

April 2, 1946.

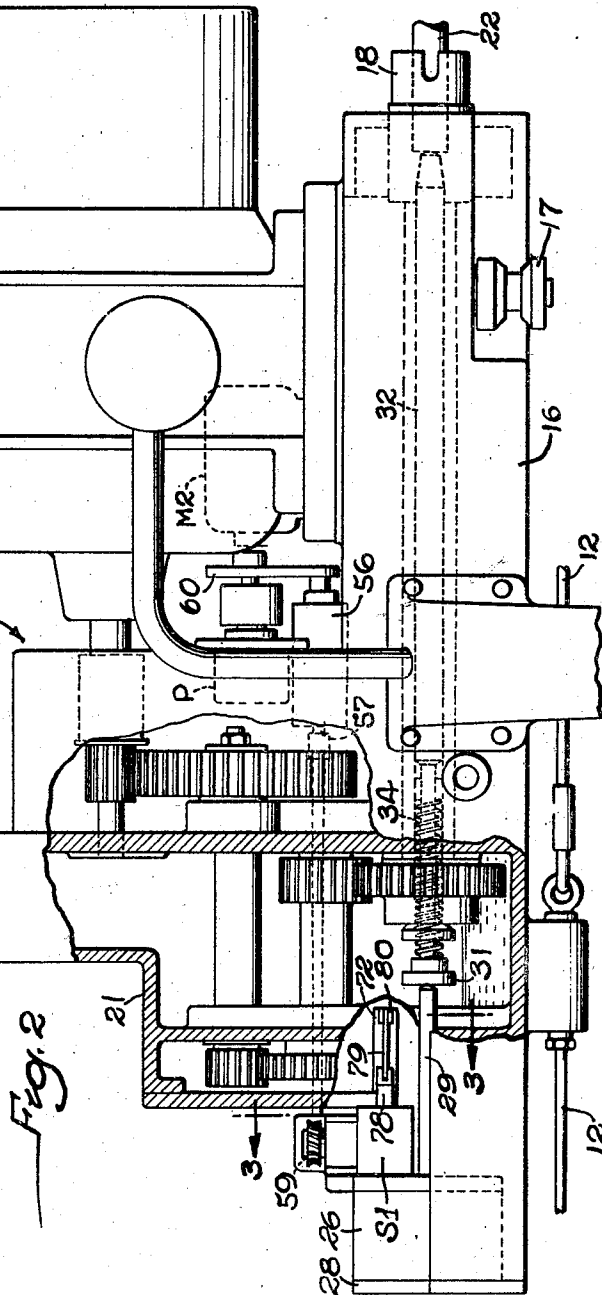
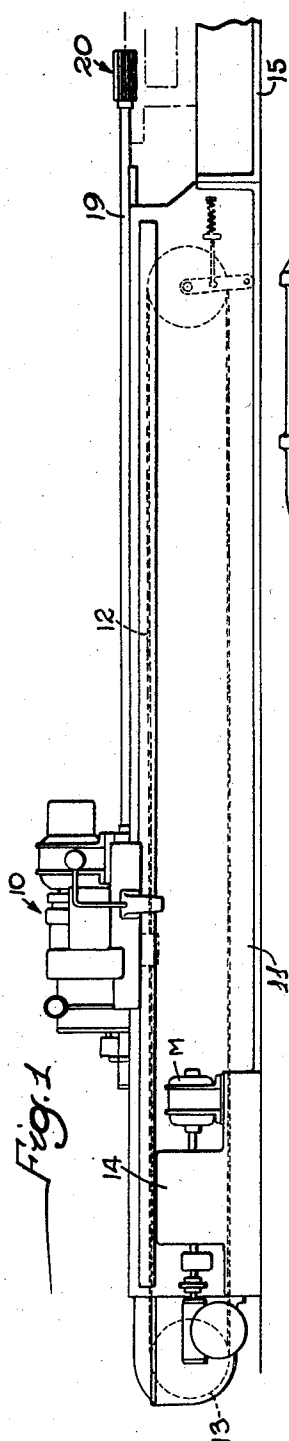
E. Y. SEBORG ET AL

2,397,814

HONING MACHINE

Filed Dec. 13, 1943

3 Sheets-Sheet 1



INVENTORS
 Harry C. Caldwell
 Earnest O. Seborg
 Sheldon F. Manning
 By Parker, Carlson, Rogers & Hutton
 ATTORNEYS

April 2, 1946.

