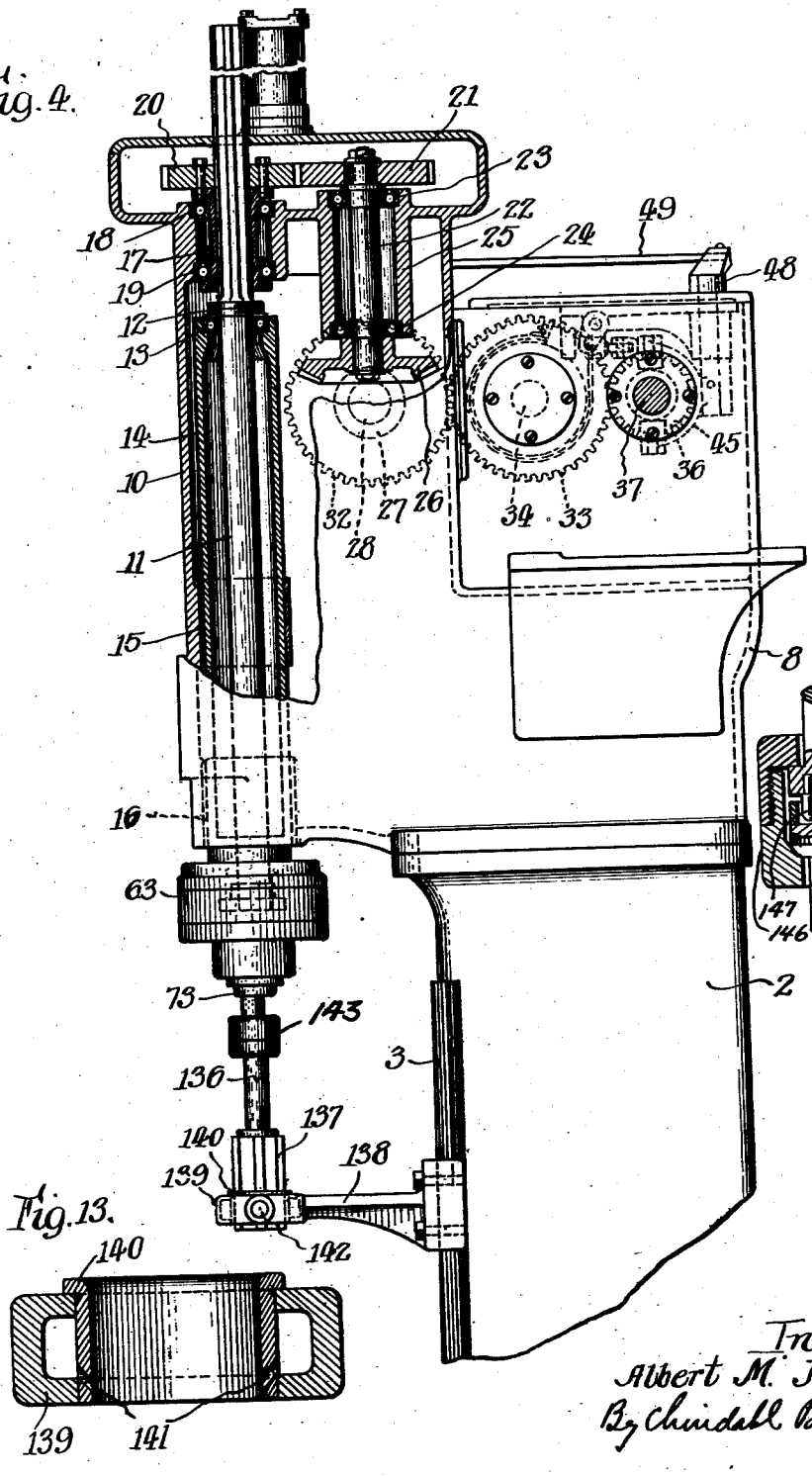


Fig. 14.

Fig. 13.

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HONING MACHINE

Filed Dec. 4, 1926 6 Sheets-Sheet 5

Fig. 5.

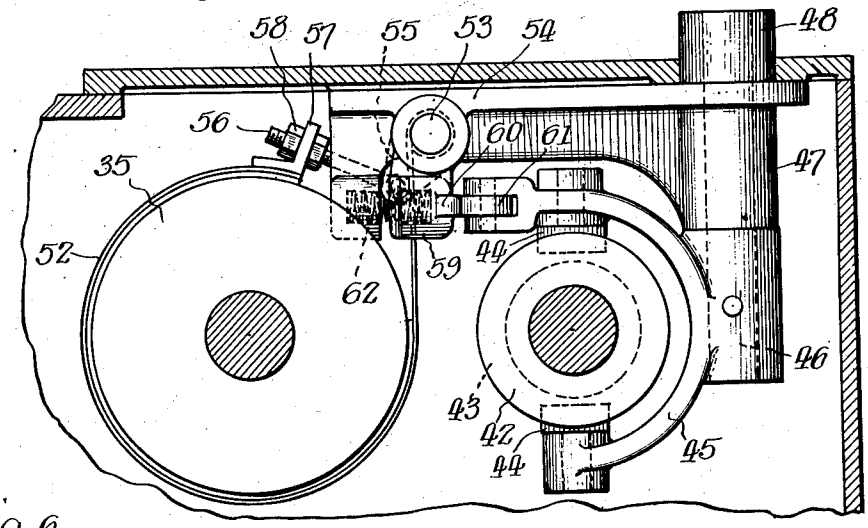
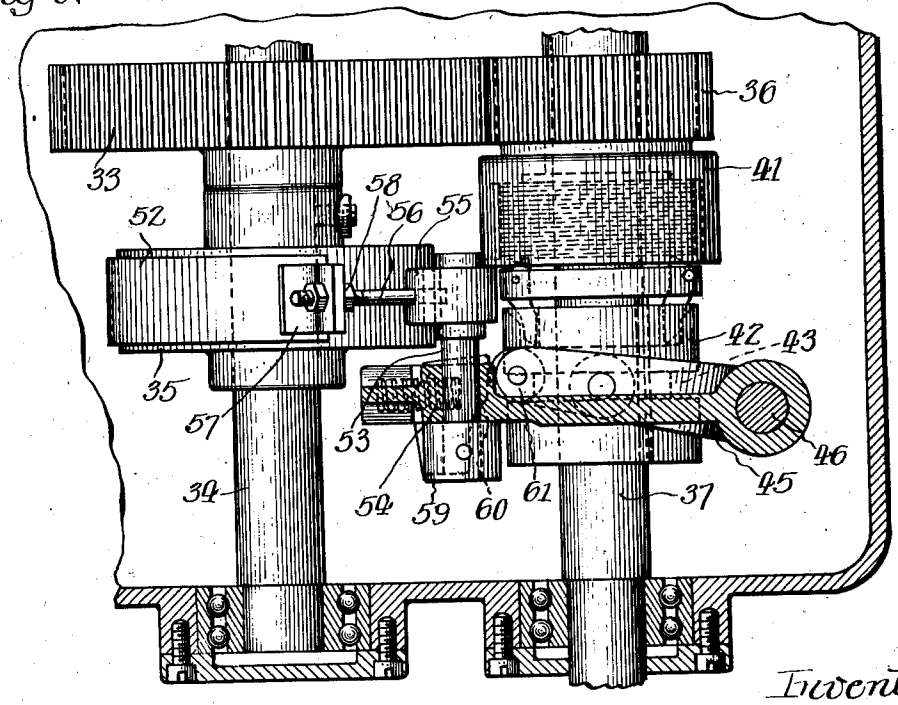


