Feb. 3, 1942. A. M. JOHNSON 2,271,768

HONING MACHINE

Filed Nov. 17, 1937 4 Sheets-Sheet 1

Fig. 1

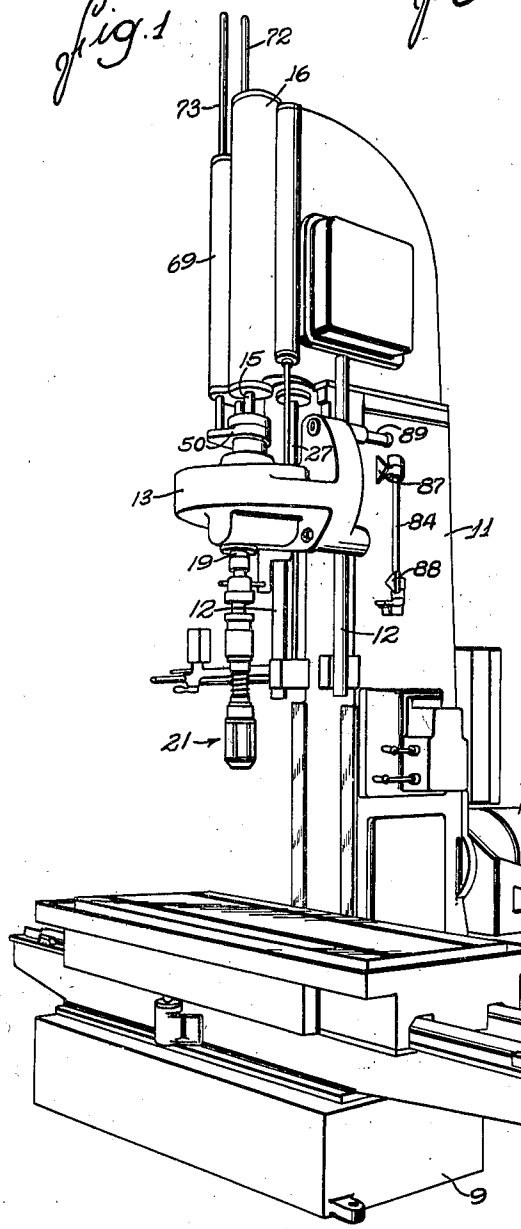
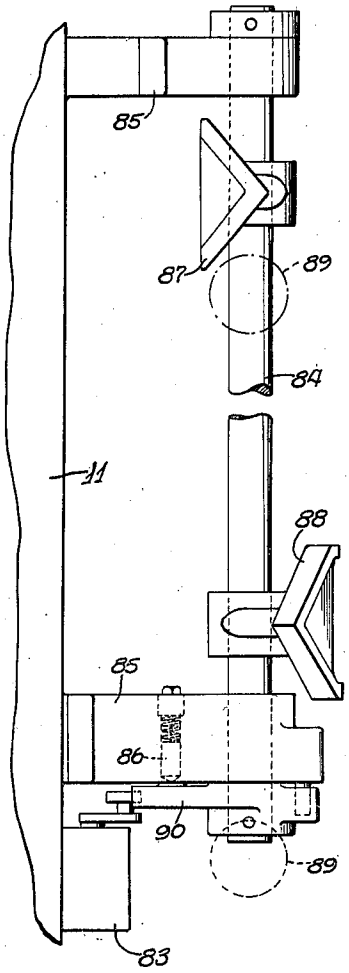


