

Sept. 9, 1941.

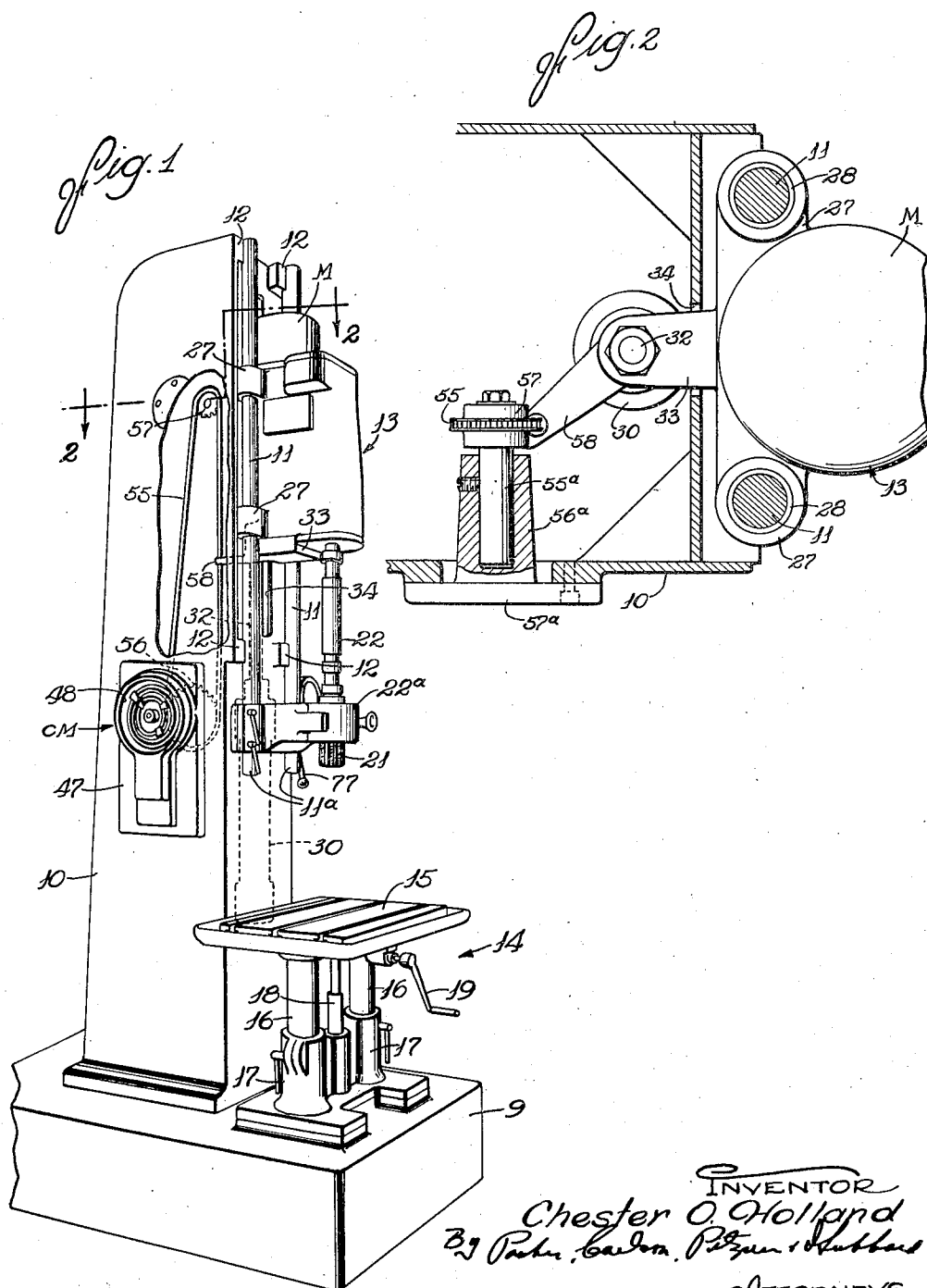
C. O. HOLLAND

2,255,583

HONING MACHINE

Filed April 15, 1939

4 Sheets-Sheet 1



INVENTOR
 Chester O. Holland
 By Parker, Carlson, Pitzer & Hubbard
 ATTORNEYS

Sept. 9, 1941.