Fig. 6.



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HONING MACHINE

Filed Dec. 4, 1926 6 Sheets-Sheet 6

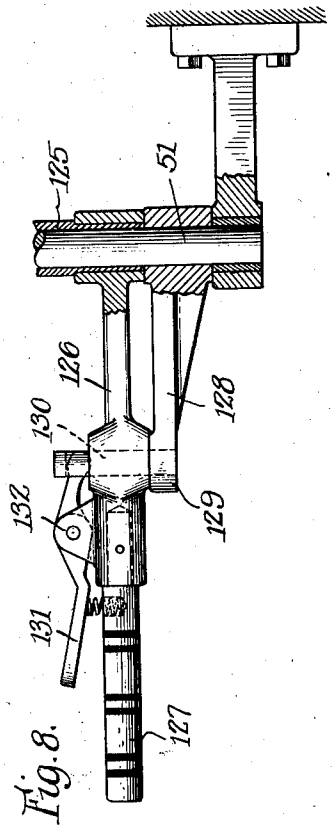


Fig. 8.

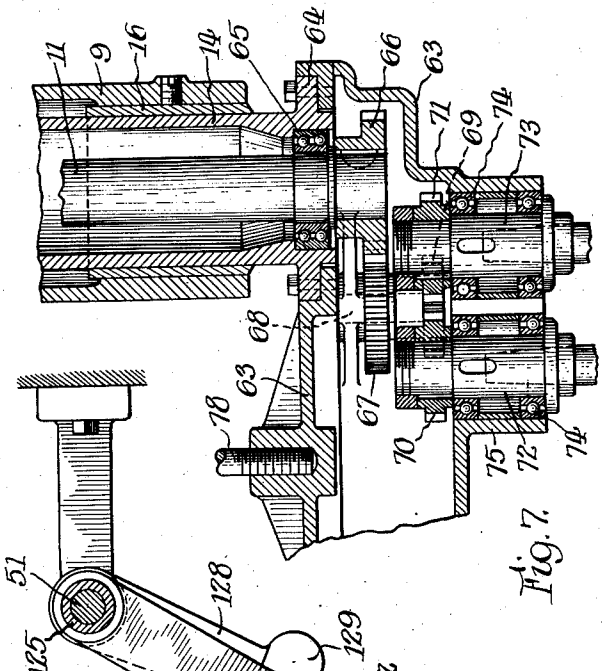


Fig. 7.

Fig. 9.

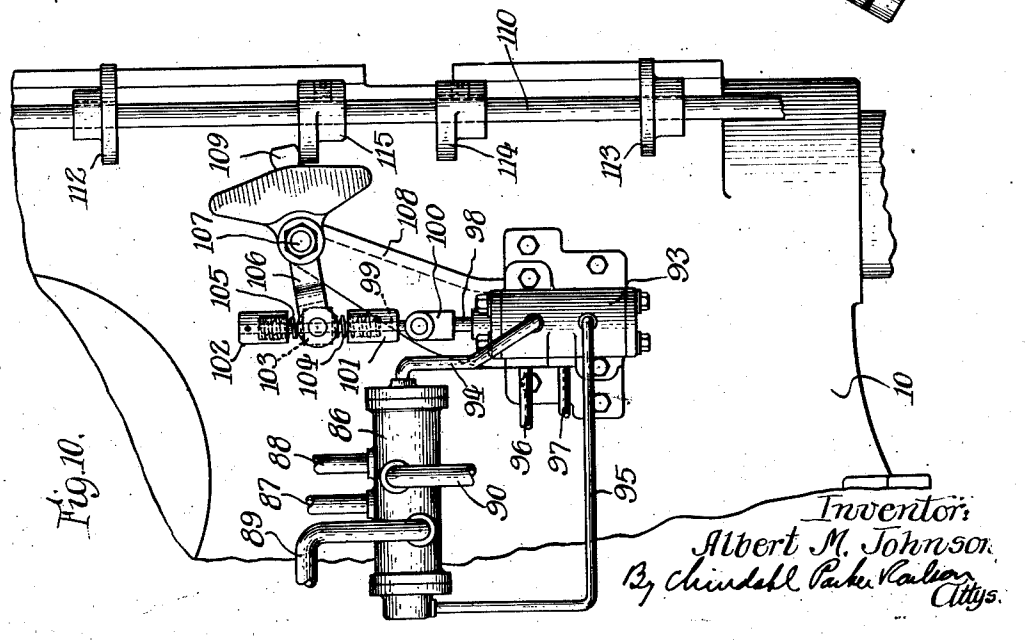


Fig. 10.