Fig. 2



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Fig. 3

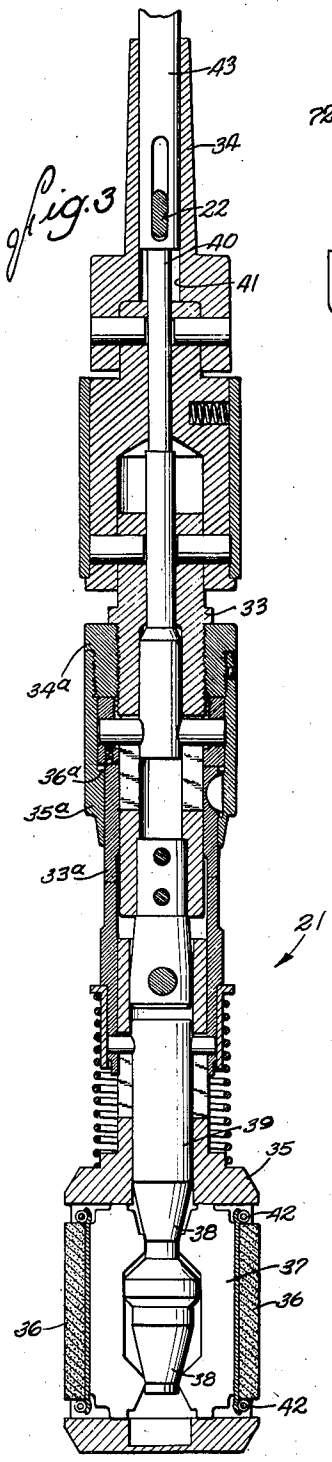
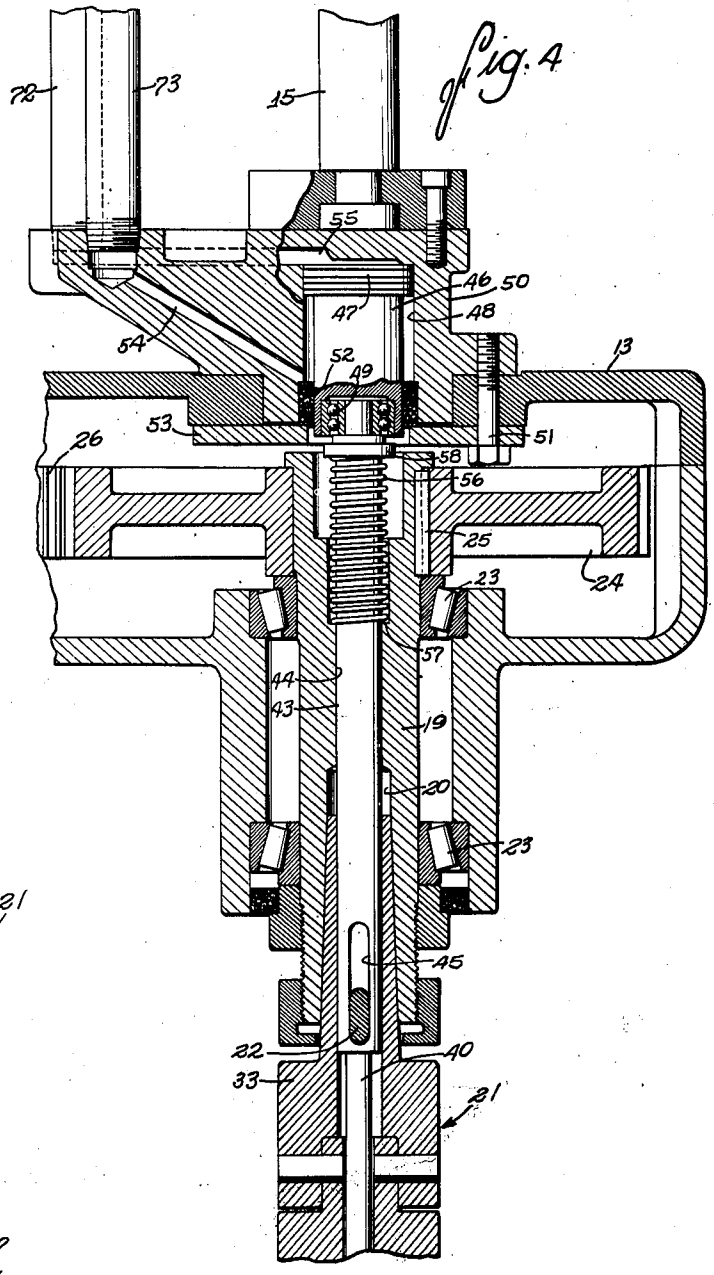