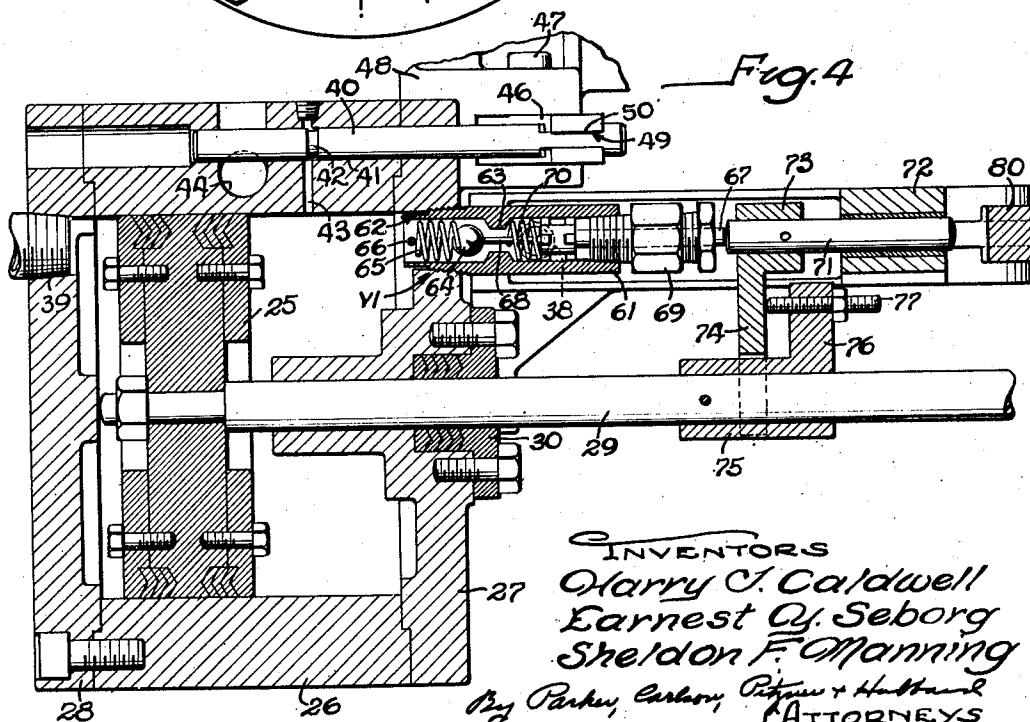
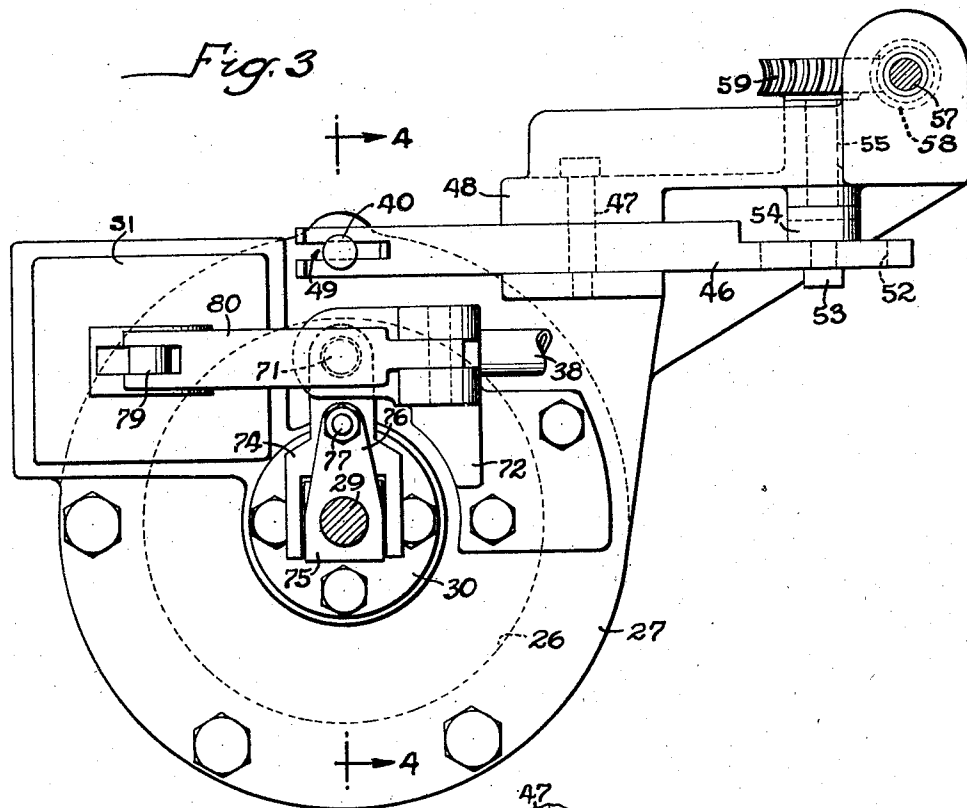
E. Y. SEBORG ET AL

2,397,814

HONING MACHINE

Filed Dec. 13, 1943

3 Sheets-Sheet 2



INVENTORS
Harry C. Caldwell
Earnest O. Seborg
Sheldon F. Manning
By Parker, Carlson, Rogers & Hubbard
ATTORNEYS

April 2, 1946.