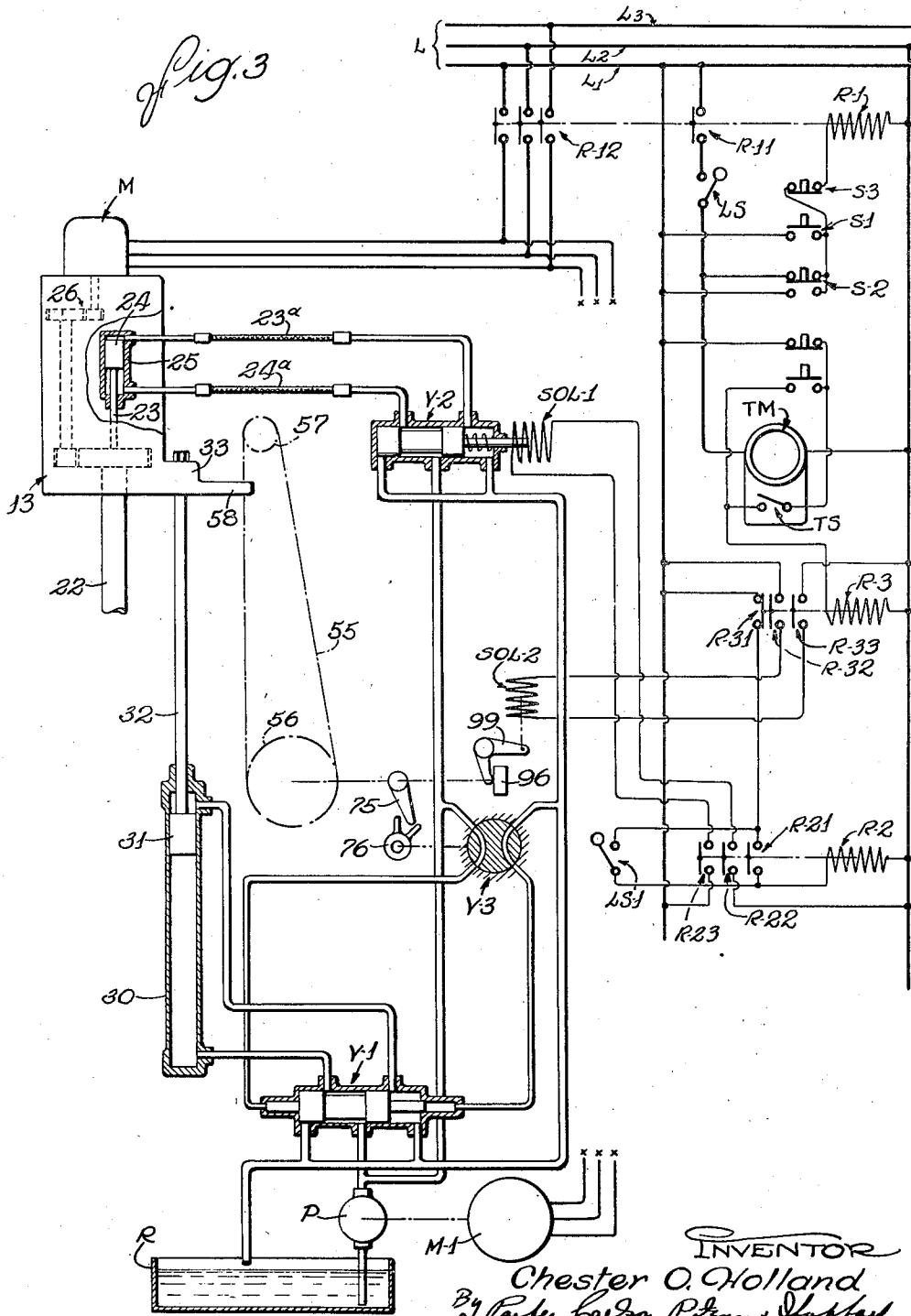
C. O. HOLLAND

2,255,583

HONING MACHINE

Filed April 15, 1939

4 Sheets-Sheet 2



INVENTOR
Chester O. Holland
 By *Parker, Carlson, P. J. & Shattuck*
 ATTORNEYS

Sept. 9, 1941.

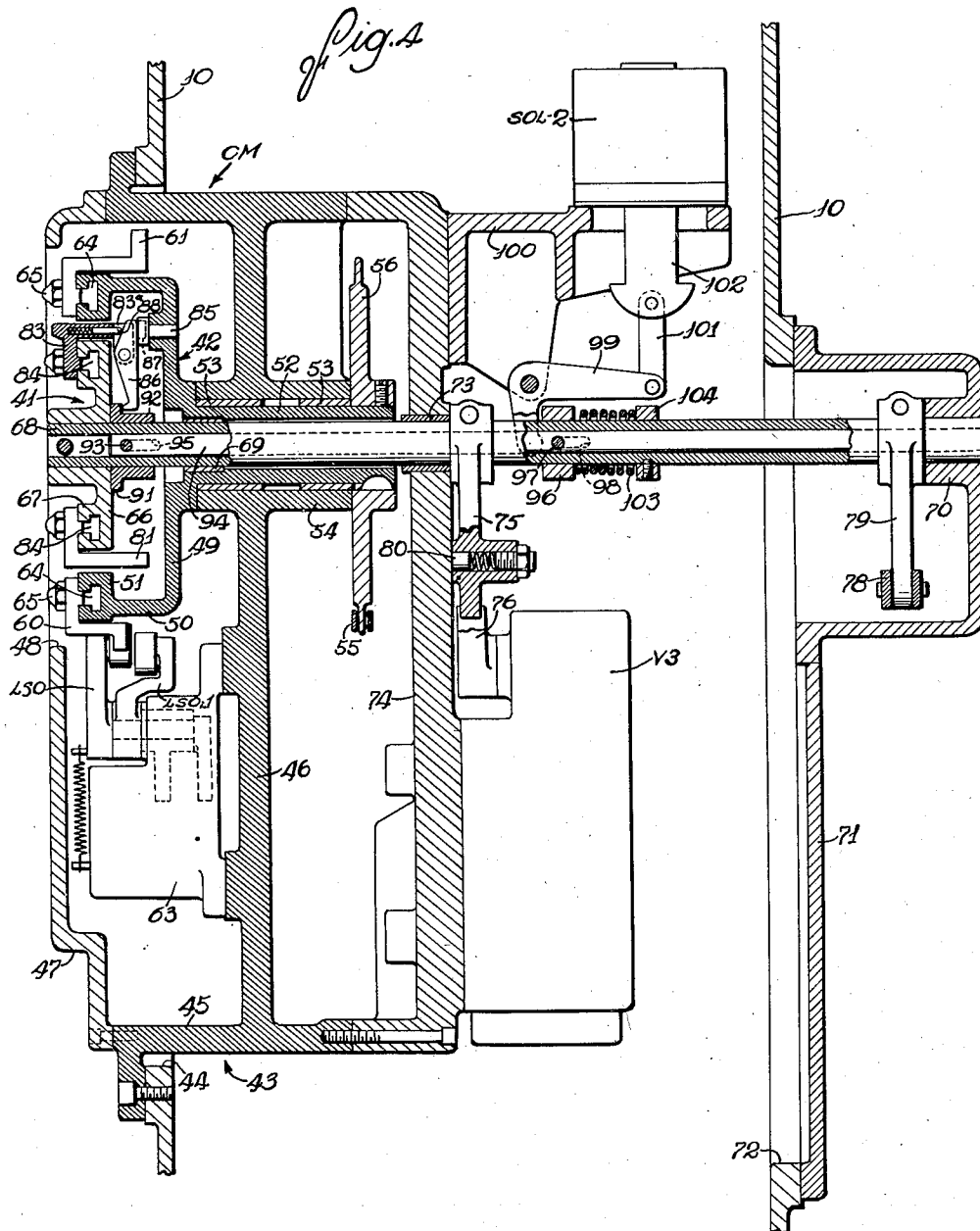
C. O. HOLLAND

2,255,583

HONING MACHINE

Filed April 15, 1939

4 Sheets-Sheet 3



INVENTOR
Chester O. Holland
By Parker, Baum, Pitzer & Hubbard
ATTORNEYS

Sept. 9, 1941.