Fig. 4



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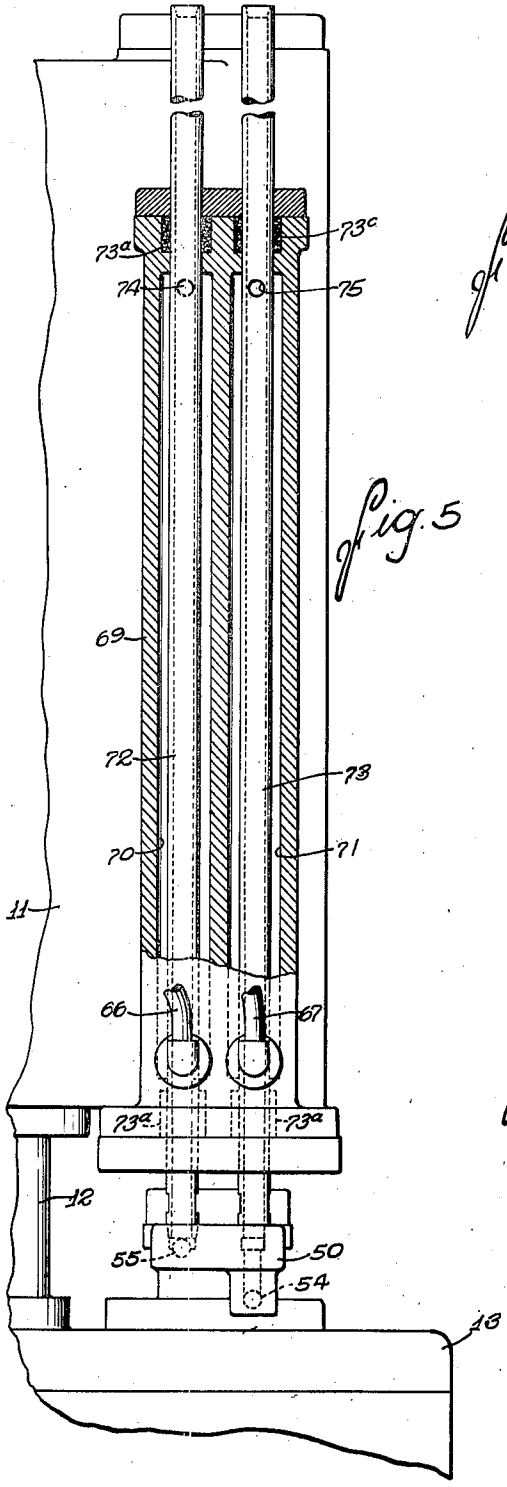