E. Y. SEBORG ET AL

2,397,814

HONING MACHINE

Filed Dec. 13, 1943

3 Sheets-Sheet 3

Fig. 5

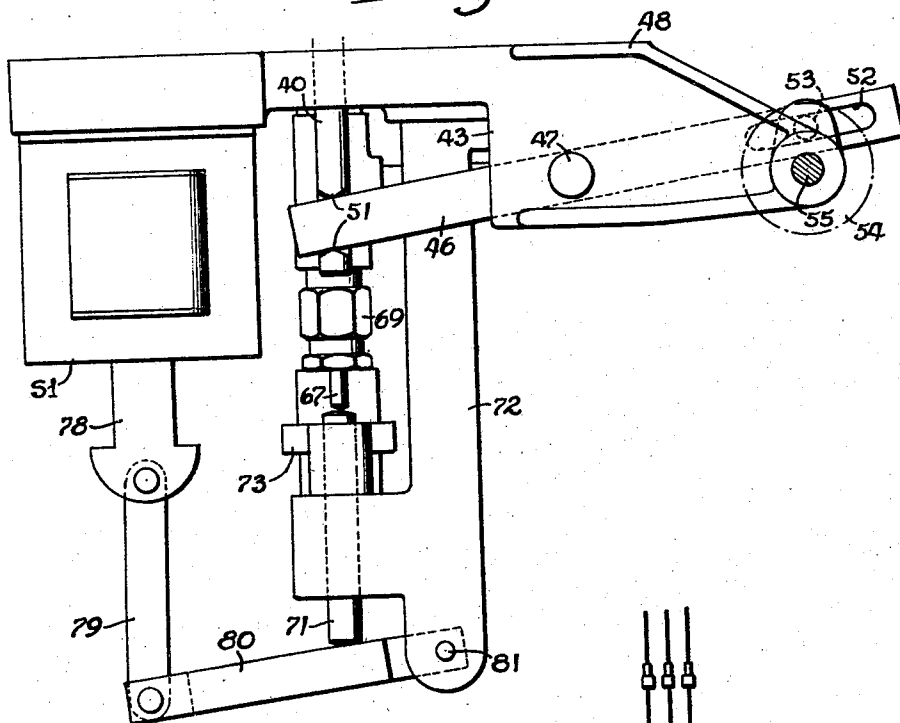
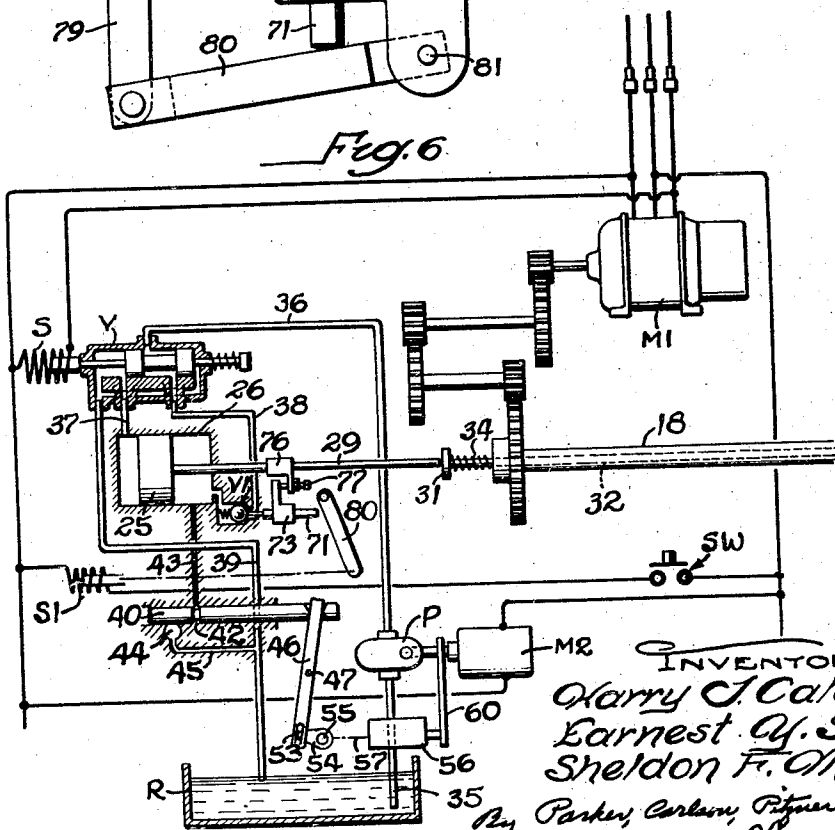