C. O. HOLLAND

2,255,583

HONING MACHINE

Filed April 15, 1939

4 Sheets-Sheet 4

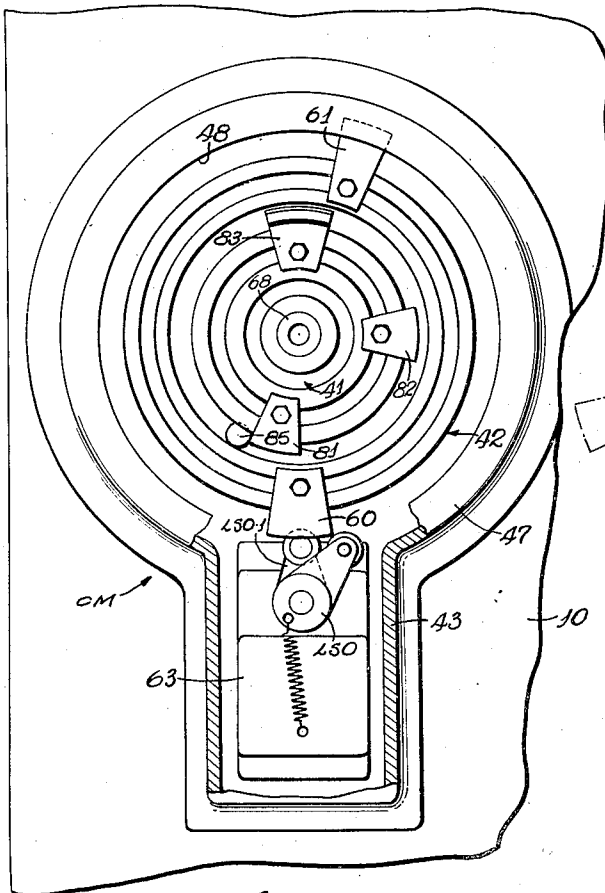


Fig. 5

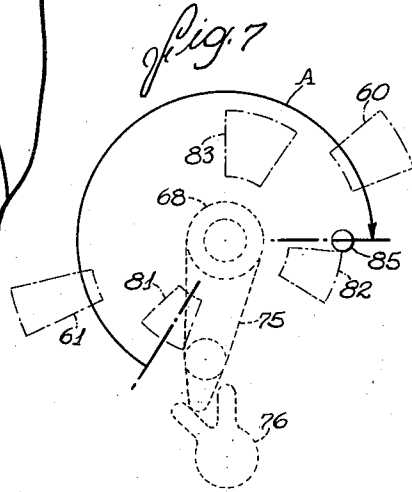


Fig. 7

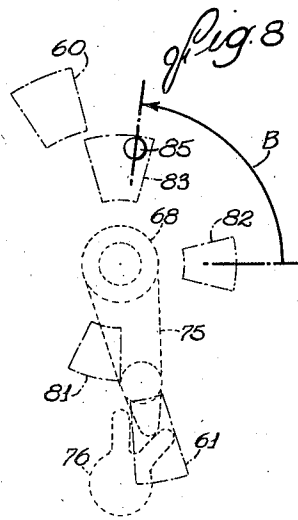


Fig. 8

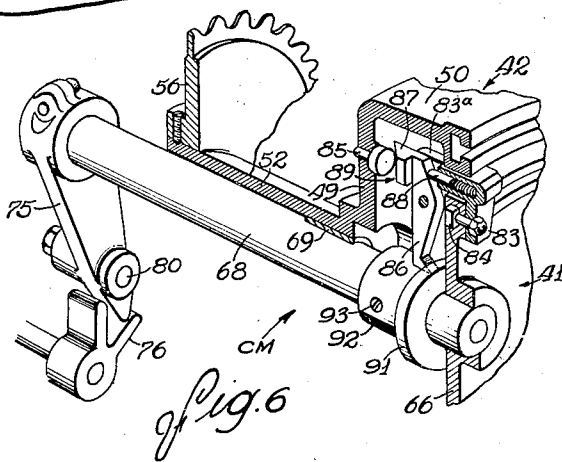


Fig. 6

INVENTOR
Chester O. Holland
By *Paul H. Carlson, Eugene J. Holland.*
ATTORNEYS

UNITED STATES PATENT OFFICE

2,255,583

HONING MACHINE

Chester O. Holland, Rockford, Ill., assignor to
Barnes Drill Co., Rockford, Ill., a corporation of
Illinois

Application April 15, 1939, Serial No. 267,976

20 Claims. (Cl. 51—34)

The invention relates to machines for dressing cylindrical surfaces, and more particularly to honing machines.

The honing operation as performed by machines of the above general character involves the relative rotation and simultaneous relative reciprocation of an expansible cylindrical abrasive tool or hone and the work piece. The tool and work piece are accordingly carried on separate supports one of which is mounted for movement toward and from the other. Preferably, the range of movement of the reciprocatory support is substantially greater than the longest work piece to be operated on so that the tool and work may be dissociated by an amplified movement of the reciprocatory support to a retracted position, thereby facilitating the removal of the finished work piece.

At the beginning of the honing operation the tool and work piece are initially brought into operative association by an advancing movement of the reciprocatory support and then the abrasive elements of the tool are expanded into contact with the surface of the work. Upon such operative association, the support is reciprocated through a plurality of working strokes to traverse the tool from one end of the work piece to the other. When the work is finished to the desired dimension, the tool is contracted and the reciprocatory support is moved through an amplified stroke to dissociate the tool and the work, thus terminating an operating cycle of the machine. The termination of the operating cycle is preferably controlled automatically.

One object of the present invention is to provide an improved control mechanism for controlling the movements of the reciprocatory support of a machine of the above general character.

Another object is to provide an improved control mechanism for controlling the reciprocation of the movable support and the expansion and contraction of the tool, which mechanism is readily adjustable to adapt the machine for operating on work pieces of different length and which has all of the adjusting instrumentalities grouped in an advantageous manner for convenient access.

Other objects reside in the provision of a vertical type machine which requires a minimum of headroom for its installation, which is compact and of clean appearance, with the associated control devices and other appurtenances enclosed within the frame or column, and which is efficient, reliable and safe in operation, these objects being attained through the novel con-

struction and arrangement of the component parts of the machine.

Additional objects and advantages of the invention will become apparent from the following detailed description of the preferred embodiment illustrated in the accompanying drawings, in which:

Figure 1 is a perspective view of a honing machine embodying the features of the invention.

Fig. 2 is a horizontal sectional view of the machine taken substantially along the line 2—2 of Fig. 1.

Fig. 3 is a diagrammatic view showing the relationship of the hydraulic, electrical and mechanical operating and control elements of the machine.

Fig. 4 is a vertical sectional view of the mechanical portion of the reciprocation controlling mechanism.

Fig. 5 is a face view of the reciprocation controlling mechanism shown in Fig. 4 as viewed from the side of the machine.

Fig. 6 is a fragmentary perspective view of the reciprocation controlling mechanism showing details of the intermediate stop.

Fig. 7 is a diagrammatic view showing the range of movement of the synchronously operated control element in the movement of the reciprocatory support through a full stroke, that is, from its fully retracted position to its forward limit position.

Fig. 8 is a diagrammatic view showing the range of movement of the control element in the movement of the reciprocatory support through a normal working stroke.

While the invention has been illustrated and will herein be described as embodied in a vertical honing machine of the type in which the tool is rotated and reciprocated relative to a stationarily supported work piece, it is to be understood that certain features of the invention may be incorporated in other types of honing machines. It is also to be understood that various changes and modifications may be made in the form, construction and arrangement of the parts without departing from the spirit and scope of the invention as expressed in the appended claims.

Referring to Figs. 1 to 3 of the drawings, the machine selected to illustrate the invention comprises generally a rectangular base 9 from which rises a hollow upright frame or column 10. Vertically disposed guide bars 11 supported in parallel spaced relation by bosses 12 projecting from the face of the column 10 constitute a guideway

for a reciprocatory support in the form of a head 13 constituting, in this instance, a tool support.

Mounted on the base 9 below the head 13 is a work support 14 herein shown as comprising a normally stationary table 15 carried on vertical standards 16 supported and guided for endwise sliding movement in vertical guide sleeves 17 rigidly secured to the base. The table may be raised or lowered to accommodate work pieces of different length by means of an elevating screw 18 adapted to be operated through the medium of a hand crank 19.

A work piece stationarily supported on the table 15 is adapted to be operated on by a rotating and reciprocating honing tool 21 of conventional construction. Accordingly, the honing tool is carried on one end of a hollow spindle 22 which is journaled at its other end on the head 13. A suitable guide 22^a adjustably supported on extensions 11^a of the guide bars 11 which project below the bosses 12 defining the lower end guideway for the head 13 serves to guide the tool 21 in its movements into or out of a work piece.

