Aug. 23, 1949. A. M. JOHNSON 2,479,622

CONTROL MECHANISM FOR HONING MACHINES

Filed Dec. 4, 1944 3 Sheets-Sheet 1

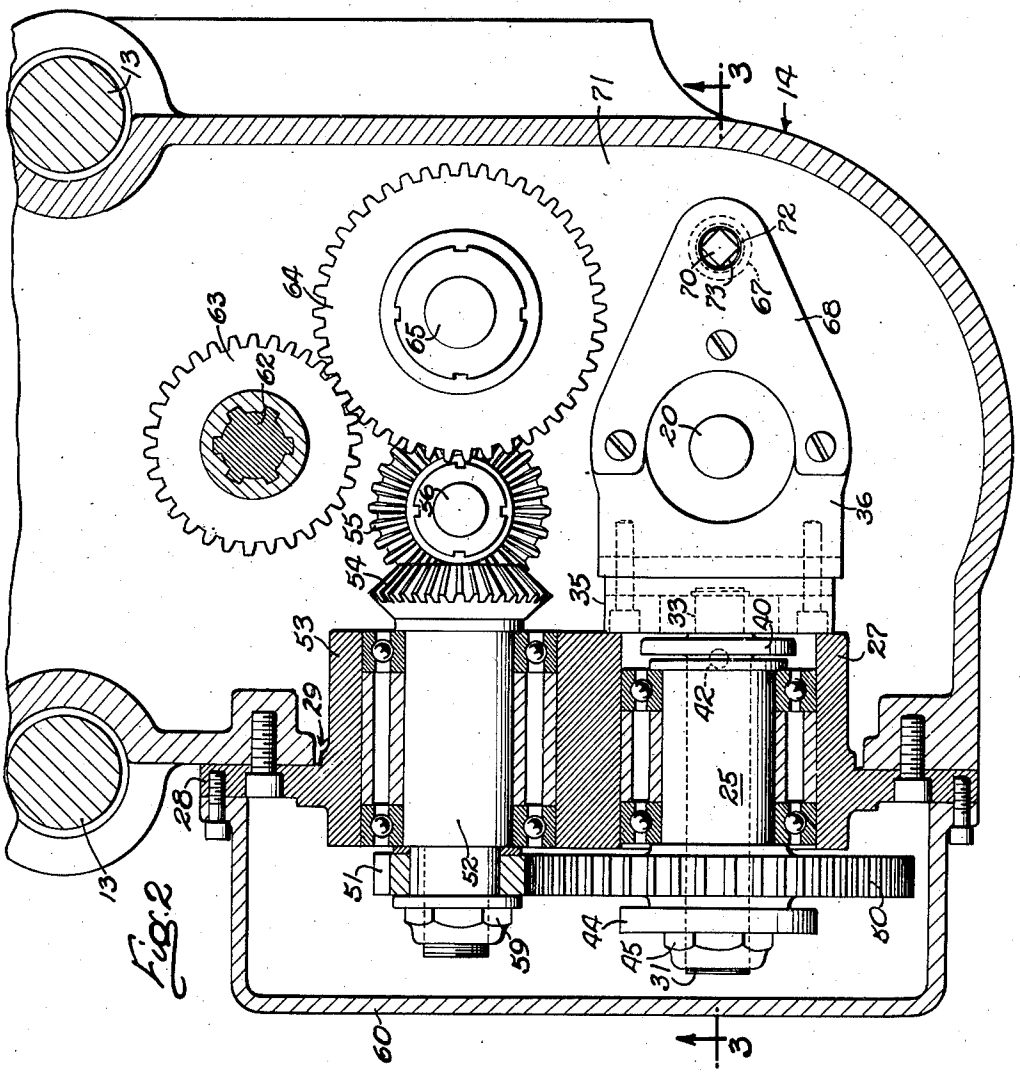


Fig. 2

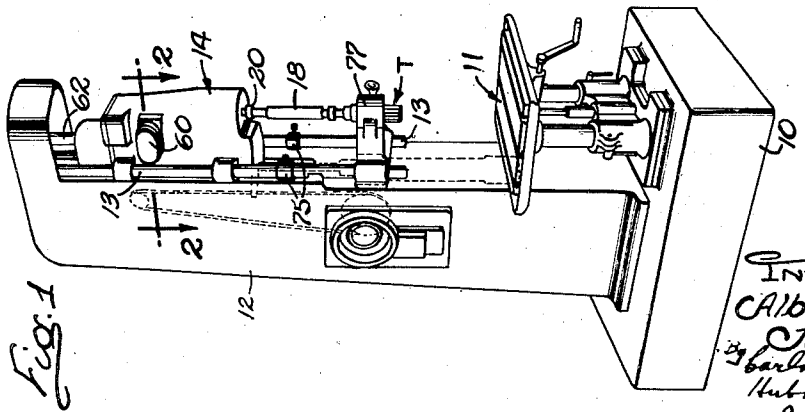


Fig. 1

INVENTOR
Albert M. Johnson
By Carlson, Pitzner, Hubbard & Wolfe
ATTORNEYS