Fig. 6



INVENTORS
Harry C. Caldwell
Ernest G. Seborg
Sheldon F. Manning
 By *Parker, Carlson, Pitzer & Huttland*
 ATTORNEYS

UNITED STATES PATENT OFFICE

2,397,814

HONING MACHINE

Ernest Y. Seborg, Harry J. Caldwell, and Sheldon F. Manning, Rockford, Ill., assignors to Barnes Drill Co., Rockford, Ill., a corporation of Illinois

Application December 13, 1943, Serial No. 514,066

11 Claims. (Cl. 51—34)

The invention relates to honing machines generally and more particularly to improvements in the tool adjusting mechanism of such machines whereby the abrasive elements of the tools are shifted radially into operative engagement with the surface of the work.

It has been found in practice, that accurate control of the rate of adjustment of the hone, that is, the rate at which the abrasive elements are moved toward the work surface materially increases the productive efficiency of the tool. More specifically, the "loading" of the abrasive elements with material removed from the work is substantially eliminated, their useful life is increased, and greater precision of finish is attained by regulating the adjustment so as to maintain a predetermined substantially uniform pressure against the work surface. The optimum pressure for this purpose varies, of course, with the material being operated on, the size of the work, the grade of the abrasive employed and other factors which need not be discussed here.

Control of the adjustment of the abrasive elements of a honing tool has been effected in various ways. One of the most efficient control devices heretofore available for hone adjustment control purposes utilizes a receding mechanical abutment arranged to restrain the movements of the member which imparts the radial movements to the abrasive elements. This type of control provides accurate regulation of the rate of movement of the elements and, in addition, prevents excessive movements when soft areas in the work are encountered and before the high spots are removed from the work surface. While such control devices give generally satisfactory results in ordinary honing operations in which the adjustment of the abrasive elements may be effected in comparatively large steps and in a relatively short time, they have been found unsuited for honing operations requiring adjustment of the elements in very small increments over a relatively long period of time.

With the above in view one object of the invention is to provide improved control mechanism for honing tools in which the adjusting movements of the abrasive elements are restrained by a fluid block or fluid abutment thus retaining the advantageous positive control of the mechanical devices but providing greater flexibility as to rates of adjustment whereby movements of the abrasive elements may be effected in smaller, more uniform increments and more accurately regulated over extended operating periods.

Another object of the invention is to provide in a honing machine an improved mechanism capable of effecting adjustment of the honing tool at an exceedingly slow yet accurately controlled rate thereby adapting the machine for certain types of precision finishing requiring relatively long honing periods.

Still another object is to provide improved control means whereby the initial adjustment of a honing tool to bring the abrasive elements into operative engagement with the work may be effected rapidly while adjustment during actual operation is effected at a much slower rate.

It is also an object of the invention to provide hone adjusting mechanism which is simple and rugged in construction, which is efficient and reliable in operation, and which is capable of accurately controlling the rate at which the hone is adjusted.

Other 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 front elevational view of a honing machine equipped with hone adjusting mechanism embodying the features of the invention.

Fig. 2 is an enlarged side elevational view of the tool supporting head of the machine shown in Fig. 1 with parts of the housing broken away to show details of the tool driving and adjusting mechanism.

Fig. 3 is a sectional view taken in a vertical plane substantially on the line 3—3 of Fig. 2.

Fig. 4 is a sectional view taken in a vertical plane substantially on the line 4—4 of Fig. 3.

Fig. 5 is a plan view showing details of the valve actuating mechanisms.

Fig. 6 is a schematic diagram showing the electrical and hydraulic circuits of the machine and their relation to the mechanical elements of the same.

While the invention is susceptible of various modifications and alternative constructions, we have shown in the drawings and will herein describe in detail the preferred embodiment, but it is to be understood that we do not thereby intend to limit the invention to the specific form disclosed, but intend to cover all modifications and alternative constructions falling within the spirit and scope of the invention as expressed in the appended claims.