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Patented Nov. 25, 1930

1,783,019

UNITED STATES PATENT OFFICE

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HONING MACHINE

Application filed December 4, 1926. Serial No. 152,560.

The invention relates to a machine for honing cylindrical surfaces to a true contour and smooth finish, and more particularly relates to a machine for producing a smooth true finish on internal cylindrical bearing surfaces such as engine cylinders, bearing bushings, etc.

Heretofore the finishing of such cylinders as, for example, internal combustion engine cylinders, has been done by what is generally known as internal grinding. The ordinary grinding method employs an abrasive wheel supported on a rigid spindle revolving on a fixed axis and having merely tangential contact with the surface being worked, resulting in appreciable roughness and irregularity in the finished bearing surface which requires long use to wear to a smooth surface.

The present invention is embodied in a machine for accurately and smoothly finishing a cylindrical surface by a honing operation, in which fine abrasive stones are rubbed upon the surface in constant contact therewith over a substantial area, and with a simultaneous rotary and reciprocatory movement which quickly trues and smooths the surface. The honing stones are operatively supported in a revolving head having a flexible spindle so that the stones may position themselves in accurate conformity to the axis of the cylinder being worked.

The principal object of the invention is to provide a machine adapted for the honing operation indicated in which a group of honing tools is operatively supported from a reciprocatory head having driving mechanism operating to effect the rotation of the tools simultaneously with their reciprocatory movement.

Another object is to provide controlling means for the mechanisms effecting the rotary and reciprocatory movements of the honing tools, by which those movements may be controlled jointly or separately, and by which the limits of the reciprocatory movement may be varied at the will of the operator.

Another object is to provide an efficient arrangement of hydraulic means for reciprocating a multiple tool support in association with means for continuously rotating the tools, wherein the tool support is balanced for accuracy and ease of operation.

Another object is to provide an adjustable guiding device for the honing tools, in which is incorporated means for delivering a liquid coolant to the tools when in working engagement.

Further objects include the provision of means for counterbalancing the weight of the reciprocating parts, and braking means for preventing overrun in the tool rotating mechanism.

Further objects and advantages will be apparent in the following detailed description of a preferred embodiment of the invention which has been selected for illustration in the accompanying drawings. It will be understood, however, that many changes in form, construction and arrangement may be made by those skilled in the art without departing from the scope and spirit of the invention, as expressed in the appended claims.

Referring to the drawings

Figure 1 is a front elevation of the complete machine.

Fig. 2 is a front elevation of the upper portion of the machine, illustrating in shadow certain of the enclosed operating parts.

Fig. 3 is a plan view of the machine partially in section and illustrating the spindle driving mechanism.

Fig. 4 is a side elevation of the upper portion of the machine partially in vertical section and further illustrating the driving mechanism for the spindles.

Figs. 5 and 6 are respectively a fractional sectional elevation and a sectional plan view of the improved braking mechanism for controlling the spindle driving gears.

Fig. 7 is a fractional sectional elevation of the spindle driving mechanism carried within the reciprocating head.

Figs. 8 and 9 are respectively a fractional side elevation and a plan view of a lever and latch control for the spindle driving and reciprocating head actuating means.

Fig. 10 is a partial plan view of the automatic controlling devices for the hydraulic reciprocating head actuating means.

Figs. 11 and 12 are detailed sectional views

of a portion of the hand manipulated control for the reciprocating head.

Fig. 13 is a cross sectional view of the honing tool guiding bracket illustrating the conduit for the liquid coolant.

Fig. 14 is a detail view of the spindle mountings.

Generally stated, the machine as illustrated herein, comprises a base having an upright column from which is supported a table for carrying the work to be operated upon. The upper portion of the column carries a pair of spaced housings in each of which is operatively supported a vertically reciprocatory shaft together with mechanism for rotating the shaft. Below the housings and over the work is positioned a reciprocatory head having guiding support in the housings and into which the two shafts extend. A group of tool carrying spindles is operatively mounted on the under side of the head having rotating driving connections within the head with the shafts, and supporting the honing tools for operative engagement with the work.

The reciprocatory head is actuated by a hydraulic piston connected centrally of the head and having its cylinder positioned between the spaced housings. A suitable pressure pump is provided with means for automatically supplying liquid to alternate ends of the cylinder, the automatic means being controlled by hand manipulated means fully described hereinafter. Associated with the latter is controlling means for the spindle rotating mechanism, the combined control being especially convenient to the operator of the machine.

Connected with the reciprocating head is a pneumatic device for counterbalancing the weight of the reciprocating tool supporting assembly. An adjustable tool guide is also provided immediately adjacent the work to assure accurate entry of the tools into the work, the guide functioning also as means for delivering coolant liquid to the work.

The machine as herein illustrated is provided with four tool operating spindles, but it will be obvious that with slight rearrangement of parts, the machine may be constructed to operate a greater or less number of spindles.

More specifically described, the machine comprises a base 1 upon which is fixed an upright column 2 frontwardly provided with a pair of vertical slide ways 3. A work supporting table 4 having slidably adjustable guiding support on the ways 3 is further supported from the base 1 by means of adjustable elevating screw standards 5 and 6. For the purpose of illustration herein, a piece of work is shown to be supported on the table comprising, in the present instance, a four cylinder internal combustion motor block 7 secured by any suitable means to the table 4.

Mounted upon the upper end of the column 2 is a main housing 8 having a pair of upright auxiliary housings 9 and 10 extending frontwardly therefrom in spaced relation, the lower ends of which are positioned above the work supported on the table 4.