Fig. 5

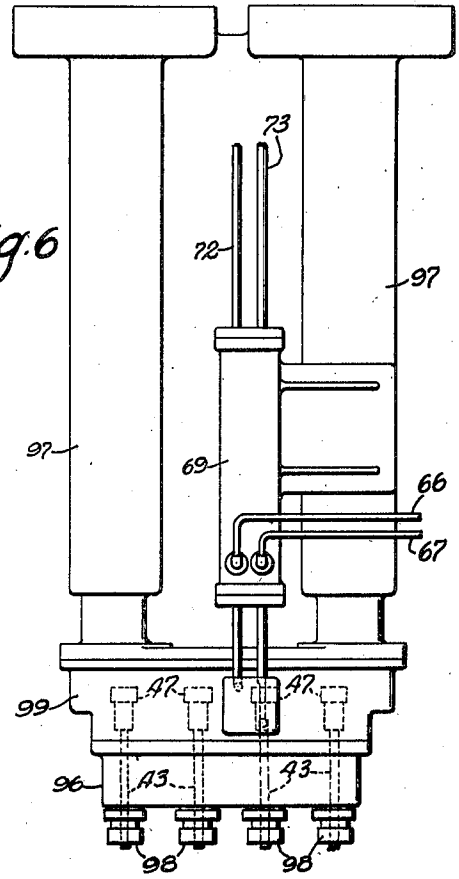


Fig. 6

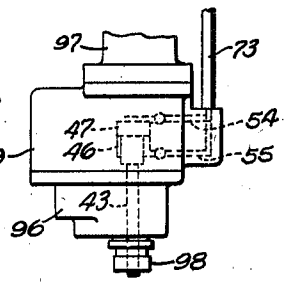


Fig. 7

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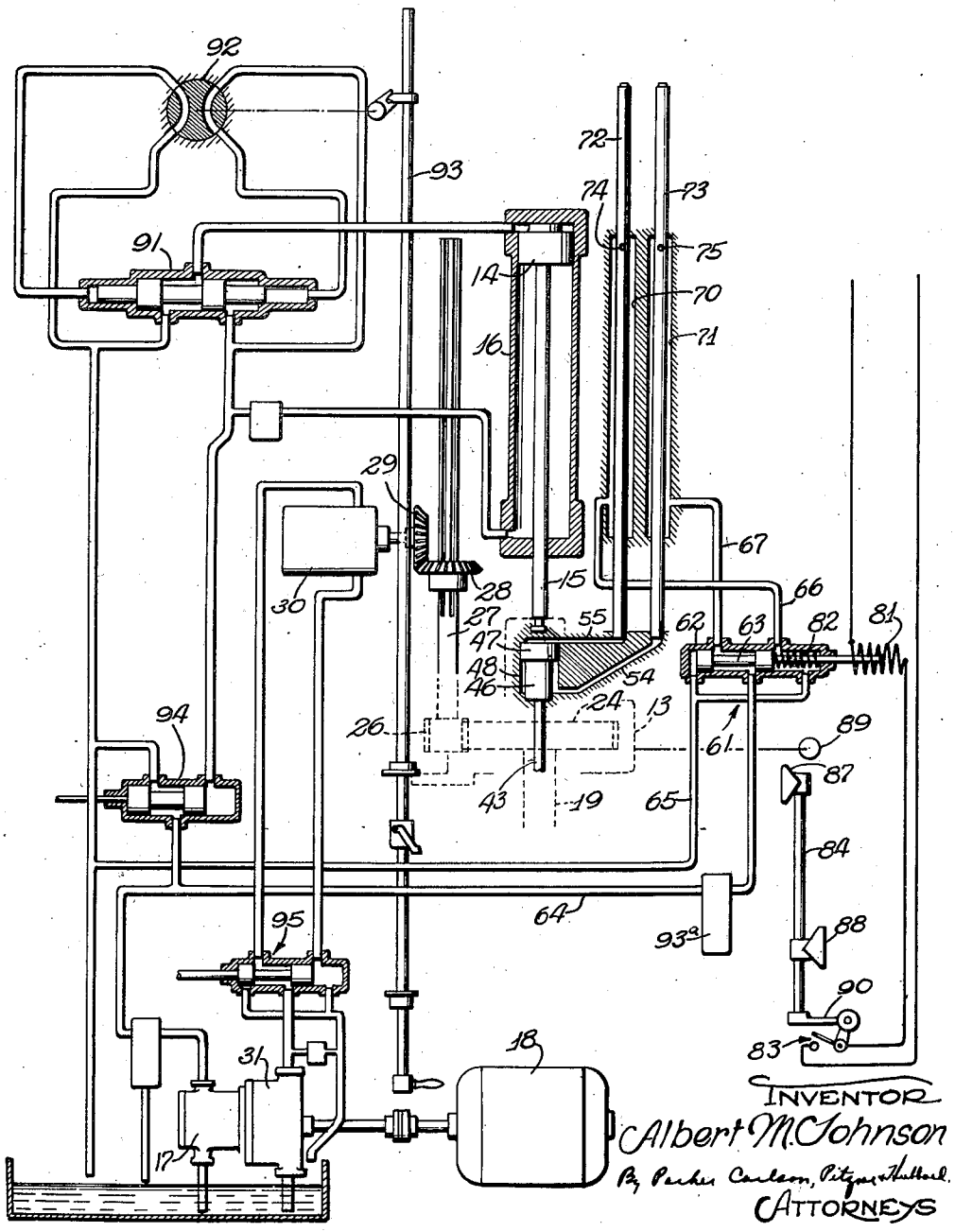
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Fig. 8