Aug. 23, 1949. A. M. JOHNSON 2,479,622

CONTROL MECHANISM FOR HONING MACHINES

Filed Dec. 4, 1944 3 Sheets-Sheet 2

Fig. 3

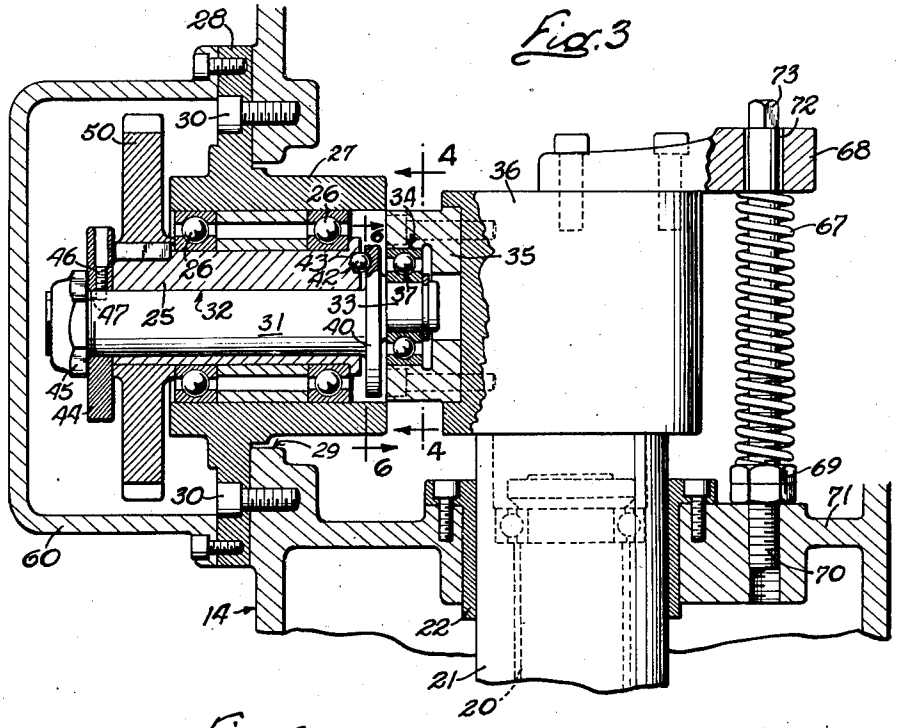


Fig. 4

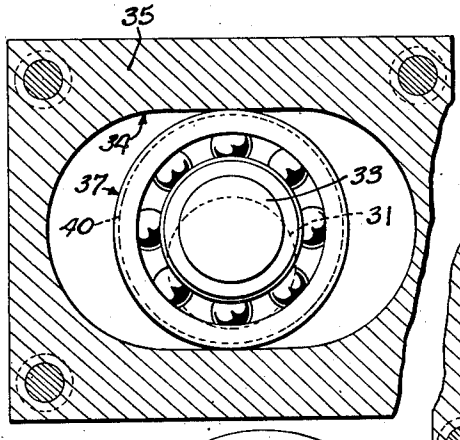


Fig. 5

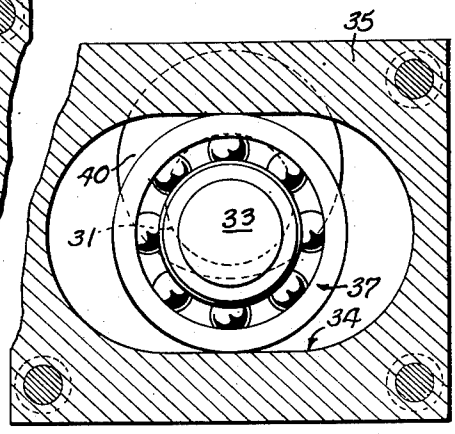
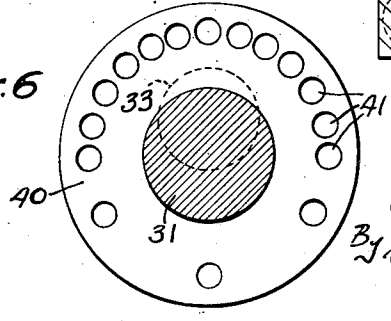