The auxiliary housings 9 and 10 each support a vertically positioned spindle driving shaft 11. The spindle shafts and their associated parts being similarly constructed, will be described as to one only and similar reference numerals applied to both. The shaft 11 is preferably provided with a thrust collar 12 (see Fig. 4) intermediately positioned on the shaft in secured relation thereto and bearing on its under side upon a conventional anti friction bearing 13 which is secured in the upper end of a guide sleeve 14. The latter extends through the lower end of the auxiliary housing 10, and is preferably provided with spaced bearings therein as illustrated at 15 and 16, the spindle driving shaft 11 extending outwardly from the lower end of the guide sleeve 14.

The upper end of the spindle driving shaft 11 is preferably splined and extends upwardly of the upper wall of the housing 10. Within the housing and in longitudinally slidable relation to the splined portion of the shaft, there is operatively mounted on the shaft a gear sleeve 17 having rotatable support in conventional antifriction bearings 18 and 19 supported in the housing. Secured to the sleeve 17 is a spur gear 20 having driven engagement with a gear 21 mounted on the stub shaft 22 operatively supported in the housing, preferably in spaced antifriction bearings 23 and 24 suitably secured in a stationary bearing hub 25.

The lower end of the stub shaft 22 carries in secured relation thereto a bevel gear 26 having driven engagement with a pinion 27 carried upon the shaft 28, the latter extending horizontally through the two housings 9 and 10 and having similar driving connection with both mechanisms for rotating the respective spindle driving shafts. The horizontal shaft 28 has suitable bearings provided in the side walls of the auxiliary housings 9 and 10 as indicated at 30 and 31.

Secured to the shaft 28 is a gear 32 having driven engagement with a gear 33 (see Figs. 3 and 6) securely mounted on the jack shaft 34 supported in bearings suitably positioned in the side walls of the main housing. The jack shaft 34 also carries, in fixed relation to the gear 33, a brake drum 35 with which is associated the braking mechanism to be more fully described hereinafter.

The gear 33 is in driven engagement with a pinion 36 loosely mounted upon the main drive shaft 37, the latter having suitable bearings in the side walls of the housing 8 and extending outwardly thereof at both ends, one end of the shaft 37 being prefer-

ably connected through a universal coupling 38 with the driving shaft of a motor 39 preferably mounted upon a suitable bracket 40 supported upon a wall of the housing 8.

Within the housing 8 the main drive shaft 37 carries a conventional clutch device (see Figs. 5 and 6) of which one element 41 is rigid with the pinion 36 and loosely rotatable upon the shaft 37, and the other element 42 is non-rotatably slidable thereupon to actuate conventional clutch engaging fingers effecting the operative control of the clutch in a manner well known in such devices. The element 42 is provided with an annular channel 43 in which is operatively positioned a pair of shifting members 44 supported in the opposite arms of the yoke 45, which latter is secured upon the stub shaft 46 extending through the upper wall of the housing and supported in a suitable bearing 47 provided therefor. The upper end of the stub shaft 46 carries a crank 48 rigid therewith, the outer end of which pivotally supports a connecting link 49 (see Figs. 2 and 3) the other end of said link being pivoted to a crank 50 rigidly mounted on a controlling rod 51 rotatively supported at one side and upon the main housing.

The braking mechanism, which is associated with the brake drum 35 and which functions to prevent overrun of the spindle driving shaft and its actuating mechanism when the clutch element 42 is moved into inoperative position, comprises a conventional brake band 52 (see Figs. 5 and 6) frictionally supported upon the periphery of the drum 35 and of which one end is secured to a stub shaft 53 suitably supported in a bracket 54 formed on the adjacent wall of the housing. The stub shaft 53 is provided with a short crank 55 fixed thereon and carrying at its bifurcated free end a cross pin upon which is operatively supported on eye-bolt 56 extending through an angle bracket 57 fixed upon the other end of the brake band 52, the eye-bolt being adjustably secured to the angle bracket by means of the positioned nuts 58.

The stub shaft 53 is also provided with a secured cam lever 59 having a lobe 60 angularly formed upon its free end and extending adjacent to an extended arm of the clutch shifting yoke 45. The extended yoke arm is provided with a roller 61 having a fixed pivot thereon and positioned to engage the cam lobe 60 when the yoke is shifted into clutch engaging position, thereby rotating the stub shaft 53 and the crank 55 to free the brake band 52 from the drum 35. When the clutch shifting yoke 45 is in position to release the main shaft driving clutch, the roller 61 is moved out of operative contact with the cam lever 59 and the latter is moved in opposite direction by a spring 62 having one end in operative engagement with the cam lever and confined in a suitable pocket provided in the bracket 54. The action of the spring 62 upon the released cam lever effects the swinging of the crank 55 to draw the brake band 52 into braking frictional contact with the drum 35, and quickly stops the rotation of the spindle shaft driving mechanism when released from the main driving shaft.

Positioned below the lower ends of the auxiliary housings 9 and 10 is a reciprocatory head structure 63 endwardly supported in secured relation upon the two guide sleeves 14 and operative therewith in reciprocatory movement upon the axes of the guiding sleeves. The head 63 is constructed preferably in hollow formation having sectionally divided upper and lower walls. The guiding sleeves 14 are secured to the upper wall of the head 63 (see Fig. 7) each of the sleeves having an annular flange 64 positioned in annular pockets provided in the upper wall of the head and secured thereto as by bolts. The respective spindle driving shafts 11 extend into the adjacent ends of the head structure 63, being supported at their lower ends preferably in anti-friction bearings 65 secured in the lower ends of the guide sleeves 14.

The downwardly protruding ends of the driving shafts 11 each carry a toothed pinion 66 having operative engagement with a gear 67 operatively mounted upon a stub shaft 68 having suitable bearings in the upper and lower wall structure of the head 63. The gear 67 is in fixed relation to a pinion 69 also mounted on the stub-shaft 68 which latter is in driving engagement with a pair of gears 70 and 71, the latter being independent of each other and securely mounted upon the upper ends respectively of the spindle supporting socket members 72 and 73, the latter being preferably carried in spaced anti-friction bearings 74 suitably mounted in the bearing flanges 75 formed in the lower wall of the head structure.