By way of illustration, the invention has been shown as embodied in a honing machine having a tool supporting head 10 (Fig. 1) mounted for

reciprocation on horizontal ways carried on an elongated bed 11. Reciprocation of the head 10 to traverse the honing tool axially of the work is effected in well-known manner through the medium of flexible driving members 12 connecting the head with a reversibly driven drum 13 supported at one end of the bed. The drum is driven by a motor M through a suitable reversing transmission 14 preferably of the hydraulic type. The work to be operated on by the machine is supported on an auxiliary bed 15 rigidly secured to the end of the main bed opposite the drum 13.

Referring to Fig. 2 of the drawings, the head 10 comprises a generally rectangular base 16 having suitable guide means such as rollers 17 for cooperation with the ways on the bed 11. Journalled in the base 16 is a hollow spindle 18 arranged to project at the forward end of the base for connection with a tubular driver 19 which carries, at its outer end, a honing tool 20. The spindle 18 is rotatably driven in this instance by a motor M1 through the medium of suitable gearing enclosed in a housing 21 rigid with the base 16. Thus, in the exemplary machine, the honing tool is continuously rotated and simultaneously reciprocated axially of the work. It will be understood, of course, that the spindle drive mechanism may be arranged to turn or index the spindle intermittently for straight line honing.

The honing tool 20 herein shown is of the conventional type employed in honing internal surfaces. In such tools, the abrasive elements are moved radially outwardly from a normal retracted position to engage the surface of the work. The invention is not limited to use with this particular type of tool but may be used to advantage with other types of honing tools, as for example the tools designed for honing external cylindrical surfaces in which the abrasive elements are moved radially inwardly from their normal retracted position. In either case, the tool is initially associated with the work with the abrasive elements in retracted position and the elements are adjusted radially into operative engagement with the work surface. When so adjusted, the tool is rotated and simultaneously reciprocated axially of the work so as to act uniformly over the entire surface thereof.

As herein shown, the honing tool 20 is adapted to be adjusted by power operated means carried on the head and acting through a push rod 22 extending axially through the driver 19. The power means is preferably of the pressure fluid actuated type and, as shown in Figs. 2, 4 and 6, comprises a piston 25 working in a cylinder 26 mounted on the base 16 in axial alignment with the spindle 18. The cylinder is closed at opposite ends by heads 27 and 28. A piston rod 29, rigidly attached to the piston 25, extends through a suitable gland 30 in the front cylinder head 27 toward the hollow spindle 18 to abut against a thrust plate 31 fixed on the end of an intermediate push rod 32 supported and guided for endwise sliding movement axially of the spindle 18. The push rod 32 is adapted to abut against the end of the tool adjusting rod 22 for imparting the movements of the piston 25 thereto.

To adjust the honing tool for operation, pressure fluid is introduced into the rear end of the cylinder 26 thereby moving the piston 25 and the rods 32 and 22 forwardly or toward the right as viewed in Fig. 2. The fluid connections are reversed and fluid is introduced into the forward end of the cylinder 26 to return the piston to the rear end of the cylinder. A spring 34 is inter-

posed between a suitable abutment in the spindle 18 and the thrust plate 31 moves the intermediate push rod 32 rearwardly with the piston thus permitting the abrasive elements of the tool to be returned to retracted position in well-known manner through the action of spring means incorporated in the tool.

In the exemplary machine, pressure fluid is supplied to the cylinder 26 by a pump P (Figs. 2 and 6) driven by a motor M2, both mounted on the base 16 of the tool supporting head 10. The pump P has an intake line 35 through which it draws fluid, such as oil, from a sump or reservoir R in the head. Fluid is delivered under pressure through a pipe 36 to a reversing valve V which may be set to direct the fluid by way of pipes 37 or 38 to either the rear end or the front end of the cylinder 26 while connecting the other end of the cylinder to an exhaust line 39. The particular valve illustrated is yieldably held in one position by suitable spring means and is adapted to be operated to its alternate position by a solenoid S connected in parallel with the spindle driving motor M'. The arrangement is such that the valve is set for expanding the tool when the spindle is rotated.

In accordance with the invention, means is provided for metering out the fluid from the forward end of the cylinder 26 to regulate the forward travel of the piston 25 and thus control the rate at which the tool 20 is adjusted. To this end the forward end of the cylinder is connected to the pipe 38 through a check valve V1 set to allow fluid to pass freely into the cylinder but normally preventing discharge of fluid from the cylinder through the pipe 38. The fluid trapped in the front end of the cylinder is thus diverted through a metering device by which the rate of flow may be accurately controlled.