Fig. 6



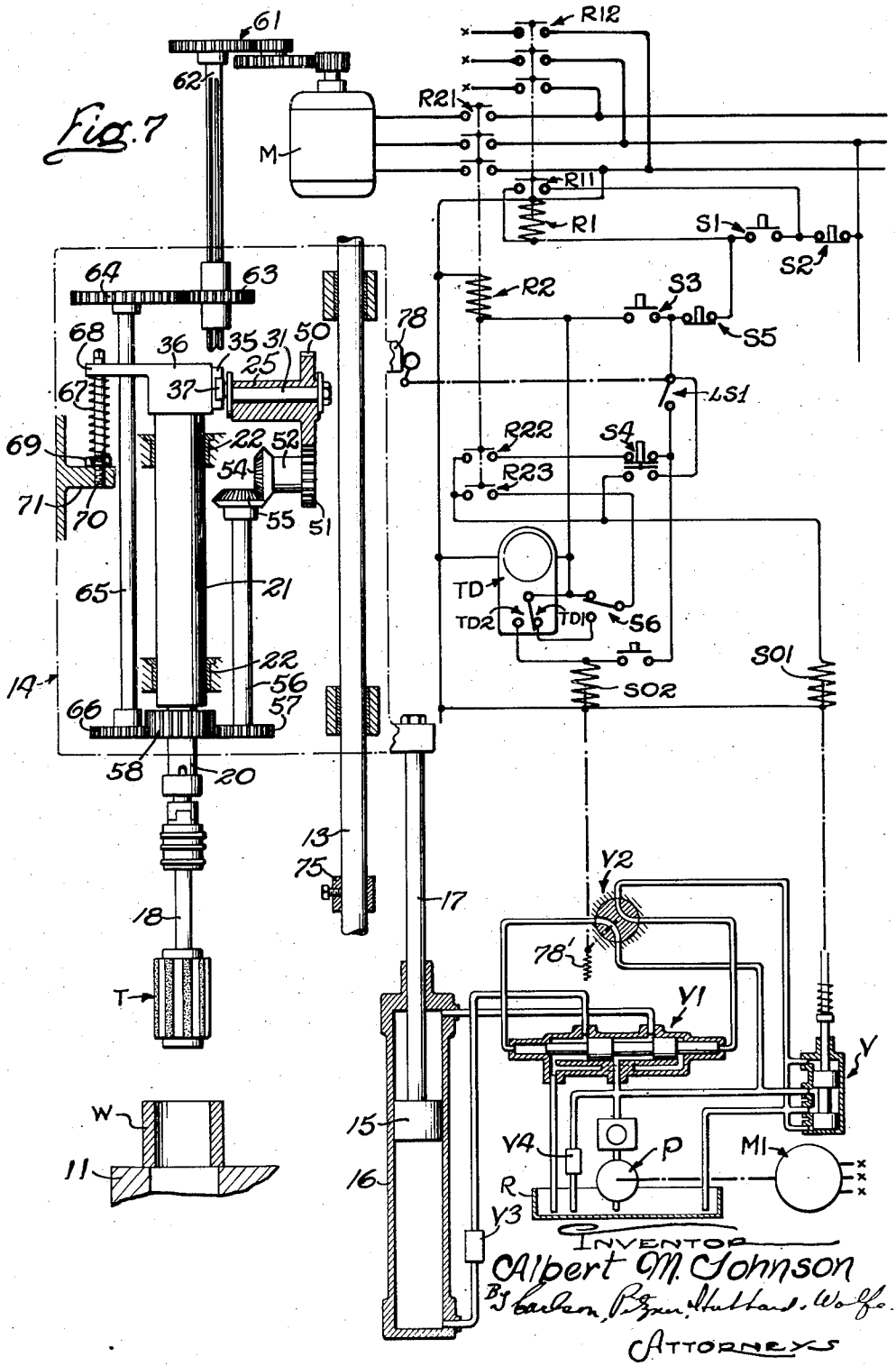
INVENTOR
Albert M. Johnson
By Cahn, Pitzner, Hubbard, Wolfe
ATTORNEYS

Aug. 23, 1949. A. M. JOHNSON 2,479,622

CONTROL MECHANISM FOR HONING MACHINES

Filed Dec. 4, 1944 3 Sheets-Sheet 3

Fig. 7



INVENTOR
Albert M. Johnson
By Carlson, Price, Hubbard & Wolfe
ATTORNEYS

Patented Aug. 23, 1949 2,479,622

UNITED STATES PATENT OFFICE

2,479,622

CONTROL MECHANISM FOR HONING MACHINES

Albert M. Johnson, Rockford, Ill., assignor to Barnes Drill Co., Rockford, Ill., a corporation of Illinois

Application December 4, 1944, Serial No. 566,485

13 Claims. (Cl. 51—34)

1

The invention relates to the art of finishing cylindrical holes or bores and more particularly to an improved machine for honing bores in relatively thin workpieces which provide bore walls of a height substantially less than the length of the conventional honing tool.

Considerable difficulty has been experienced in finishing such bores with honing machines as heretofore constructed because of the impracticability of maintaining the reciprocatory movements of the honing tool within the relatively close limits necessary to insure uniform tool action on the bore walls. In machines of the type referred to, the reciprocation of the tool is effected by reciprocating the carriage or head upon which the tool is supported.

One object of the invention is to overcome the above difficulties by providing an improved honing machine so constructed and arranged that the tool may be reciprocated in rapid, accurately controlled strokes while the head remains stationary thus permitting the reciprocatory movements of the head to be utilized solely for associating and disassociating the tool and work.

Another object is to provide a novel control system for honing machines adapted to effect automatic operation of the machine through a cycle in which the tool supporting head is initially advanced to operatively associate the tool with the work, held stationary during the working portion of the cycle, and retracted at the end of the cycle to withdraw the tool from the work.

Still another object is to provide improved mechanism for reciprocating the honing tool through an accurately controlled working stroke substantially shorter than the length of the tool which mechanism is readily adjustable for working strokes of different length.

A further object is to provide simple, yet effective means for counterbalancing the weight of the tool spindle and tool so as to reduce the strain on the reciprocating mechanism.

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 perspective view of a honing machine embodying the features of the invention.