In the machine herein disclosed the head structure supports four tool operating spindles, two of which are operatively connected to each of the spindle driving shafts 11 as next above described. It will be obvious that more spindles may be added and simultaneously operated from the head 63 by including more of the spindle supporting sockets with similar driving gears on their upper ends, and with interengaging gears similar to the gear 69 for extending the train to any number of spindles desirable.

The reciprocatory movement of the head 63 is accomplished by means of a hydraulically actuated piston 76 operable in the cylinder 77 and having a connecting rod 78 extending through the lower end of the cylinder for operative attachment to the head 63, the connecting rod being preferably screw threaded at its connecting end for engagement in a lug 79 formed on the reciprocating head and

locked in position as by a conventional lock nut.

The cylinder 77 is positioned between the two housings 9 and 10 which enclose the guide sleeves 14, the ends of the cylinder being supported in an upper bracket 80 and a lower bracket 81 mounted between the spaced inner walls of the housings. The brackets 80 and 81 are preferably supported against separation longitudinally of the cylinder by means of tension rods 82 suitably secured therein. The connecting rod 78 preferably extends through the upper end of the cylinder to equalize the area above and below the piston and maintain uniform speed thereof, the two ends of the connecting rod having conventional pack bearings in the ends of the cylinder as indicated at 83. The central attachment of the connecting rod 78 with the head structure 63 effects the application of power for the reciprocation of the latter at a point which balances the head structure in its reciprocating movement and minimizes the possibility of side sway or twisting, and assures even wear upon the guide sleeves 14. This arrangement increases the accuracy of movement of the honing tools.

The upper and lower ends of the cylinder 77 are provided respectively with ports 84 and 85 opening through the brackets 80 and 81 into communication with the interior of the cylinder. The ports 84 and 85 are respectively in communication through suitable piping (not shown) with a pressure fluid circulating or hydraulic system for actuating continuously reciprocatory mechanisms, which is well known in the art and does not form a part of the present invention but which is partially disclosed herein, and for clarity is described as to its principal elements which are designed to operate with oil. The pipe connections with the ports 84 and 85 lead to a four way controlling valve 86 (see Fig. 10) and are indicated at 87 and 88. Other pipe connections 90 and 89 also leading to the four way valve 86 are respectively connected with the pressure side and the suction side of a suitable oil pump, the latter being generally indicated at 91 in Figs. 1, 2 and 3, the pump being enclosed in a suitable casing and mounted upon the bracket 92 supported on the side wall of the housing. The control valve 86 operates to direct the pressure fluid into the connections 87 and 88 with the cylinder parts to cause continuous reciprocation of the piston 76, and its operation is effected by the longitudinal movement therein of a piston which is in turn controlled by a pilot valve 93, having pipe connections 94 and 95 with opposite ends of the four-way valve cylinder, and having pressure and suction pipe connections 96 and 97 with the pump 91. The pilot valve 93 includes a longitudinally moving piston controlling the ports through the pipe connections with the ends of the four-way valve, and is controlled by means of a piston rod 98.

The piston rod 98 carries a spring stop device comprising a bar 99 pivotally mounted at one end in a bearing block 100 secured to the piston rod. The bar 99 has mounted thereon in spaced relation a pair of endwardly recessed elements 101 and 102, the recesses therein opening inwardly and longitudinally of the bar 99. Positioned between the elements 101 and 102 is a block 103 slidably mounted on the rod 99 and spaced respectively from the recessed elements. Positioned in the respective recesses is a pair of coiled springs 104 and 105 confined in the recesses and bearing inwardly upon the block 103, thus offering resilient resistance to the movement of the block along the bar 99 out of normally centered position. The block 103 is pivotally secured to a lever 106 having pivotal mounting on a pin 107 secured in a bracket 108 suitably mounted on the side wall of the housing 10. The lever 106 extends oppositely to form a lug 109 protruding from a counter-weighted portion of the lever. The pilot valve controlling mechanism here described is constructed to permit the movement of the pilot valve with a slight overrun in the valve operating lever 106 against spring tension, to assure the complete movement of the valve and protect it against possible damage by jamming.

Mounted laterally on the reciprocating head 63, is a stop bar 110 extending parallel to the axis of movement of the reciprocating head and having a sliding bearing support at its upper end in a bracket 111 mounted on the housing 10. The stop bar 110 is provided with a pair of stop disks 112 and 113 rigidly secured to the bar and positioned to engage the pilot valve operating lug 109 at the limits of movement of the head structure 63 as actuated by the hydraulic piston 76.

The stop bar 110 is also provided with auxiliary stops adjustably mounted on the bar intermediately of the stop disks 112 and 113. The adjustable stop 114, positioned nearer the lower stop disk, functions to vary the upper limit of the reciprocatory motion of the head 63, that limit being determined by the height necessary to withdraw the honing tools from the particular piece of work being operated upon. A second auxiliary stop 115 is adjustably mounted on the stop bar nearer the upper stop disk. The adjustable stops 114 and 115 are constructed for selective engagement with the pilot valve operating lug 109 by rotation of the stop bar 110, such rotation being effected by a hand lever 116 mounted on the lower end of the stop bar.

The selectively engaged auxiliary stops 114 and 115 are secured in either operative or inoperative position by means of a collar 117

(see Figs. 11 and 12) secured to the stop bar 110 and bearing upon the face of the bracket bearing 118 supporting the stop bar 110, the bearing relation being maintained by an oppositely positioned collar 119. The abutting face of the collar 117 is provided with a concentric recess 120 terminating at each end in a deeper recess. Mounted in the opposed face of the bracket bearing, is a pin 121 confining a coiled spring between its lower end and the bottom of its retaining recess, which tends to force it into the recess 120 in the collar 117, the deeper portions of the collar recess receiving the pin in the extreme limits of rotative movement of the stop bar, and securing it in such position until positively moved by the crank 116.