The metering device as herein shown, comprises a reciprocatory member or plunger 40 (Figs. 4 and 6) reciprocable in a bore 41 formed, in this instance, in the side wall of the cylinder 26. The plunger is provided intermediate its ends with a fluid receiving pocket or recess such as a peripheral groove 42 adapted in the reciprocation of the plunger to register alternately with two ports 43 and 44 which are spaced apart longitudinally of the bore 41.

As will be seen by reference to Figs. 4 and 6 of the drawings, the port 43 communicates with the forward end of the cylinder 26 and constitutes an outlet therefor while the port 44 is connected by a pipe 45 with the exhaust line 39. Accordingly, the groove 42 is periodically filled with fluid forced from the forward end of the cylinder 26 by the advance of the piston 25 which fluid is discharged through the exhaust port 44. In this way small uniform charges of fluid are metered out from the cylinder at regularly spaced intervals thus permitting incremental advances of the piston 25 and corresponding incremental movements of the abrasive elements of the honing tool 20. The quantity of fluid permitted to escape from the cylinder in each reciprocation of the plunger 40 is dependent, of course, upon the dimensions of the groove 42. The groove may be made quite small thus restricting the piston to a very slow rate of advancing movement.

Reciprocation of the plunger 40 may be effected in any suitable manner. In the exemplary apparatus, the plunger is reciprocated by a lever 46 (Figs. 3-6) pivotally secured by a pin 47 to a bracket 48 rigid with the cylinder head 27. One end of the lever 46 is slotted, as at 49, to receive

a flattened section 50 of the plunger 40 formed by recessing opposite sides of the plunger. The end walls of the recesses are oppositely tapered as shown in Fig. 5 to provide V-shaped contact elements 51 engageable with the side edges of the lever.

The other end of the lever 46 is formed with a longitudinally disposed slot 52 adapted to receive an eccentric crank pin 53 carried on a hub 54 fast on a shaft 55. The shaft is journaled on the bracket 48 and may be driven in any preferred manner. As herein shown, the shaft 55 is driven at a selected rate from the pump motor M2 through an adjustable speed changer 56 (Figs. 2 and 6). The speed changer has an outlet shaft 57 fitted with a worm 58 meshing with a worm wheel 59 keyed to the shaft 55. In the particular embodiment illustrated, the speed changer is driven from the motor M2 by a V-belt 60 (Figs. 2 and 6).

By suitable adjustment of the speed changer 56, the rate of reciprocation of the plunger 40 and consequently the frequency of the tool adjusting movements of the piston 25 can be regulated for any desired period of operation. The amplitude of the adjusting increments is determined, of course, by the capacity of the fluid recess 42 in the plunger 40. Plungers having recesses of various capacities will ordinarily be kept on hand and may be quickly and easily placed in service to provide the adjusting increment required for any operation.

At the beginning of an operating cycle the honing tool 20 is associated in the work with the abrasive elements retracted and the elements must therefore be shifted a substantial distance to bring them into operative engagement with the work surface. To avoid loss of time in this initial or preliminary adjustment of the tool, the invention provides novel means whereby substantially unrestricted discharge of fluid from the cylinder 26 ahead of the piston 25 is permitted during a predetermined initial portion of its forward movement. To this end, provision is made for operating the valve V1 to by-pass the metering device so that the piston 25 may advance at a rapid rate until the tool is in condition to operate upon the work whereupon the slow metered adjusting rate is automatically initiated.

In the exemplary apparatus, the valve V1 is a ball type check valve comprising a tubular casing 61 (Fig. 4) adapted to be screwed into a threaded exhaust port 62 in the front cylinder head 27. The casing is formed with an internal shoulder 63 defining an exhaust passage encircled by a tapered valve seat facing the cylinder. A movable valve member 64, herein shown as a ball, is yieldably urged against the valve seat by a spring 65 interposed between the member and a pin 66 extending transversely across the casing. The valve member 64 is therefore normally held in a position to prevent fluid flow from the cylinder through the valve while offering relatively little resistance to fluid flow into the cylinder.

In accordance with the invention, valve actuating means is provided for shifting the valve member 64 from its seat to open the valve while the initial adjustment of the honing tool is effected. The valve actuating means, as herein shown, comprises a plunger 67 movable longitudinally of the valve casing 61 and having at its inner end a pin 68 engageable with the valve member 64. The plunger is slidably supported in a gland formed in a plug 69 screwed into the outer end of the valve casing 61. A spring 70

interposed between the inner end of the plunger 67 and the shoulder 63 in the valve casing urges the plunger outwardly, thus permitting the member 64 to shift forwardly under the action of the spring 65 and close the passage through the valve.