Fig. 2 is a transverse sectional view of the tool supporting head taken in a horizontal plane substantially on the line 2—2 of Fig. 1.

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

Fig. 4 is a sectional view taken in a vertical

2

plane substantially on the line 4—4 of Fig. 3 showing the spindle reciprocating mechanism adjusted for minimum stroke.

Fig. 5 is a view similar to Fig. 4 but showing the reciprocating mechanism adjusted for maximum stroke.

Fig. 6 is a sectional view taken in a vertical plane substantially on the line 6—6 of Fig. 3 showing details of the locking means for the reciprocating mechanism.

Fig. 7 is a diagrammatic view showing the electrical and hydraulic operating and control systems and their relationship to the mechanical elements of the machine.

For purposes of illustration, the invention has been shown and will be described herein as applied to a single spindle vertical honing machine of the type in which the honing tool is rotated and reciprocated relative to a stationarily supported workpiece. It will be understood, however, that the invention is not limited to use in a machine of the particular type illustrated and that various changes and adaptations may be made in the form, construction and arrangement of the parts without departing from the spirit and scope of the invention as defined by the appended claims.

Referring to Fig. 1 of the drawings, the machine selected to illustrate the invention comprises generally a bed or base 10 having mounted thereon an adjustable table or work support 11 and an upright column 12. The column 12 is located at the rear of the table and is provided on its front face with spaced parallel guide members 13 for supporting and guiding a reciprocatory tool head 14. Power driven means, herein shown as a pressure fluid operated actuator comprising a piston 15 (Fig. 7) working in a cylinder 16 and connected with the head by a rod 17, is provided for shifting the head toward or from the work support 11. A honing tool T (Figs. 1 and 7) of any suitable type is carried by a driver 18 attached in well known manner to the lower end of a rotatable spindle 20 supported in the head 14.

In accordance with the present invention, support for the spindle 20 is provided by an elongated tubular member or quill 21 fitted with anti-friction bearings constructed and arranged in well known manner to permit rotation of the spindle while preventing its endwise movement relative to the quill. The quill 21, in turn, is supported in spaced bearings 22 for limited endwise movement axially of the spindle. As the quill and spindle are constrained to move to-

gether, reciprocation of the latter may be effected by reciprocating the quill.

Novel mechanism is provided for reciprocating the quill 21 and spindle 20 relative to the head 14, in short, accurately controlled strokes capable of being varied over a substantial range to adjust the machine for the particular work to be operated on. In its preferred form, as shown in Figs. 2–6, the reciprocating mechanism comprises generally a rotatable driven member 25 supported on the head 14 and having an adjustable eccentric connection with the quill 21.

Referring to Figs. 2 and 3, the member 25, herein shown as a cylindrical bushing, is supported for rotation about its central axis by anti-friction bearings 26 seated in a bearing sleeve 27 forming a part of a panel 28 rigid with the head 14. The panel 28 is arranged to overlie an opening 29 in one side wall of the head 14 so as to locate the rotational axis of the bushing 25 substantially perpendicular to the axis of the quill 21 and is preferably removably secured to the head as by machine screws 30 so that it may be removed therefrom along with the reciprocating mechanism as a unit. This unitary construction simplifies manufacture and assembly of the mechanism and facilitates repair or replacement of worn parts.

The adjustable eccentric driving connection between the member 25 and the quill 21 is provided by a shaft 31 fitted in a longitudinal bore 32 in the bushing and having at its inner end an eccentric crank pin 33 engaging in a transverse slot 34 formed in a cam block 35 rigid with the quill. In the exemplary machine, the cam block 35 is removably secured to a pad formed at one side of a cap member 36 rigid with the upper end of the quill. As will be seen by reference to Figs. 4 and 5 of the drawings, the slot 34 in the cam block is generally oval and is dimensioned to receive the outer race ring of an anti-friction bearing 37 mounted on the crank pin 33.

To provide adjustability, the bore 32 in the member 25 is located eccentrically of the rotational axis of the bushing. Preferably, the eccentricity of the bore is the same as that of the crank pin 33. By rotating the shaft 31 in the bore 32, the axis of the crank pin 33 may be adjusted from the neutral or minimum stroke position shown in Fig. 4 in which it is alined with the axis of the member 25 to the maximum stroke position shown in Fig. 5 in which it is offset from the rotational axis of the member by an amount equal to its eccentricity relative to the shaft 31 plus the eccentricity of the bore 32 relative to the axis of the member 25. With the mechanism adjusted for minimum stroke, the machine may be used for honing in the conventional manner.

Means is provided for locking the shaft 31 to the member 25 in various selected positions of adjustment. For this purpose, the shaft is formed with a peripheral flange 40 disposed inwardly of the crank pin 33 and adapted to extend over the adjacent end of the member 25. The inner face of the flange 40 is formed with a plurality of recesses 41 arranged in a circular row concentric with the axis of the shaft and suitably spaced apart circumferentially of the flange. These recesses are positioned to register with a detent element, herein shown as a steel ball 42, seated in a recess 43 in the end of the member 25 as the shaft is turned to its various positions of adjustment.