The auxiliary selective stop 115 and the upper stop disk 112 are normally positioned to limit the operative reciprocating movement of the honing tools after they have been lowered into the work to be honed. During this operation the auxiliary stop 115 is positioned for engagement with the pilot valve operating lever 109. At the end of the honing operation it is desired to withdraw the honing tools entirely from the work by lifting the reciprocating head above its normal operating movement, and this is accomplished by swinging the hand crank 116 to rotate the auxiliary stop 115 out of engaging position, whereupon the stop rod and reciprocating head rise to the limit of engagement of the first auxiliary stop 114 with the lever 109. When it is necessary to dress or replace the honing tools, the latter may be lifted wholly out of their guiding support (hereinafter described) by reversely swinging the hand crank 116 from the position described next above, thereby rotating the stop 114 into non-engaging position relative to the lever 109 and permitting the head to rise to the limit of the disk stop 113.

The reciprocating movement of the head 63 and its supported spindles is further controlled by a main control valve 122 (see Figs. 1, 2 and 3) interposed in the main pressure line from the pressure pump 91, and by which the oil may be directed under pressure to the four-way valve 86 or cut off therefrom, or bypassed to the suction side of the pump. This main control valve is controlled by a crank 123 having pivoted connection with the valve stem 124 of the reciprocating valve member of the main control. The crank 123 is mounted upon a sleeve 125 carried in rotative relation upon the lower portion of the control rod 51. The closing of the main control valve 122 positively prevents the circulation of the oil through the reciprocating mechanism and secures the latter in such position as it may be in when the valve is closed.

A convenient combined hand manipulating control for the main control valve through the sleeve 125, and for the clutch controlling the actuating mechanism for the spindle shafts through the bar 51, comprises a crank bracket 126 (see Figs. 1, 8 and 9) secured to the lower end of the sleeve 125 and extending laterally thereof, the bracket 126 having an extended handle 127 secured in its outer end. Beneath the bracket 126 is an independent radially extending bracket 128 which is secured to the control rod 51 and is provided at its outer end with a concentric plate 129 swingable in contact with the under side of the bracket 126. Mounted in the upper bracket 126 is an axially slidable pin 130 extending therethrough and into bearing contact with the concentric plate 129, at one end of which latter is provided an opening to receive the pin and lock the two brackets in common operative relation. The pin 130 is controlled by a latch 131 pivoted between a pair of lugs 132 formed on the upper surface of the bracket 126, and operatively engaged at its inner end with the pin 130, the outer end of the latch extending adjacent the handle 127 for convenient selective operation while swinging the handle. By this means, it will be obvious, the main control valve and thereby the reciprocating movement of the auxiliary head may be controlled independently of or coincidentally with the starting and stopping of the mechanism which rotates the tool carrying spindles. This is of great convenience and importance in the movement of the spindles into and out of position in the replacing of work to be operated upon.

Attached centrally of the reciprocating head 63 and rearwardly of the hydraulic piston connecting rod 78, is a second connecting rod 133 extending parallel to the axis of movement of the head and upwardly into a pneumatic cylinder 134 mounted on the upper wall of the housing, the connecting rod 133 being operatively secured to a piston 135 within the cylinder. The upper end of the cylinder 134 is provided with a port opening to the atmosphere, while the lower end has a port opening for free communication with a constant pressure reservoir or supply of compressed air. (Connections not herein shown.) This arrangement provides for utilizing a substantially constant reservoir air pressure for counterbalancing the weight of the reciprocating parts throughout their stroke, and materially aids the speed of operation and the quick reversal of those parts without dwell or shock.

Supported within the spindle sockets 72 and 73, at each end of the head 63, are the tool carrying spindles 136 at the lower ends of which are operatively supported the honing tools 137. The latter may be of any desired construction and generally comprise a series of longitudinally positioned spaced honing stones arranged in suitable retaining heads permitting expansion and contraction

of the stones within a limited range of diameter. It being necessary to provide flexible couplings in these spindles, so that the honing tool may automatically aline itself with the axis of the cylinder to be finished thereby, a tool guiding fixture 138 is provided immediately over the work being operated upon. The guiding fixture 138 is adjustably supported for vertical movement on the slideways 3 provided on the front face of the column 2, the fixture being secured in adjusted position by any suitable means well known to those familiar with the art. The fixture 138 includes a shelf 139 (see Fig. 13) extending laterally over the cylindrical openings to be worked by the honing tools, the shelf 139 having openings centered with the cylinders of the work, the openings preferably being provided with bushings 140 having inner cylindrical bearing passages of diameter similar to that of the cylinders to be worked. The shelf 139 is preferably of hollow construction to provide a coolant liquid conduit. The bushings 140 are respectively provided with lateral ports 141 opening into the chamber within the hollow shelf, the chamber having communication through a pipe 142 with a supply of circulating coolant liquid which is delivered through the ports 141 to the honing tools and the work being operated upon. With the guiding shelf 139 positioned adjacent the work, a new piece of the latter being placed therebeneath, the tools are guided by the bushings 140 into the cylinders to be worked, and upon completion of the honing operation, the honing tools are drawn upwardly out of the work as previously described in connection with the stop devices, the lower ends of the honing tools remaining in the guide bushings until the work has been replaced. At such time as it may be necessary to renew or dress the honing stones, the guide fixture 138 may be lowered out of engagement therewith or the reciprocating head 63 moved to the upper limit of its range of movement.

The flexible couplings provided in the spindles 136 and indicated at 143 in Fig. 4 may be of any desired construction.