For shifting the plunger 67 to open the valve, a push rod 71 is supported in axial alignment with the plunger and guided for endwise movement in a suitable bearing formed in a bracket 72 rigidly secured to the cylinder head 27. Fixed on the push rod is a collar 73 having a bifurcated arm 74 projecting laterally to straddle a rectangular block 75 pinned to and reciprocable with the piston rod 29. The block 75 is formed with an upstanding lug 76, into which is threaded an adjustable stop screw 77 adapted to engage the arm 74 and hold the push rod 71 and valve actuating plunger 67 in a valve opening position until the piston has executed a predetermined portion of its advancing stroke. The screw 77 may be readily adjusted to permit the valve V1 to close at the instant the abrasive elements of the honing tool are moved into operative engagement with the work.

Means is also provided whereby the machine attendant may open the valve V1 at any time to effect rapid adjustment of the honing tool. For this purpose a solenoid S1 (Figs. 3, 5 and 6) is mounted at one side of the bracket 72 and its armature 78 is connected by a link 79 with one end of a lever 80 having its other end pivoted as at 81 on the outer end of the bracket. The lever 80 is positioned to engage the outer end of the push rod 71 and to shift the same to valve opening position when the solenoid is energized. Energization of the solenoid may be controlled through the medium of a manually operable switch SW located for convenient access by the attendant.

It will be apparent from the foregoing that the invention provides hone adjusting and control mechanism of a novel and advantageous character by which the abrasive elements of a honing tool may be adjusted through a wide range of incremental steps and at a more accurately controlled rate than has heretofore been practicable. More particularly, the improved control mechanism permits the abrasive elements of the honing tool to be moved in exceedingly small increments and at various selected rates which may be adjusted to effect relatively slow adjustment of the tool over an extended period. Accurate control of the adjustment rate is obtained by arranging the control mechanism for metering out the fluid trapped in the forward end of the cylinder of the hone adjusting mechanism in the advancing movement of the piston to adjust the tool. The metering out is effected in a manner such that adjustment takes place in incremental steps the frequency of which can be varied as required by the particular work to be done. In general, the control mechanism is simple and foolproof in construction, efficient and reliable in operation and it has a wide range of adjustability that enables it to function satisfactorily under substantially any conditions met with in the honing art.

The invention also provides novel means whereby a honing tool may be adjusted rapidly to bring the abrasive elements into operative engagement with the work surface preliminary to the actual honing of the surface. In this way loss of time is avoided and the maximum productive capacity of the machine is realized.

We claim as our invention:

1. Adjusting mechanism for honing tools hav-

ing radially shiftable abrasive elements comprising, in combination, a member movable longitudinally to shift the abrasive elements of the tool, means for imparting movement to said member including a cylinder closed at both ends, a piston reciprocable in said cylinder and having a piston rod engageable with said member in the forward movement of the piston, means for supplying pressure fluid to the rear end of said cylinder to move said piston forwardly, said piston acting in such movement to force out fluid trapped in the forward end of the cylinder, and means restricting the discharge of fluid from the forward end of said cylinder to predetermined increments released at accurately timed intervals, and means for varying the lengths of the intervals between successive increments to control the rate at which the abrasive elements of the tool are shifted.

2. Adjusting mechanism for honing tools having radially movable abrasive elements comprising, in combination, a member shiftable longitudinally to move the elements of the tool, means for shifting said member including a cylinder closed at both ends, a piston reciprocable in said cylinder and having a piston rod engageable with said member in the forward movement of the piston, means for supplying pressure fluid to the rear end of said cylinder to move said piston forwardly, said piston acting in such movement to expel the fluid trapped in the forward end of the cylinder, and an intermittently operating metering device for restricting the flow of fluid from the forward end of the cylinder to increments of predetermined volume, the operating speed of said device being adjustable to regulate the rate at which the tool is adjusted.

3. Adjusting mechanism for honing tools comprising, in combination, a cylinder, a piston in said cylinder, means for supplying fluid to both ends of the cylinder, a port communicating with the forward end of said cylinder, said piston when driven forwardly by pressure fluid introduced into the rear end of said cylinder acting to force the fluid in the forward end of the cylinder through said port, an exhaust port, a plunger having a fluid receiving recess, and means for reciprocating said plunger to present said recess at said ports alternately to receive a quantity of fluid from said cylinder and to discharge the fluid into said exhaust port.