A washer 44 held against the opposite end of the member 25 by a nut 45 threaded on the shaft 31 serves to maintain the flange tightly engaged with the detent 42 thereby locking the shaft and member together for rotation as a unit about the axis of the member. Adjustment of the shaft to vary the eccentricity of the crank pin 33 may be conveniently effected by backing off the nut 45 and turning the shaft to the desired position. To provide a visual indication of the adjusted position of the crank pin, the washer 44 may be provided with a suitable index mark and non-rotatably fixed to the shaft 31. As shown in Fig. 3, a set screw 46 threaded in the washer and engaging in a keyway 47 in the shaft prevents relative rotation of the parts.

While any suitable means may be utilized for driving the member 25 and the shaft 31, it has been found especially convenient to drive this mechanism directly from the spindle 20. A driving connection for this purpose is provided by a gear 50 (Figs. 2, 3 and 7) keyed to the outer end of the member 25 and meshing with the pinion 51 keyed to the outer end of a shaft 52 journaled in a bearing sleeve 53 formed on the panel 28 at one side of the bearing sleeve 27. At its inner end, the shaft 52 carries a bevel gear 54 meshing with a bevel gear 55 on a shaft 56 journaled in the head 14 parallel to the spindle 20. A gear 57 on the shaft 56 (Fig. 7) meshes with a pinion 58 keyed to the end of the spindle projecting from the quill 21. The pinion 58 is formed with a wide face so as to maintain its driving engagement with the gear 57 as the quill and spindle are reciprocated in the head.

As shown in Fig. 2, the gears 50 and 51 are located so that they are conveniently accessible for replacement whenever it is desired to change the driving ratio between the spindle and the reciprocating mechanism. The gear 51 is held in place on the shaft 52 by a nut 59 threaded on the end of the shaft. The nut 45 and washer 44 perform a similar function for the gear 50. Preferably the gears and the retaining nuts are enclosed in a suitable housing 60 removably secured to the outer face of the panel 28.

Any suitable means may be provided for driving the spindle 20. In the exemplary machine, the spindle is adapted to be driven by a motor M stationarily supported on the column 12 and drivingly connected through a train of gears 61 with a splined shaft 62 extending into the head 14 and parallel to its reciprocatory path. The shaft 62 has a splined driving connection with a gear 63 journaled in the head 14 and meshing with a pinion 64 keyed to an intermediate shaft 65 journaled in the head. A gear 66 on the shaft 65 meshes with the pinion 58 on the spindle, the wide face of the pinion serving to maintain the driving connection as the spindle is reciprocated relative to the head.

Simple and efficient means is provided for counterbalancing the weight of the quill 21 and spindle 20 to relieve the strain on the reciprocating mechanism. The counterbalancing means in its preferred form, as shown in Figs. 3 and 7, comprises a compression spring 67 interposed between a rigid portion of the head and an arm 68 secured to the top of the cap member 36 of the quill and projecting laterally at one side thereof. To provide for adjusting the tension of the spring, its lower end is adapted to bear against a nut 69 threaded on a rod 70 which, in turn, is threaded into a flange 71 formed within the head 14. The rod is arranged to project upwardly through the spring and through an aperture 72 in the arm 68 and its upper end is squared as at 73 for engage-

ment by a wrench whereby the rod may be screwed in or out to vary the spacing of the nut from the flange 11 and thus the tension of the spring.

In accordance with the present invention, a control system of novel and advantageous character is provided for effecting automatic cycling of the machine in a manner which materially simplifies and reduces the work of the machine attendant and otherwise greatly facilitates the honing of shallow bores. Once the machine is set up for operating on a particular class of work, the attendant's duties consist simply of placing the unfinished workpieces on the work support, manipulating a single control element such as a push button to start the cycle, and removing the finished workpiece when the cycle is terminated automatically.

For operating on work of which a typical example W is shown in Fig. 7 of the drawings, the machine is provided with a honing tool of the proper grade and size for finishing the bore of such workpiece. In setting up the machine, suitable stops herein shown as sleeves 75 mounted on guide members 13 are rigidly secured in place thereon for engagement by the head 14 when the latter is shifted downwardly so as to substantially center the tool within the bore of the workpiece. The eccentricity of the spindle reciprocating mechanism is adjusted in the manner above described to provide the required working stroke, that is to traverse the tool axially of the work in a series of strokes such that the abrading elements of the tool are at all times in contact with the bore of the work throughout its entire length. A timing device TD forming a part of the control system is set to determine the length of the working portion of the machine cycle.

Momentary actuation of a motor starting switch S1 energizes a control relay R1 which closes a switch R11 to complete a holding circuit for itself independently of the starting switch. This holding circuit may be interrupted to deenergize the relay at any time by actuation of a normally closed stop switch S2. Relay R1, when energized, also closes a switch R12 to supply current to a motor M1 arranged to drive a pump P for supplying pressure fluid to the cylinder 16 of the head reciprocating actuator.

While the machine is idle, pressure fluid delivered by the pump P is by-passed to a reservoir or sump R through a normally open stop valve V. Upon closure of the stop valve, the pressure fluid supplied by the pump is directed by a reversing valve V1 to the upper or lower end of the cylinder 16 to advance or retract the piston 15 and the head 14 to which it is connected. A pilot valve V2 of the conventional rotary type controls the setting of the reversing valve in well known manner thus determining the direction in which the head is to be moved.