A conventional coupling structure is illustrated in Fig. 14 and comprises upper and lower spindle sections 144 and 145 having flanged adjacent ends secured in operative relation by a sectional union collar 146 having its two parts screw threaded together and which permits lateral play between the spindle sections. The lower section of the spindle is maintained in driven relation to the upper section by a plurality of pins 147 fixed in the end of either or both of the sections and extending into over-size recesses in the end of the opposite section, wherein lost motion is provided between the pins and their respective recesses to permit the requisite relative lateral movement.

I claim as my invention:

1. A machine of the class described having, in combination, a reciprocatory head, rotatable spindles operatively supported upon said head, a pair of spaced guiding sleeves attached to said head, stationary bearings for said guiding sleeves, a pair of shafts respectively supported within said guiding sleeves and having operative connection with said spindles, means for rotating said shafts, and hydraulic reciprocating means operatively connected to said head between said guiding sleeves separately from said guiding members and shafts.

2. A machine of the class described having, in combination, a reciprocatory head, a rotatable spindle operatively supported upon said head, a pair of spaced guiding sleeves attached to said head, stationary bearings for said guiding sleeves, a pair of shafts respectively supported within said guiding sleeves and having driving connection with said spindle, a cylinder positioned between said guiding sleeves and axially parallel thereto, a hydraulically operable piston in said cylinder having operative connection with said head to impart reciprocatory movement thereto, and means for rotating said shafts simultaneously with the reciprocation of said head.

3. A machine of the class described having, in combination, a reciprocatory head, tool supporting spindles mounted on said head, honing tools operable by said spindles, means for rotating said spindles to effect a honing action, guiding means for said head, hydraulic means having a reciprocatory piston operatively connected to said head to impart reciprocatory movement thereto, a cylinder having one end open and having its other end adapted for free communication with a supply of pressure fluid of substantially constant pressure, and a piston in said cylinder having operative connection with said head, said last mentioned piston operating to resist the movement of said head in one direction and to aid its movement in the opposite direction, said rotating means and hydraulic means being operable simultaneously.

4. A honing machine having, in combination, a reciprocatory head, tool supporting spindles operatively mounted on said head, honing tools operable by said spindles, means for rotating said spindles to effect a honing action, guiding means for said head, hydraulic means having a reciprocatory piston operatively connected to said head to impart reciprocatory movement thereto, a cylinder having one end open and having its other end freely communicating with a supply of pressure fluid of substantially constant pressure, and a piston in said cylinder having operative connection with said head, said supply of pressure fluid being approximately maintained at a pressure substantially counterbalancing the weight of said head and its sup-

ported parts throughout the length of its reciprocatory path of movement.

5. A honing machine having, in combination, a reciprocatory head, tool supporting spindles operatively mounted on said head, honing tools operable by said spindles, means for rotating said spindles to effect a honing action, guiding means for said head, hydraulic means for reciprocating said head, and pneumatic means for counterbalancing the weight of said head and its attachments, said pneumatic means being operative with substanially constant effect throughout the path of movement of said reciprocatory head.

6. A honing machine having, in combination, a stationary work support, an upright shaft mounted for axial and rotational movement relative to said support, a honing tool suspended from said shaft and arranged to be driven thereby, manually controlled means for rotatably driving said shaft, valve-controlled hydraulically actuated means for reciprocating said shaft, and means for selectively effecting the controlling operation, of said manual means and said valve simultaneously or independently.

7. In a machine of the class described, the combination of a head, pressure fluid means for imparting continuous reciprocatory motion to said head, valve means controlling said pressure fluid means to limit the range of movement of said head, a relatively stationary member adapted to operate said valve means, a bar rotatably mounted on said head extending adjacent said member and substantially parallel to the axis of movement of said head, a pair of spaced elements mounted on said bar in position respectively to operatively engage said member at the extreme limits of movement of said head, and an intermediate element mounted on said bar adapted to be selectively moved by the rotation of said bar into position to operatively engage said member.

8. In a machine of the class described, the combination of a reciprocatory head, a bar rotatably mounted on said head and extending parallel to the axis of movement of said head, means for continuously reciprocating said head, controlling means for said reciprocating means adapted to limit the range of movement of said head and having an operating member extending adjacent said bar, a pair of spaced elements mounted on said bar in position respectively to operatively engage said member at the extreme limits of movement of said head, an intermediate element adjustably mounted on said bar adapted to be selectively moved by the rotation of said bar into position to operatively engage said member and determine an intermediate limit of movement of said head.

9. In a machine of the class described, the combination of a reciprocatory head, a bar rotatably mounted on said head and extending parallel to the axis of movement of said head, means for continuously reciprocating said head, controlling means for said reciprocating means adapted to limit the range of movement of said head and having an operating member extending adjacent said bar, a pair of spaced elements mounted on said bar in position respectively to operatively engage said member at the extreme limits of movement of said head, an intermediate element adjustably mounted on said bar adapted to be selectively moved by the rotation of said bar into position to operatively engage said member, a crank secured on said bar, and means for selectively retaining the position of said crank to selectively position said intermediate element.

10. In a honing machine of the class described, the combination of a reciprocatory head, a rotatable spindle operatively supported on said head, means for rotating said spindle, means for reciprocating said head, a rotatable bar operatively controlling one of said means, a sleeve rotatably mounted on said bar and operatively controlling the other of said means, and means for selectively rotating said sleeve and said bar coincidently or separably.

11. In a machine of the class described, the combination of a reciprocatory head, rotatable spindles operatively supported on said head, means for rotating said spindles, means for reciprocating said head, a rotatable bar operatively controlling said rotating means, a sleeve rotatably mounted on said bar and operatively controlling said reciprocating means, a crank handle mounted on said sleeve, a crank mounted on said bar extending adjacent said crank handle, and means for selectively interlocking said crank handle and said crank.

12. In a machine of the class described, the combination of a reciprocatory head, a rotatable spindle operatively supported on said head, means for rotating said spindle, means for reciprocating said head, a rotatable bar operatively controlling said rotating means, a sleeve rotatably mounted on said bar and operatively controlling said reciprocating means, a crank handle mounted on said sleeve, a crank mounted on said bar extending adjacent said crank handle, and a latch device mounted on said crank handle normally engaging said crank and adapted to be selectively disengaged therefrom.