A honing tool of the type illustrated in Fig. 1 is adapted to be expanded and contracted by endwise movement of a tool actuating rod 23 (Fig. 3) extending through the hollow spindle 22 and into the head 13. Such movements are imparted to the rod 23 by power actuated means herein shown as comprising a piston 24 operating in a vertically disposed cylinder 25 mounted within the head 13 in axial alignment with the spindle. Pressure fluid is introduced into opposite ends of the cylinder 25 alternately through suitable ducts, such as the flexible tubes 23^a and 24^a, to shift the piston up or down in the cylinder in proper timed relation to the operation of the other parts of the machine, as will be described hereinafter.

In order to effect the relative rotation of the tool and work required for the performance of the honing operation, suitable power driven means, such as a motor M, is provided for rotating the tool spindle 22. In a preferred form of the machine, the spindle driving motor M is mounted directly on the head 13, as shown in Figs. 1 and 3, and is drivingly connected with the spindle by appropriate speed reduction gearing 26 enclosed within the head. The incorporation of the driving motor in the head in this manner materially simplifies the machine structure and in conjunction with other features of the machine to be described presently effects a material reduction in the over-all height of the machine.

As herein shown, the head 13 is mounted for reciprocation on the guide bars 11 by means of laterally projecting bearing brackets 27 (Figs. 1 and 2) apertured to receive bushings 28 of "Oilite" or other suitable bearing material arranged to slide on the guide bars. Four such brackets are provided in the machine illustrated, these being arranged in pairs on opposite sides of the head 13 with the brackets of each pair spaced apart a substantial distance longitudinally of the head so as to maintain the head in accurate alignment with the guide bars. Where the range of travel or stroke of the head is relatively long, it may be necessary or desirable to support the guide bars 11 at one or more points intermediate the bosses 12. In such instances, the sliding bearings 28 may be replaced by roller type bearings such as shown in the

Johnson Patent No. 2,139,234 of December 6, 1938.

While any suitable means may be utilized to reciprocate the head 13 on the guideway to move the tool into engagement with the work piece and to traverse it lengthwise thereof, it is preferred to employ hydraulically actuated means for this purpose because of the smoothness and uniformity of the motion produced by such driving mechanism. The hydraulically actuated means in its preferred form, as shown in Figs. 1-3, comprises a cylinder 30 mounted in a vertical position inside of the column 10 with its upper end located below the lower end of the guideway. A piston 31 working in the cylinder 30 is connected by a rod 32 with a bracket or arm 33 rigid with the head 13 and projecting rearwardly therefrom through a vertical slot 34 (Figs. 1 and 2) in the face of the guideway. Movements of the piston in the cylinder are therefore effective to move the head back and forth in the guideway, such movements being imparted to the piston by the introduction of pressure fluid into opposite ends of the cylinder alternately.

The location of the cylinder 30 at the rear of the head and below the guideway for the same instead of above the head as has heretofore been the general practice is advantageous in reducing the over-all height of the machine. Due to this arrangement of the head reciprocating cylinder and to the mounting of the spindle driving motor M directly on the head, there are no projecting parts, such as cylinders, drive shafts, etc., above the top of the column 10 even when the head is in its uppermost position and the machine therefore requires a minimum of headroom for its installation.

Pressure fluid for reciprocating the head 13 and for expanding and contracting the tool 21 is supplied to the cylinders 30 and 25, respectively, by a motor driven pressure fluid pump P through the hydraulic circuit shown diagrammatically in Fig. 3 of the drawings. A reversing valve V-1 controls the supply of pressure fluid to the head reciprocating cylinder 30 while a valve V-2, also of the reversing type, controls the supply of pressure fluid to the tool actuating cylinder 25. The valve V-1 as herein shown is adapted to be operated hydraulically to its two active positions under control of a pilot valve V-3 which, in turn, is operated in timed relation to the reciprocation of the tool head by novel reciprocation controlling mechanism CM, to be described presently. Valve V-2 is preferably spring-biased to the normal position shown in Fig. 3 and is adapted to be operated to reverse position by a solenoid SOL-1.

In order to enable the machine to operate efficiently and at a high productive capacity, it is equipped with a system of controls designed to reduce the work of the attendant to a minimum. This control system comprises interrelated electrical and mechanical control devices including the control mechanism CM, hereinbefore referred to, and operative in response to the momentary actuation of a simple control device such as a push button to initiate and carry through a complete machine cycle.

While the operating steps constituting a machine cycle may vary in different types of machines and for different classes of work, the operating cycle of the exemplary machine begins with the starting of the spindle driving motor M and the pump driving motor M-1. These motors are started by a momentary closure of the manually

operable push button "start" switch S—1 which connects a relay R—1 across line conductors L—1 and L—2 of a power line L which includes a third conductor L—3. Relay R—1 prepares a locking circuit for itself by closing switch R—11 and closes a switch R—12 to connect the motors M and M—1 across the line L.

To maintain the relay R—1 energized and thus continue the operation of the motors M and M—1 after the push button is released, the relay locking circuit is completed by a switch LS adapted to be closed by the control mechanism CM upon the movement of the head 13 from its fully retracted position. The locking circuit as herein shown includes a momentarily closed "inching" switch S—2 and a normally closed "stop" switch S—3. The latter switch is available for stopping the machine in case of emergency as it serves to open the circuit of the relay R—1 and thus effect opening of the motor switch R—12. The switch S—2 is utilized primarily in setting up the work when it is frequently necessary to operate the motors M and M—1 for short periods without initiating a complete machine cycle. To this end, the switch S—2 is arranged when operated to close an auxiliary energizing circuit for the relay R—1 and to open the locking circuit for the relay. Thus the relay R—1 is energized and current is supplied to the motors M and M—1 only while the switch S—1 is held in operated position.

The motor M, when started in the above manner, rotates the tool spindle 22 while motor M—1 drives the pump P which accordingly delivers a supply of pressure fluid to the hydraulic circuit. Due to the action of the control mechanism CM in the preceding machine cycle, the pilot valve V—3 is set in the position shown in the drawing when the tool head is in its fully retracted position. Accordingly, when pressure fluid is delivered to the hydraulic circuit upon the starting of the pump P in the manner above described, valve V—3 initiates the operation of the reversing valve V—1 so that pressure fluid is directed to the upper end of the head reciprocating cylinder 30. At the same time, the lower end of the cylinder 30 is opened to a suitable drain so that the spent pressure fluid therein may be exhausted and returned to a sump or reservoir R from which the pump P draws the fluid for reuse. Piston 31 is accordingly shifted toward the lower end of the cylinder, thereby moving the head 13 and tool 21 toward the work piece.

When the tool is brought into operative relation with the work, the control mechanism CM closes a normally open switch LS—1 in a manner to be described presently, thereby completing a circuit for a relay R—2 which becomes energized and completes a locking circuit for itself by way of its switch R—21 and a normally closed switch R—31 of a relay R—3. Relay R—2 also closes switches R—22 and R—23 to complete an energizing circuit for the solenoid SOL—1 which operates the valve V—2 to its reverse position and thereby directs pressure fluid into the upper end of the cylinder 25. The piston 24 is shifted toward the lower end of the cylinder and through the medium of the rod 23 expands the abrasive elements of the tool 21 into contact with the surface of the work piece.