As shown in Fig. 7, the head 14 is in its upper or retracted position while the valves V1 and V2 are set for directing the flow of pressure fluid to effect the advance of the head from such position toward the work support. It will be understood that the parts are positioned as shown in the drawing at the beginning of an operating cycle. In the retracted position of the head, the honing tool T is withdrawn a substantial distance above the workpiece W and into a guide fixture 77 which acts in well known manner to maintain the tool in a contracted condition until it has been entered in the work. Upon entering the work, the tool is expanded to force the abrasive elements against the walls of the bore to be honed.

An operating cycle of the machine is initiated by momentary closure of a normally open cycle starting switch S3 (Fig. 7) which completes an energizing circuit for a control relay R2. The relay upon energizing, closes a switch R21 to start the spindle driving motor M and additionally closes a holding circuit for itself independent of the starting switch S3. The holding circuit, as herein shown, includes an "inching" switch S4, a limit switch LS1, a cycle stop switch S5 and the switches R11, R22 and S2. Limit switch LS1 is adapted to be held open by a cam block 78 or the like when the head 14 is fully retracted and to close upon movement of the head away from the retracted position. A selector switch S6 is provided so that the holding circuit for the relay R2 may be placed under control of or rendered independent of the timing device TD selectively. For this purpose, a normally closed switch TD1 adapted for actuation by the timer is cut into or out of the holding circuit by manipulation of the selector switch.

Closure of the switch R22 by the relay R2 completes a parallel circuit for a solenoid SO1 which energizes to actuate the stop valve V and close the bypass line from the pump P. Pressure fluid delivered by the pump is then directed by the valve V1 to the upper end of the cylinder 16 to shift the piston 15 downwardly and thus advance the head 14 toward the work support. Fuid from the lower end of the cylinder 16 is exhausted through a resistance valve V3 and the valve V1 to the sump R. Such downward movement of the head continues until the head engages the fixed stops 75 which have been positioned to interrupt the movement of the head when the tool is substantially centered in the workpiece W. A relief valve V4 associated with the pressure line from the pump prevents excessive increase in pressure while the head is maintained against the stops by the pressure of the fluid in the upper end of the cylinder 16.

The head 14 is held in engagement with the stops 75 while the tool T performs its action on the workpiece. Tool action is effected through rotation of the tool by the motor M and simultaneous reciprocation by the reciprocating mechanism heretofore described. The timing of the tool action, conveniently called the working portion of the cycle, is effected by the timing device TD which, after a predetermined interval, opens the switch TD1 and closes a switch TD2.

Opening of the switch TD1 stops the spindle driving motor by interrupting the holding circuit for the relay R2 in the event that the selector switch S6 has been appropriately set for such automatic stopping. With the switch S6 set in the position shown in the drawings, operation of the spindle driving motor continues until the head has been returned to retracted position as will appear presently. Closure of the switch TD2 completes an energizing circuit for a solenoid SO2 which shifts the pilot valve V2 to reverse position against the action of a spring 78' normally urging the valve to the advance position. Operation of the pilot valve initiates the shifting of the reversing valve V1 to its alternate position in which pressure fluid is directed to the lower end of the cylinder 16 while the upper end of the cylinder is connected to the exhaust line. The piston 15 and head 14 are accordingly moved upwardly and the tool is withdrawn from the work.

As the head 14 approaches its upper limit position, limit switch LS1 is operated to open another point in the holding circuit for the control relay

R2 and the circuits for the solenoids SO1 and SO2 are also opened. Relay R2, upon deenergizing following the opening of the time switch TD1, stops the motor M and the timing device TD. Solenoid SO2 permits the pilot valve to return to its normal rest position under the action of the spring 78'. Solenoid SO1 permits the stop valve V to return to open position and thus render the fluid pressure system temporarily ineffective. Preferably, the deenergization of the solenoids SO1 and SO2 is timed so that the reversing valve V1 may be shifted to its head advancing position before the pressure fluid system is disabled. If for any reason, this shift does not occur at the end of the cycle, it will take place immediately upon the beginning of the succeeding cycle due to the setting of the pilot valve V2.

The retraction of the head 14 marks the end of the machine cycle and the machine remains idle until another cycle is initiated by actuation of the starting switch S3. The retraction of the head advises the attendant that the cycle has been completed and he may remove the finished workpiece and replace it with another one to be operated on.

It will be apparent from the foregoing that the invention provides a honing machine embodying novel and advantageous features which particularly adapt it for the honing of shallow bores and which greatly facilitate such operations. The novel cycle controlling system incorporated in the machine materially simplifies and reduces the work of the attendant so that a relatively unskilled workman may be placed in charge of the machine.

The invention also provides novel means for reciprocating the tool supporting spindle relative to the head for the performance of the honing operation thus permitting normal reciprocatory movements of the tool head to be utilized for associating and disassociating the tool and the work. The reciprocating mechanism is simple in construction, yet efficient and reliable in operation. Moreover, it is readily adjustable through a wide range to adapt it for operation on a wide variety of work.