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Patented Feb. 3, 1942 2,271,768

UNITED STATES PATENT OFFICE

2,271,768

HONING MACHINE

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

Application November 17, 1937, Serial No. 174,955

12 Claims. (Cl. 51—34)

The invention relates to machines for dressing cylindrical surfaces, and more particularly to honing machines of the type which rotate and simultaneously reciprocate an expansible and contractible abrasive tool over the surface to be dressed.

One object of the invention is to provide an improved honing machine of the above general character in which the tool expanding and contracting means is incorporated in the machine itself instead of in the tool as has heretofore been the general practice, thereby making it possible to force the abrasive elements of the tool against the surface of the work with the uniform and relatively high pressures necessary to enable the machine to operate efficiently on extremely hard metals and to remove the maximum amount of stock in a minimum of time.

Another object is to provide a honing machine embodying novel means by which the pressure of the tool on the work may be quickly and accurately adjusted to suit the particular requirements of the material being operated upon.

Another object is to provide novel means for expanding and contracting the honing tool without interrupting its rotation or reciprocation.

Still another object is to provide novel control means operable automatically to expand the tool upon its entry into the work and to contract the tool before withdrawal from the work.

A further object is to provide hydraulically operated means of a novel and advantageous character for expanding and contracting the honing tool.

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 detail view of one of the control members.

Fig. 3 is a view, partly in section, of a tool suitable for use with the machine.

Fig. 4 is a vertical sectional view of the reciprocatory spindle head of the machine.

Fig. 5 is a side view partly in section, showing details of the pressure fluid supply system for the head.

Fig. 6 is a fragmentary front view of a modified form of the machine equipped with a multiple spindle head.

Fig. 7 is a side view of the spindle head shown in Fig. 6.

Fig. 8 is a diagrammatic view of the electrical and hydraulic circuits of the machine showing the interrelationship of the various machine elements.

By way of illustration, the invention has been shown and will be described hereinafter as applied to a vertical type honing machine equipped for honing internal cylindrical surfaces. It is to be understood, however, that the invention may be readily applied to machines for honing other classes of work, as well as to other types of honing machines. It is also to be understood that various changes and modifications in the form, construction and arrangement of the parts may be made by those skilled in the art without departing from the spirit and scope of the invention as expressed in the appended claims.

Referring to Figs. 1 and 8 of the drawings, the machine selected to illustrate the invention comprises generally a base 9 which carries an adjustable work support in the form of a rectangular table 10. Rising from the rear of the base is an upright frame member or column 11 having on its front face a pair of spaced parallel guide bars 12 which constitute a track or guideway for supporting a reciprocatory spindle head 13 for movement toward and from the work support.

Reciprocation of the head 13 is effected by means of a piston 14 connected with the head by a piston rod 15. The piston is arranged to work in a vertically disposed cylinder 16 mounted on the column 11 above the head. A pump 17 (Fig. 8), driven by an electric motor 18, supplies pressure fluid to the cylinder 16 through a hydraulic circuit to be described hereinafter.

Journaled on the head 13 and reciprocable therewith is a vertical spindle 19 having a tapered socket 20 adapted to hold a honing tool 21. A key 22 extending transversely through the spindle and the shank of the tool provides a positive driving connection between the parts. As shown in Fig. 4, the spindle is supported at spaced points along its length by tapered roller bearing units 23 arranged to prevent endwise movement of the spindle while permitting it to rotate freely. Rotation of the spindle is effected through the medium of a gear 24 fixed on the upper end of the spindle by a key 25. The gear 24 meshes with a pinion 26 (Fig. 8) fast on a vertical drive shaft 27 which is reciprocable with the head. The shaft has a splined driving connection with a beveled gear 28 journaled on the frame of the machine which gear is driven by a bevel gear 29 on the shaft of a hydraulic motor 30. Pressure

fluid for operating the motor 30 is supplied by a pump 31 driven by the electric motor 18.