Downward movement of the head 13 continues until the tool reaches the lower end of the work piece, that is, the lower end of the working stroke, whereupon the pilot valve is operated to its alternate position by the control mechanism CM, reoperating the valve V—1 to its alternate position

to direct pressure fluid into the lower end of the cylinder 30 and to connect the upper end of the cylinder to the drain. The direction of movement of the head is accordingly reversed and the tool is traversed upwardly to the upper end of the work piece.

Instead of permitting the head to move upwardly to fully retracted position, the control mechanism CM is so arranged that, upon the tool 21 reaching the upper end of its working stroke, valve V—3 is again operated to reverse the direction of movement of the head. This cycle of operations continues with the head reversing at each end of the working stroke until the operation of the control mechanism is modified to initiate an amplified stroke of the head to withdraw the tool from the work.

The modification of the action of the control mechanism CM may be effected either manually or automatically, the latter being preferred as it relieves the attendant of the necessity of keeping a close watch on the operation of the machine. As herein shown, the automatic operation is effected under control of an auxiliary device such as an electric timer TM arranged to be started in response to the closure of the switch LS. The timer TM which may be of any suitable and well known construction includes a normally open switch TS arranged to be closed after the lapse of a predetermined time which may be varied in accordance with the character of work to be performed. Closure of the switch TS completes a circuit for the relay R—3 which opens the switch R—31 to deenergize relay R—2 and simultaneously closes switches R—32 and R—33 to complete an energizing circuit for a solenoid SOL—2. Relay R—2 becomes deenergized and opens the circuit of the solenoid SOL—1, thereby permitting valve V—2 to return to its normal position and direct pressure fluid into the lower end of the cylinder 25. The piston 24 is immediately shifted to the upper end of the cylinder and acts to contract the abrasive elements of the tool.

The solenoid SOL—2, conveniently termed the "pull-out" solenoid, operates to modify the action of the control mechanism CM through the medium of mechanical means to be described hereinafter, whereby the pilot valve V—3 is not operated to its reverse position until the head reaches the extreme upper limit of its stroke with the tool completely withdrawn from the work. As the head approaches the retracted position, the valve V—3 is operated to the position shown in Fig. 3, thus preparing the machine for the next operating cycle. At the same time, the switch LS is opened to deenergize the relay R—1 and thus stop the motors M and M—1.

Having in mind the various control functions to be performed in an operating cycle of the machine, the construction and operation of the control mechanism CM which constitutes an important part of the control system will now be described.

Referring to Figs. 4 to 8, the control mechanism in its preferred form comprises a pair of co-operating control elements 41 and 42 mounted to rock about a common axis. The latter element is adapted to be rocked through an angle proportionate to the distance moved by the tool head 13 and in synchronism with the movements of the head. Rocking movements of this element are utilized to actuate the switches LS and LS—1 previously referred to and additionally to rock

the control element 41 between two limit positions to operate the pilot valve V—3, the control elements being provided with suitable adjustable stops, dogs, etc. for this purpose.

As herein shown, the control switches and pilot valve are mounted on a removable supporting frame 43 which is set in an aperture 44 in one side of the column 10 and bolted or otherwise rigidly secured to the wall of the column. The frame preferably comprises a casting having integrally formed side walls 45 and an end wall 46 defining an outwardly opening compartment for housing the control elements and associated control devices such as the switches LS and LS—1. A cover plate 47 having an aperture or window 48 aligned with the control elements is bolted to the front of the frame structure to partially cover the compartment. The control elements are thus disposed in a position in which they are conveniently accessible and yet not likely to be damaged by men working around the machine. Moreover, the control mechanism and associated control devices are assembled in a unitary structure which may be quickly and easily removed from the machine for repair or replacement by simply disengaging the supporting frame and withdrawing it from the column.

Referring now to Fig. 4, the control element 42 as herein shown is of generally cup-shaped form consisting of a bottom disk 49 encircled by an upstanding wall 50 whose marginal edge terminates in an enlarged inwardly projecting flange 51 of generally rectangular cross section. The control element is mounted to rock about a horizontal axis through the medium of a rearwardly projecting cylindrical hub 52 rigid with the bottom of the element. As herein shown, the hub is journaled in bearings 53 supported in a hollow sleeve 54 preferably cast integrally with the vertical wall 46 of the supporting frame.

While any suitable means may be utilized to rock the control element 42 in synchronism with the movements of the tool head 13, the mechanism provided for this purpose in the exemplary machine comprises a flexible traction member in the form of an endless chain 55 (Figs. 1-4) running over one sprocket wheel 56 keyed to the hub 52 of the control element and over a second sprocket 57 journaled on the column. As shown in Fig. 2, the sprocket wheel 57 is rotatably supported on a stud 58^a anchored in an inwardly projecting boss 58^a of a plate 57^a which is bolted or otherwise rigidly secured to the side of the column 10 adjacent the upper end thereof.

The sprocket wheels are positioned so that one run of the chain is aligned with the slot 34 in the face of the column and substantially parallel to the reciprocatory path of the head 13. At a suitable point in this parallel run, the chain is anchored to an extension 59 of the arm 33 which projects rearwardly from the head. Accordingly, the movements of the head are imparted to the chain and through the sprocket wheel 56 to the control element 42. Preferably, the sprocket 56 is dimensioned so that the control element executes something less than a complete revolution incident to the movement of the head through its maximum range of travel. In the exemplary machine, the control element rotates through the arc indicated by the arrow A in Fig. 7 of the drawings.

For operating the switches LS and LS—1, the control element is provided with a pair of switch actuators or dogs 60 and 61. As herein shown, the dogs are of Z-shape construction and are

mounted around the periphery of the control element with one leg overlying the flange 51 and the other extending rearwardly to engage operating members LSO and LSO—1, respectively, of the switches LS and LS—1. As will be seen by reference to Fig. 4, the dog 61 is substantially longer than the dog 60 so that their switch operating legs move in different vertical planes, the switch operating members LSO and LSO—1 being similarly spaced apart for engagement by one dog only.

As it is frequently necessary to change the timing of the switches LS and LS—1, the dogs 60 and 61 are preferably adjustably secured to the control element. To this end, the flange 51 is formed with an annular T-slot in which each dog is independently anchored by means of a T-headed bolt 64 and nut 65. By loosening the nut 65 the dogs may be shifted around the periphery of the control element and thus positioned to operate the associated switches at the instant the head 13 reaches any desired point in its travel. In practice, the dog 60 is set so as to close the switch LS as the tool head moves out of retracted position and to open the switch when the head returns to that position. The dog 61 is usually set to momentarily close the switch LS—1 just as the tool enters the work, preferably before the head reaches the upper end of its working stroke. When so adjusted, the dog does not engage the switch operating member again until the head is retracted, thus avoiding unnecessary wear of the coating parts.