4. Adjusting mechanism for honing tools comprising, in combination, a cylinder, a piston reciprocable in said cylinder, means for supplying fluid under pressure to the cylinder at one side of the piston, an outlet from said cylinder at the other side of said piston, said piston acting to force fluid from said cylinder through said outlet when advancing to adjust a honing tool, and means for controlling the discharge of fluid through said outlet to regulate the rate of advance of said piston, said controlling means including a member operable periodically to permit the passage of a predetermined quantity of fluid through said outlet.

5. Adjusting mechanism for honing tools comprising, in combination, a cylinder closed at both ends, a piston reciprocable in said cylinder, fluid supply connections at both ends of said cylinder, an outlet port at one end of the cylinder, a valve normally operative to prevent the discharge of fluid from the cylinder through the fluid supply connection at said one end of the cylinder thereby directing the fluid discharge through said port, means restricting the discharge of fluid through

said port to maintain a relatively slow rate of piston movement in a direction effective to adjust the tool, and means for operating said valve to permit a flow of fluid through said fluid connections whereby to increase the rate of movement of said piston during a predetermined portion of its advance in said tool adjusting direction.

6. Adjusting mechanism for honing tools comprising, in combination, a cylinder, a piston reciprocable in said cylinder, means for supplying fluid under pressure to said cylinder to force said piston forwardly, a pair of outlet ports in said cylinder at the advancing side of said piston, valve means operative to prevent the discharge of fluid through one of said ports, control means for metering the discharge of fluid through the other of said ports, and means actuated by said piston in its reciprocation for operating said valve to permit unrestricted discharge of fluid there-through during a predetermined portion of the piston stroke.

7. Adjusting mechanism for honing tools comprising, in combination, a shiftable member operative to adjust a honing tool, a cylinder, a piston reciprocable in said cylinder, a piston rod for transmitting the movements of said piston to said member, means for supplying fluid to each end of the cylinder, a pair of outlet ports in said cylinder at the advancing side of said piston, valve means normally closing one of said ports to the discharge of fluid from said cylinder, means for restricting the discharge of fluid through the other of said ports to control the rate of advance of said piston, an actuating member operable to open said valve, and means carried by said piston rod adapted to coact with said actuating member to hold said valve open during a predetermined portion of the piston stroke.

8. Adjusting mechanism for honing tools comprising, in combination, a rod shiftable to adjust a honing tool, a cylinder, a piston reciprocable in said cylinder, means providing a connection between said piston and said rod, means for supplying fluid to each end of said cylinder, a pair of outlet ports in said cylinder at the advancing side of said piston, valve means normally closing one of said ports to fluid flow from said cylinder, means for restricting the flow of fluid from said cylinder from the other of said ports to control the rate of advance of the piston, and means controlled manually for opening said valve to permit unrestricted discharge of fluid from said cylinder through said one port.

9. Adjusting mechanism for honing tools comprising, in combination, a rod shiftable to adjust a honing tool, a cylinder, a piston reciprocable in said cylinder, means providing a connection between said piston and said rod, means for supplying fluid to each end of said cylinder, a pair of outlet ports in said cylinder at the advancing side of said piston, valve means normally closing one of said ports to fluid flow from said cylinder, means for restricting the flow of fluid from said cylinder from the other of said ports to control the rate of advance of the piston, a solenoid adapted when energized to open said valve and thereby permit substantially unrestricted discharge of fluid from said cylinder through said one port, and switch means for controlling the energization of said solenoid.

10. Adjusting mechanism for honing tools having radially movable abrasive elements comprising, in combination, a cylinder closed at both ends, a piston reciprocable in said cylinder, a

pump for supplying fluid under pressure to one end of said cylinder to advance said piston in a direction effective to move the abrasive elements of the tool into engagement with a surface to be operated on, said piston acting to force fluid from the other end of said cylinder through an outlet port, and means for regulating discharge of fluid through said port to control the rate of movement of said piston, said regulating means including a reciprocatory member operative to release a predetermined quantity of fluid from the cylinder in each reciprocatory stroke, and power driven means for reciprocating said member.

11. Adjusting mechanism for honing tools comprising, in combination, a cylinder closed at both

ends, a piston reciprocable in said cylinder, a pump for supplying fluid under pressure to one end of said cylinder to advance said piston in a direction effective to adjust the honing tool, said piston acting to force fluid from the other end of said cylinder through an outlet port, a metering device adapted to regulate the discharge of fluid through said port to control the rate of movement of said piston, a motor operative to drive said pump and said metering device, and an adjustable speed changer interposed between said motor and said device.

EARNEST Y. SEBORG,
HARRY J. CALDWELL,
SHELDON F. MANNING.