13. In a honing machine, the combination of a reciprocatory head, means for reciprocating said head, a valve controlling said reciprocating means and having a longitudinally movable operating stem, a bar operatively connected to said stem, a pair of spaced members mounted on said bar, a slidable block positioned intermediately of

said members and spaced therefrom, resilient means confined between said slidable block and said members respectively, and an operating lever connected to said block, and a member mounted on said head positioned for reciprocatory movement therewith adjacent to said lever, said member having spaced elements adapted to operatively engage said lever.

14. In a honing machine, the combination of a reciprocatory head, a plurality of tool carrying spindles operatively supported on said head, means for supporting work in position for operation thereupon by said tools, and a guide member adjustably positioned adjacent said work adapted to guide said tools into said work, said guide member having conduits therein adapted to deliver coolant fluid upon said tools.

15. In a machine of the class described, the combination of a reciprocatory head, a tool supporting spindle rotatably mounted on said head, means for supporting work in position for operation thereupon by said tool, a guide member adjustably positioned adjacent said work having an opening therein to receive said tool, and a bushing mounted in said opening adapted to guide said tool for entry into said work, said guide member having a conduit therein for the circulation of coolant fluid, and said bushing having a port communicating therewith for the delivery of said fluid upon said tool.

16. A machine for truing the bore of an internal combustion engine cylinder or the like having, in combination, a spindle carrying a honing tool, a support upon which the work is positioned with the axis of the bore to be honed alined with the axis of the spindle, means for rotating the spindle, pressure fluid actuated means for effecting relative movement between the work and the spindle longitudinally of the latter, said pressure fluid actuated means having a main control valve and an auxiliary control valve, automatic means for operating said auxiliary valve, whereby to effect the continuous relative reciprocation with a normal stroke of a length determined by the length of the bore, manually operable means for controlling said automatic means to produce an abnormal stroke of a predetermined length such as to disassociate the tool and the work, independent means for operating said main control valve so as to stop relative longitudinal movement at the end of said abnormal stroke, and means controlled by the last mentioned means and operable to stop said spindle-rotating means coincident with the stopping of the reciprocating means.

17. A machine of the class described having, in combination, a reciprocatory head, a tool supporting spindle rotatably mounted in said head, a pair of spaced guide sleeves attached to said head, stationary bearing members for said sleeves, means for rotating said spindle including a driven shaft journaled in one of said bearing members and enclosed within the sleeve associated therewith, said shaft being operatively connected to said spindle, hydraulic reciprocating means including a piston and cylinder positioned between said guiding sleeves axially parallel thereto and operable to impart reciprocatory movements to the head, and means for rotating said shaft simultaneously with the reciprocation of said head.

18. A machine for truing the bore of an internal combustion engine cylinder or the like having, in combination, a spindle carrying a honing tool, a support upon which the work is positioned with the axis of the bore to be honed alined with the axis of the spindle, means for rotating the spindle, pressure fluid actuated means for effecting relative movement between the work and the spindle longitudinally of the latter, said pressure fluid actuated means having a hydraulic control valve, means operable to effect the continuous reciprocation of the spindle with a normal stroke of predetermined length, manually operable means for controlling said automatic means to produce an abnormal movement of the spindle of a predetermined length such as to disassociate the tool from the work, means for controlling the spindle-rotating means, and means for selectively effecting the controlling operation of said reciprocating means and said rotating means either simultaneously or independently.

19. A machine of the character set forth comprising, in combination, a tool carrier, a tool rotatably supported by the carrier, means for rotating the tool, a work carrier, means for rapidly reciprocating one of the carriers to effect relative reciprocatory movement between the tool and the work, a cylinder having one end open and its other end freely communicating with a source of pressure fluid of substantially constant pressure, and a piston in said cylinder having operative connection with said reciprocating carrier, said supply of pressure fluid being approximately maintained at a pressure substantially counterbalancing the weight of the reciprocating carrier and its attached parts throughout the length of its reciprocatory movement.

20. A machine of the character set forth comprising, in combination, a tool carrier, a tool rotatably supported by the carrier, means for driving the tool, a work carrier, means for rapidly reciprocating one of the carriers to effect relative reciprocatory movement between the tool and the work, and means including a source of fluid under pressure for counterbalancing the weight of the reciprocating carrier and its tools, said counterbalancing means being operative with substantially constant effect throughout the

path of movement of the reciprocatory carrier.

21. In a honing machine, the combination of a reciprocating member, a honing tool movable with said member, hydraulically actuated means for driving said member, means responsive to movement of said member for automatically reversing the same, means for rotating said tool, a control element under the control of the operator, means responsive to movement of said element for controlling said tool rotating means, and means under the control of said element for regulating the movement of said reciprocating member.

22. In a machine having a reciprocating member, the combination of hydraulic means for driving said member, valve mechanism automatically operable to reverse said member, additional valve mechanism for regulating the movement of said member, a tool movable with said member, means for rotating said tool, means for controlling said tool rotating means, and unitary means under the control of the operator for operating said regulating valve mechanism and said tool rotating means.

23. In a machine having a reciprocating member, the combination of hydraulic means for driving said member, means for regulating the reciprocating movement of said member, a tool movable with said member, means for rotating said tool, and unitary means under the control of the operator for operating said regulating means and for controlling the rotation of said tool.

24. A machine of the character set forth comprising, in combination, a work support, a tool spindle, a support in which said spindle is rotatably mounted, a tool on said spindle, manually controlled means including a clutch for rotatably driving said spindle, valve controlled hydraulically actuated means for effecting relative movement between said two supports in a direction axially of said spindle, and means for selectively effecting the operation of said clutch and said valve simultaneously or independently.

In testimony whereof, I have hereunto affixed my signature.

ALBERT M. JOHNSON.