The control element 42, in addition to operating the electrical switches as above described, also acts to rock the control element 41 about the common axis of the elements for the purpose of operating the pilot valve V—3. As herein shown (Fig. 4), the control element 41 is in the form of a circular disk 66 having a relatively wide upstanding rim 67 formed with an annular T-slot concentric with the axis of the element. The control element is pinned on one end of a hollow shaft 68 which extends through the hub 52 and into the interior of the column 10.

In the particular machine illustrated, the shaft 68 is supported adjacent its outer end by a bearing 69 set in a recess in the hub 52 and at its inner end in a bearing 70 formed in a removable cover plate 71 utilized to cover an opening 72 in the side wall of the column 10 through which access is had to certain parts of the control mechanism. A third bearing 73 carried on a vertical supporting plate 74 bolted to the frame 43 supports the shaft at an intermediate point.

The shaft 68 is adapted when rocked in its bearings to operate the pilot valve V—3 and thus periodically reverse the direction of movement of the tool head 13. To this end, the shaft is provided with a rigid arm 75 adapted to engage the actuator 76 of the pilot valve which, as herein shown, is mounted on the supporting plate 74 below the shaft 68.

In the normal operation of the machine the shaft 68 is rocked to operate the pilot valve through the action of the control element 42. When necessary, however, the shaft may be rocked manually by means of a hand lever 77 (Fig. 1) pivoted to the column 10 and operatively connected by a link 78 (Fig. 4) with a crank arm 79 fast on the shaft. A spring-pressed plunger 80 operating in a socket in the arm 75 frictionally engages the plate 74 and tends to hold the shaft to either operated position.

The rocking of the shaft 68 by the control ele-

ment 42 is effected through the medium of a series of stops adjustably carried on the control element 41. As the pilot valve must be operated at the extreme limits of the tool stroke as well as at an intermediate position, marking one end of the working stroke, three stops are provided comprising limit stops 81 and 82 and intermediate stop 83. Limit stops 81 and 82 are of similar construction and, as shown in Fig. 4, are of L-shaped form having one leg overlying the flange 67 and the other extending rearwardly of the disk 66 toward the bottom 49 of the element 42. The stops are adjustably secured to the control element by means of T-headed bolts 84 seated in the T-slot in the element 41. Thus the position of the elements may be readily adjusted as required.

Mounted on the bottom 49 of the control element 42 is a stop engaging member 85 in the form of a headed pin projecting into the interior of the cup-shaped control member in position to engage the stops as the member is rocked by reciprocation of the head. On such engagement with the stops, the control element 41 and shaft 68 are rocked first in one direction and then in the other direction to operate the pilot valve 43.

The intermediate stop 83 defines the upper limit of the working stroke of the tool head. In order to permit movement of the head to retracted position when the tool is to be withdrawn from the work, this stop is constructed so that it can be withdrawn from the path of stop engaging member 85 and thus avoid premature operation of the pilot valve.

Referring now to Figs. 4 and 6, the intermediate stop 83 as herein shown comprises an L-shaped bracket adjustably secured in the T-slot of the element 41 by a T-headed bolt 84 with one leg 83^a projecting rearwardly of the control element. The leg 83^a of the member is formed with an inwardly projecting lug on which a lever 86 is pivoted intermediate its ends. The outer end of the lever is formed with a rearwardly projecting finger 87 adapted to be positioned in the path of the stop engaging member 85 of the control element 42 when the lever is in one position and adapted to clear such member when the lever is in the other position. A spring-pressed plunger 88 bearing against the outer end of the lever normally holds it in the path of the stop engaging member.

Referring more particularly to Fig. 6, it will be observed that one face of the finger 87 is beveled as at 89 so that the member 85 upon engaging the same when the element 42 is rocked in one direction simply acts to cam the finger forwardly without imparting movement to the control element 41. By reason of this construction, the stop 83 acts as a skip stop permitting the tool head to advance from retracted position and to the lower end of the working stroke without operating the pilot valve V—3. In this movement, the control element 42 moves through the arc indicated by the arrow A in Fig. 7. As the head approaches the lower end of the working stroke, the stop engaging member 85 engages the stop 82, thus rocking the control member 41 in a clockwise direction and operating the pilot valve V—3 to the position shown.

On the return stroke of the head, the control element 42 is rocked through the arc indicated by the arrow B in Fig. 8, at which point the stop engaging member 85 engages the rear face of the finger 87 and thus rocks the control element 41 to operate the pilot valve to the position

shown in this figure. The head is accordingly reversed and continues to reciprocate in its working stroke between the positions defined by the limit stop 82 and the intermediate stop 83 until the finger 87 is withdrawn from the path of the stop engaging member.

As explained heretofore, the exemplary machine is equipped with automatic means for terminating the operation of the machine at the end of a predetermined interval sufficient to finish the work to the desired dimension. This automatic means includes the timer TM, relay R—3 and solenoid SOL—2 which, as previously described, is energized at the completion of the honing operation. The solenoid SOL—2 is accordingly arranged to modify the action of the control mechanism by withdrawing the finger 87 of the intermediate stop lever 86 from the path of the stop engaging member 85. For this purpose, the inner end of the lever 86 is extended into the path of an annular flange 91 formed on a collar 92 slidable on the shaft 68. As herein shown, the collar 92 is secured by a pin 93 to a rod 94 which extends through the hollow shaft 68. A slot 95 in the shaft permits limited sliding movement of the rod and sleeve longitudinally of the shaft, and in such movement the lever 86 is rocked about its pivot and into withdrawn position.

For shifting the rod 94, a collar 96 is secured thereto adjacent the rear of the supporting plate 74 by means of a pin 97 projecting through a slot 98 in the hollow shaft. The collar is adapted to be engaged by one arm of a bell crank lever 99 pivoted on a bracket 100 secured to the plate 74, said arm being bifurcated so as to bear against the collar on opposite sides of the shaft 68. Bracket 100 also supports the solenoid SOL—2 above and in alignment with the other arm of the bell crank which is connected by a link 101 with the armature 102 of the solenoid. Upon energization of the solenoid, the bell crank is rocked about its pivot and through the medium of the sleeve 96 shifts the rod 94 to the right, as viewed in Fig. 4. The sleeve 92 is likewise shifted to the right and acts to rock the intermediate stop lever 86 to withdrawn position. A coiled compression spring 103 interposed between the sleeve 96 and a collar 104 pinned to the shaft 68 tends to hold the rod and associated parts in a normal position in which the intermediate stop lever is positioned for engagement by the stop engaging member 85. Accordingly, when the solenoid becomes deenergized, the lever 86 returns to its active position.

It will be apparent from the foregoing that the invention provides a honing machine of novel and improved construction in which the various elements are assembled in an advantageous manner to provide a machine of clean, compact construction requiring a minimum of headroom for its installation. The machine embodies novel control mechanism which is readily adjustable to adapt the machine for operating on work pieces of different length. The adjustable elements of the control mechanism are conveniently grouped for easy access and partially enclosed so that they are not liable to be damaged by men working around the machine, and in turn are not likely to injure the workmen. The machine is thus not only efficient and reliable in operation but is clean and attractive in appearance and entirely safe to operate.