I claim as my invention:

1. In a honing machine, a head mounted for reciprocation, a tool carrying spindle mounted on said head for reciprocation therewith and for reciprocation relative thereto, a support for work to be operated on by the tool carried by said spindle, a first power driven means for reciprocating said spindle, a second power driven means for advancing and retracting said head with respect to said work support, a control system including a manually actuated control element, means in said control system operative in response to a momentary actuation of said control element for initiating the operation of said first power driven means to effect the reciprocation of said spindle and the tool carried thereby, and other means operative in response to the actuation of said control element for initiating the operation of said second power driven means to effect an advance of said head to operatively associate the tool with the work.

2. In a honing machine, a head mounted for reciprocation, a tool carrying spindle mounted on said head for reciprocation therewith and for reciprocation relative thereto, a support for work to be operated on by the tool carried by said spindle, a first power driven means for reciprocating said spindle, a second power driven means for advancing and retracting said head with respect

to said work support, a control system including a manually actuated control element, means in said control system operative in response to a momentary actuation of said control element for initiating the operation of said first power driven means to effect the reciprocation of said spindle and the tool carried thereby, other means responsive to the actuation of said control element for initiating the operation of said second power driven means to advance said head and operatively associate the tool with the work, and means for causing said second power driven means to retract said head and thereby disassociate the tool from the work after a predetermined interval.

3. In a honing machine, a head mounted for reciprocation, a tool carrying spindle mounted on said head for reciprocation therewith and for reciprocation relative thereto, a support for work to be operated on by the tool carried by said spindle, a first power driven means for reciprocating said spindle, a second power driven means for advancing and retracting said head with respect to said work support, a control system including a manually actuated control element, means in said control system operative in response to a momentary actuation of said control element for initiating the operation of said first power driven means to effect the reciprocation of said spindle and the tool carried thereby, other means responsive to the actuation of said control element for causing said second power driven means to advance said head so as to operatively associate the tool with the work and to hold said head in advanced position while the tool is operating on the work, and timing means for causing said second power driven means to retract said head and disassociate the tool from the work after a predetermined interval.

4. In a honing machine, in combination, a work support, a head mounted for movement toward and from the work support, a tool supporting spindle mounted on said head for rotation and for reciprocation relative thereto, a first power actuated means for advancing and retracting said head, a second power actuated means for reciprocating said spindle, control mechanism for the machine including a manually actuated element adapted when actuated to initiate the operation of both said power actuated means, said first mentioned power actuated means operating to advance said head to bring the tool carried by said spindle into operative association with work carried on said work support, said second power actuated means operating to reciprocate said spindle and the tool while such operative association with the work is maintained, and a timing device started concurrently with said power actuated means operative to initiate the withdrawal of the head and thereby disassociate the tool from the work after a predetermined interval.

5. In a honing machine, a head mounted for reciprocation, a tool carrying spindle mounted on said head for reciprocation therewith and for reciprocation relative thereto, a support for work to be operated on by the tool carried by said spindle, a first power driven means for reciprocating said spindle, a second power driven means for advancing and retracting said head with respect to said work support, a control system including a manually actuated control element, means in said control system operative in response to a momentary actuation of said control element for initiating the operation of said first power driven means to effect the reciprocation of said

spindle and the tool carried thereby, other means responsive to the actuation of said control element for causing said second power driven means to advance said head so as to operatively associate the tool with the work and to hold said head in advanced position while the tool is operating on the work, timing means operative to interrupt the reciprocation of said spindle by said first power driven means, and means controlled by said timing means for causing said second power driven means to retract said head and thereby disassociate the tool from the work.

6. In a honing machine, a head mounted for reciprocation, a tool carrying spindle mounted on said head for reciprocation therewith and for reciprocation relative thereto, a support for work to be operated on by the tool carried by said spindle, a first power driven means for reciprocating said spindle, a second power driven means for advancing and retracting said head with respect to said work support, a control system including a manually actuated control element, means in said control system operative in response to a momentary actuation of said control element for initiating the operation of said first power driven means to effect the reciprocation of said spindle and the tool carried thereby, other means responsive to the actuation of said control element for causing said second power driven means to advance said head so as to operatively associate the tool with the work and to hold said head in advanced position while the tool is operating on the work, a timer operative to cause said second power driven means to retract said head to disassociate the tool from the work, control means actuated by said timer for interrupting the reciprocation of said spindle prior to the retraction of said head, and means operable selectively to render said control means operative or inoperative at will.

7. Spindle reciprocating mechanism for a honing machine comprising, in combination, a cylindrical member supported for rotation about a central axis and having a longitudinal bore located eccentrically of said axis, a shaft rotatably fitted in said bore, an eccentric crank pin at one end of said shaft, the eccentricity of said crank pin being adjustable relative to the rotational axis of said member by rotation of the shaft in said bore, a peripheral flange adjacent one end of said shaft overlying the end of said member, said flange having a plurality of circumferentially spaced recesses, a detent element engageable selectively in said recess and in a complemental recess in said member to hold the shaft and member against relative rotation, and means detachably secured to the other end of said shaft and coacting with the adjacent end of said member to hold the shaft and member against relative endwise movement whereby to prevent disengagement of said detent means.