I claim as my invention:

1. A vertical type honing machine having, in

combination, a hollow upright column, a work supporting table adjacent the base of said column, means on the face of the column forming a vertical guideway, a reciprocatory head supported on the guideway for movement toward and from the work table, an arm rigid with said head projecting rearwardly therefrom through a vertical slot in the face of the column, a tool spindle journaled on said head for carrying a honing tool to operate on work supported on the table, power driven means for rotating the spindle, means for reciprocating the head to traverse the tool from one end of the work piece to the other comprising a cylinder mounted within the column with its axis disposed substantially parallel to the reciprocating path of the head and with its upper end disposed below the guideway in alinement with the arm projecting from the head, a piston working in said cylinder, and a rod connecting said piston with said arm, control means for said reciprocating means including a rotatable member carried on one side of the column, and means disposed within said column and operatively connected with said arm for rotating said member in timed relation to the reciprocation of the head.

2. In a vertical type honing machine, in combination, a hollow upright column, a head mounted for reciprocation on said column, a tool spindle journaled on said head for carrying an expansible honing tool, power actuated means for expanding and contracting the tool, pressure fluid actuated means for reciprocating the head, a control system for the machine including a valve for controlling said pressure fluid actuated means, a control device for initiating the operation of said tool expanding means, a control device for stopping the machine at the end of an operating cycle, and mechanism actuated by the head in its reciprocation for operating said valve and said control devices, said valve, said devices and said mechanism being assembled in a unitary structure on a common frame adapted to be mounted within the column of the machine.

3. The combination in a honing machine having a work support and a tool support, of power actuated means for reciprocating one of said supports through a series of working strokes such as to traverse the tool over the work followed by a substantially longer withdrawal stroke to dissociate the tool and work, a control element adapted to be rocked between two positions and operative in its movement from one position to the other to reverse the direction of movement of the reciprocatory support, a plurality of stops mounted on said member in spaced relation, a second control element mounted to rock about a common axis with said first element, means for rocking said second element in synchronism with the movements of the reciprocatory support, and a member carried by said second element positioned to engage said stops to rock said first element between its alternate positions, said stops being adjustable relative to each other to locate one stop for engagement by said member as the reciprocatory support approaches one end of its working stroke, to locate another stop for engagement by the member as the support approaches the other end of its working stroke, and to locate still another stop for engagement by the member as the support approaches the limit of its withdrawal stroke.

4. The combination in a honing machine having a work support and a tool support, of power actuated means for reciprocating one of said supports through a series of working strokes such as

to traverse the tool over the work followed by a substantially longer withdrawal stroke to dissociate the tool and work, a control element adapted to be rocked between two positions and operative in its movement from one position to the other to reverse the direction of movement of the reciprocatory support, three stops mounted on said member in spaced relation, two of said stops being set to define respectively the limits of the working stroke and the third stop being set to define the limit of the withdrawal stroke of the reciprocatory support, a second control element mounted to rock about a common axis with said first element, means for rocking said second element in synchronism with the movements of the reciprocatory support, and a member carried on said second element operative in the rocking of the element to engage said stops independently and thereby rock the first control element from one position to another.

5. The combination in a honing machine having a reciprocatory support, of power actuated means for reciprocating the support, control means associated with said power actuated means for reversing the direction of movement of the support at each end of its stroke, said control means comprising a pair of control elements mounted to rock about a common axis, means for rocking one of said elements in synchronism with the movements of the support, a pair of stops mounted on the other element in spaced relation, a stop engaging member carried by said one element operative to engage said stops alternately when the element is rocked whereby to rock said other element between two positions, a control device operated in response to the movement of said other element from either position to the other to reverse the direction of movement of the support and thereby confine the movements of the support within predetermined limits, and means for withdrawing one of said stops from the path of said stop engaging member to permit the support to move beyond one of said predetermined limits.

6. In a honing machine having a reciprocatory head, in combination, pressure fluid means for reciprocating the head, a valve associated with said pressure fluid actuated means operable to reverse the direction of movement of the head, actuating means for operating said valve including a circular element adapted to be rocked about a central axis between two positions, a pair of circumferentially spaced stops adjustably mounted adjacent the periphery of said element, a second control element mounted to rock about the axis of said first element, means for rocking the second element in synchronism with the movements of the head, a stop engaging member carried by the second element adapted to engage said stop alternately and thereby rock the first element back and forth between said two positions, and means for withdrawing one of said stops from the path of said member to cause the head to move beyond its normal working range.

7. In a honing machine having a reciprocatory head, in combination, pressure fluid means for reciprocating the head, a valve associated with said pressure fluid actuated means operable to reverse the direction of movement of the head, actuating means for operating said valve including a circular element adapted to be rocked about a central axis between two positions, a pair of circumferentially spaced stops adjustably mounted adjacent the periphery of said element, a second control element mounted to rock about

the axis of said first element, means for rocking the second element in synchronism with the movements of the head, a stop engaging member carried by the second element adapted to engage said stops alternately and thereby rock the first element back and forth between said two positions, means for withdrawing one of said stops from the path of said member to amplify the movement of the head beyond its normal working range, and means operated by the second control element incident to the amplified movement of the head for stopping the machine.

8. A control mechanism for a honing machine having a reciprocatory head, said mechanism comprising, a generally circular control element mounted to rock about a central axis between two active positions and operative in each position to reverse the direction of movement of the head, a pair of limit stops adjustably supported in spaced relation around the periphery of said element, an intermediate stop mounted on said element between said limit stops, a second control element mounted to rock about the axis of said first element, means for rocking the second element in synchronism with the movements of said head, a member on said second element adapted to coact with one of said limit stops and said intermediate stop alternately to rock the first element from one position to another whereby to confine the movements of the head within predetermined limits, and means for withdrawing said intermediate stop from the path of said member to effect movement of the head beyond one of said predetermined limits to a retracted position, said member engaging the other of said limit stops to rock the first control element to its alternate position as the head approaches the retracted position.

9. A control mechanism for a honing machine having a reciprocatory head, said mechanism comprising, a generally circular control element mounted to rock about a central axis between two active positions and operative in each position to reverse the direction of movement of the head, a pair of limit stops adjustably supported in spaced relation around the periphery of said element, an intermediate stop mounted on said element between said limit stops, a second control element mounted to rock about the axis of said first element, means for rocking the second element in synchronism with the movements of said head, a member on said second element adapted to coact with one of said limit stops and said intermediate stop alternately to rock the first element from one position to another whereby to confine the movements of the head within predetermined limits, means for withdrawing said intermediate stop from the path of said member to effect movement of the head beyond one of said limits to a retracted position including a rod mounted coaxially of said control elements for endwise sliding movement, and an actuator shiftable with said rod and engageable with said stop, said member engaging the other limit stop to rock the first control member to its alternate position as the head approaches the retracted position.