8. Spindle reciprocating mechanism for a honing machine comprising, in combination, a cylindrical member supported for rotation about a central axis and having a longitudinal bore located eccentrically of said axis, a shaft rotatably fitted in said bore, an eccentric crank pin at one end of said shaft, the eccentricity of said crank pin being adjustable relative to the rotational axis of said member by rotation of the shaft in said bore, a peripheral flange on said shaft extending over the adjacent end of said member, a plurality of recesses in said flange spaced apart circumferentially of said shaft, a recess in the adjacent end of said member, and a detent element seated in the recess in said member and engageable selectively in the recesses in said flange to hold said shaft against rotation relative to said member.

9. In a honing machine, in combination, a non-rotatable axially reciprocable quill having a tool supporting spindle journaled therein, means for reciprocating said quill comprising a shaft disposed with its axis substantially perpendicular to said quill, an eccentric crank pin at one end of said shaft operatively connected with said quill, a rotatably supported bushing having a longitudinal bore for the reception of said shaft, said bore being located eccentrically with respect to the rotational axis of said bushing whereby the eccentricity of said crank pin may be adjusted with respect to said axis by turning said shaft relative to said bushing, means for locking said shaft and said bushing together in any selected position of adjustment, and means for driving said bushing.

10. In a honing machine, in combination, a reciprocatory head, an elongated tubular member supported in said head for limited endwise movement, a tool supporting spindle journaled in said member and secured against endwise movement relative thereto, power actuated means for reciprocating said head, power actuated means for rotating said spindle, a rotatable member supported on said head with its axis substantially perpendicular to the longitudinal axis of said tubular member, an eccentrically disposed crank pin rotatable with said last mentioned member and coacting with said tubular member to reciprocate the tubular member and said spindle in response to such rotation, and means providing a driving connection from said spindle rotating means to said rotatable member.

11. In a honing machine, in combination, a head supported for reciprocation, a tool carrying spindle mounted on said head for reciprocation therewith and for rotation and reciprocation relative thereto, a support for work to be operated on by the tool carried by said spindle, a motor for rotating and reciprocating said spindle, pressure fluid operated means for advancing and retracting said head with respect to said work support, a control system for the machine including a manually operable starting switch, a relay adapted to be energized in response to the actuation of said starting switch, a first switch closed by said relay when energized to initiate the operation of said motor, a second switch closed by said relay when energized for initiating the operation of said pressure fluid operated means to advance said head and operatively associate the tool with the work, an electrically driven timing device started in operation concurrently with the energization of said relay, and means including a switch actuated by said timing device for initiating reverse operation of said pressure fluid operated means to retract said head and thereby disassociate the tool from the work.

12. In a honing machine, in combination, a head supported for reciprocation, a tool carrying spindle mounted on said head for reciprocation therewith and for rotation and reciprocation relative thereto, a support for work to be operated on by the tool carried by said spindle, a motor for rotating and reciprocating said spindle, pressure fluid operated means for advancing and retracting said head with respect to said work support, a control system for the machine including a manually operable starting switch, a relay adapted to be energized in response to the actuation of said starting switch, a first switch closed by

said relay when energized to initiate the operation of said motor, a second switch closed by said relay when energized for initiating the operation of said pressure fluid operated means to advance said head and operatively associate the tool with the work, stop means for interrupting the advance of said head to maintain the tool in operative relation with the work, an electrically driven timing device, means including a switch operated by said timing device for initiating reverse operation of said pressure fluid operated means to retract said head and thereby disassociate the tool from the work, and means operative upon the retraction of the head for stopping said timing device and said pressure fluid operated means.

13. In a honing machine, in combination, a head mounted for linear translation, a tool carrying spindle mounted on said head for translation therewith and for reciprocation relative thereto, a support for work to be operated on by a tool carried by said spindle, power driven means for reciprocating said spindle, pressure fluid actuated means for advancing and retracting said head with respect to said work support, a manually actuated control element, and control means including a valve and a timing device operative in response to a momentary actuation of said control element for initiating the advance of said head by said pressure fluid actuated means

to operatively associate the tool with the work, for interrupting the advance of the head and for holding it stationary while the tool is reciprocated in engagement with the work by said power driven means, and for subsequently initiating retraction of said head by said pressure fluid actuated means to disassociate the tool from the work.

ALBERT M. JOHNSON.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
287,697	Marchand	Oct. 30, 1883
290,901	Marchand	Dec. 25, 1883
1,584,717	Belden et al.	May 18, 1926
1,599,956	Drew	Sept. 14, 1926
1,700,967	Baerbalck	Feb. 5, 1929
1,856,268	Schmiedeknecht	May 3, 1932
1,949,510	Woodward	Mar. 6, 1934
1,950,936	Baumberger	Mar. 13, 1934
2,083,194	Johnson	June 8, 1937
2,163,443	Abrams	June 20, 1939
2,176,316	Swanson	Oct. 17, 1939
2,181,234	Hanes	Nov. 28, 1939
2,263,878	Johnson	Nov. 25, 1941
2,270,590	Johnson	Jan. 20, 1942
2,294,184	Johnson	Aug. 25, 1942