10. In a honing machine, in combination, a support for a honing tool, power actuated means on said support for expanding and contracting the tool, a support for work to be operated on by said tool, power actuated means for moving one of said supports toward the other support to bring the tool and work into operative associa-

tion and then to reciprocate said one support through a series of working strokes to traverse the tool over the work, control mechanism including an element adapted to be rotated first in one direction and then in the other direction in synchronism with the movements of said one support, a first control member carried by said element operative when the tool is associated with the work to initiate the expansion of the same, and a second control member carried on said element operative to control the reciprocation of the support through said working strokes.

11. In a honing machine, in combination, a support for a honing tool, power actuated means on said support for expanding and contracting the tool, a support for work to be operated on by said tool, power actuated means for moving one of said supports toward the other support to bring the tool and work into operative association and then to reciprocate said one support through a series of working strokes to traverse the tool over the work, control mechanism including an element adapted to be rotated first in one direction and then in the other direction in synchronism with the movements of said one support, a second control element operable between two positions to control the reciprocation of said one support through its working strokes, a member carried by the first element coacting with stops carried by the second element to operate the same from one position to the other, a control device for initiating the operation of said tool expanding and contracting means to expand the tool, and a dog carried by said second control element operative to actuate said control device when the tool is brought into operative association with the work.

12. In a honing machine, in combination, a support for a honing tool, power actuated means on said support for expanding and contracting the tool, a support for work to be operated on by said tool, power actuated means for moving one of said supports toward the other support to bring the tool and work into operative association and then to reciprocate said one support through a series of working strokes to traverse the tool over the work, control mechanism including an element adapted to be rotated first in one direction and then in the other direction in synchronism with the movements of said one support, a second control element operable between two positions to control the reciprocation of said one support through its working strokes, a member carried by the first element coacting with stops carried by the second element to operate the same from one position to the other, a control device for the tool expanding and contracting means normally effective to maintain the tool in contracted condition, a dog carried by said second control element arranged to initiate the operation of said control device and thereby effect expansion of the tool, said dog acting automatically when the tool and work are operatively associated, and automatically operable means for releasing said control device to initiate contraction of the tool.

13. In a honing machine, in combination, a reciprocatory support for carrying an expansible honing tool, power actuated means on said support for expanding the tool, power actuated means for reciprocating said support, control mechanism including a control element adapted to be rocked through an arc proportioned to the movements of said support and in synchronism therewith, a control device associated with said

reciprocating means operable by said element to effect an initial advance of the support to operatively associate the tool and work and then to reciprocate the support between predetermined limit positions to traverse the tool repeatedly over the work, a second control device operable by said element for initiating the operation of said tool expanding mechanism, and a third control device operable by said element for stopping the machine.

14. In a honing machine, in combination, a reciprocatory support for carrying an expansible honing tool, pressure fluid actuated means for reciprocating said support, power actuated means for expanding the tool, control mechanism including a control element adapted to be rocked through an arc proportioned to the movements of said support and in synchronism therewith, a valve operable by said control element for controlling said pressure fluid actuated means, electrical means operable by said control element for initiating the operation of said power actuated means to expand the tool, and other electrical means operable by said control element to stop the machine.

15. In a honing machine, in combination, a hollow supporting frame, a head mounted for reciprocation on said frame, a tool spindle journaled on said head for carrying an expansible and contractible honing tool, power actuated means for expanding and contracting the tool, pressure fluid actuated means for reciprocating the head, a control system for the machine including a valve for controlling said pressure fluid operated means, a control device for initiating the operation of said tool expanding means, a second control device for stopping the machine at the end of an operating cycle, and mechanism actuated by the head in its reciprocation for operating said valve and said control devices, said valve, said devices and said mechanism being assembled in a unitary structure on a common frame adapted to be mounted within said hollow supporting frame.

16. In a honing machine, in combination, a support for a honing tool, power actuated means for expanding and contracting the tool, a support for work to be operated on by the tool, power actuated means for moving one of said supports toward the other support to bring the tool and work into operative association and then to reciprocate said one support through a series of working strokes to effect a relative traverse of the tool and the work, control mechanism including a movable element, motion transmitting means operable to drive said element continuously through a range substantially shorter than the working strokes of said one support first in one direction and then in the other direction in synchronism with the movements of the support, means actuated by said element when the tool is associated with the work to initiate the expansion of the same, and other means actuated by said element to control the reciprocation of the support through said working strokes.

17. In a honing machine, in combination, a support for a honing tool, pressure fluid actuated means for expanding and contracting the tool, a support for work to be operated on by the tool, pressure fluid actuated means for moving one of said supports toward the other support to operatively associate the tool and work and then to reciprocate said one support through a predetermined range in a series of working strokes to effect a relative traverse of the tool

and the work, control mechanism including a movable element, means for moving said element continuously through a range relatively smaller than the range of movement of the reciprocatory support first in one direction and then in the other direction in synchronism with the movements of said one support, valve means actuated by said element when the tool is associated with the work to initiate the operation of said first pressure fluid actuated means for expanding the tool into engagement with the work, and other valve means actuated by said element to control said second pressure fluid actuated means and thus effect reciprocation of the support through said working strokes.

18. In a honing machine, in combination, a reciprocatory support for carrying an expansible and contractible honing tool, a first power actuated means for reciprocating said support, a second power actuated means for expanding and contracting the tool, control mechanism including a control element adapted to be shifted through a range proportioned to the movements of said support and in synchronism therewith, control means associated with said first power actuated means operable by said element to effect an initial advance of the support to operatively associate the tool and the work, to reciprocate the support between predetermined limit positions for traversing the tool repeatedly over the work, and then to retract the support to disassociate the tool and the work, a second control device associated with said second power actuated means and operable by said element for initiating the expansion of the tool upon its operative association with the work and for contracting the tool prior to its disassociation from the work, and a third control device operable by said element for stopping the machine.

19. In a honing machine, in combination, a reciprocatory support, power actuated means for reciprocating said support, control mechanism for said power actuated means including a pair of control elements mounted to rock about a common axis, means actuated by one of said elements for controlling the direction of movement of the support by said power actuated means, means for rocking the other of said elements through an arc proportioned to the range of travel of the support, a pair of stops on said one element, a stop engaging member on the other element engageable alternately with said stops to operate said one element and thereby confine the movements of the support within predetermined limits, a control member movable axially of said control elements to withdraw one of said stops from the path of the stop engaging member to initiate movement of the support beyond one of said limits to a retracted position, and another stop on said one control element engageable by the stop engaging member to operate the element as the support approaches the retracted position.

20. In a honing machine, in combination, a hollow supporting frame, a support mounted for reciprocation on said frame, power actuated means for reciprocating said support, control mechanism for said power actuated means including a reversing element mounted to rock about a horizontal axis, a control element disposed closely adjacent said reversing element and adapted to rock about the same axis, a pair of spaced stops adjustably mounted on the face of said reversing element, a stop engaging

member carried by said control element, a motion transmitting connection interposed between said support and said control element operative to rock the element through an arc proportioned to the range of travel of the support, said member engaging said stops alternately to confine the movements of the support within prede-

5 terminated limits determined by the positions of the stops, and means supporting said elements in a recess in one side of said frame with the face of said control element exposed to provide convenient access for adjustment of said stops.

CHESTER O. HOLLAND.