While any suitable tool may be employed, the improved machine is particularly adapted to use a tool of the general type shown in Fig. 3. Such tools comprise a jointed body portion 33 having a tapered shank 34 at one end for attachment to the tool spindle of the machine. The opposite end of the body is constructed to form a frame 35 arranged to support a series of abrasive stones 36. The stones 36 are mounted on the usual carriers 37 which rest on inclined cam surfaces 38 of a cam member 39 mounted for axial movement in the frame. The cam member is operatively connected with a round adjusting bar 40 through the medium of a sectional sleeve 33a slidably supported on an intermediate section of the body 33 and having pin connections with adjacent ends of the member and the bar. The upper end of the bar 40 is arranged to project into a bore 41 extending through the shank 34.

Expansion and contraction of the tool is effected by endwise movements of the bar 40 and cam member 39. Thus, when the bar is forced downwardly relative to the body of the tool, the cam surfaces 38 of the member 39 shift the abrasive stones 36 outwardly, thereby increasing the effective diameter of the tool. When the bar 40 is retracted, the abrasive stones are returned to their normal positions by annular springs 42 which encircle the ends of the carriers 37. Suitable adjustable stop means forming no part of the present invention is incorporated in the body of the tool for limiting the endwise movements of the adjusting bar and cam member, and thus determine the limits of tool expansion and contraction. Briefly stated, the stop means includes a nut 34a in threaded engagement with one section of the tool body 33 and having its lower end positioned in abutting relation to the upper end of the sleeve 33a. The nut thus serves to limit the upward movement of the sleeve and adjusting bar 40. A second nut 35a threaded on the nut 34a is formed with an internal shoulder 36a engageable by the upper section of the sleeve 33a which is of substantially greater diameter than the other sleeve sections. The nut 35a thus serves to limit the downward movement of the adjusting bar 40. It will be apparent that the limit positions as well as the range of movement of the bar 40 may be adjusted as required by manipulation of the nuts 34a and 35a.

Means is provided on the spindle head 13 for shifting the tool adjusting bar 40 to expand or contract the tool. This means is preferably arranged to be hydraulically actuated whereby relatively high pressures may be exerted to force the abrasive stones against the surface of the work.

As herein shown, the means for expanding the tool comprises a tool adjusting rod 43 arranged to engage the projecting end of the bar 40, and hydraulically actuated means for moving the rod toward and from the adjusting bar. The adjusting rod 43 is slidably supported in an axial bore 44 extending through the spindle 19 and its lower end is adapted to project into the bore 41 of the tool shank to engage the upper end of the adjusting bar 40 when the tool is secured to the spindle as shown in Fig. 4. A slot 45 is formed in the end of the rod to receive the key 22 so that the latter does not interfere with the endwise movements of the rod.

The upper end of the adjusting rod 43 is operatively connected with a cylindrical member 46 having a piston enlargement 47 arranged to work in a cylinder 48 disposed above and in axial alinement with the spindle 19. The connection between the piston and the rod preferably includes a ball bearing unit 49 which permits the piston to remain stationary while the rod rotates with the spindle, thus reducing wear on the piston and cylinder.

As herein shown, the cylinder 48 is formed in a casing 50 rigidly secured to the head 13 as by bolts 51. The lower end of the cylinder is closed by a suitable packing ring 52 which encircles the member 46 and is held in place by a plate 53 bolted or otherwise rigidly secured to the head. Ducts 54 and 55 connect with the upper and lower ends of the cylinder, respectively, to provide for the introduction of pressure fluid above or below the piston 47. Thus, when pressure fluid is introduced through the duct 55, the piston is forced toward the lower end of the cylinder and the adjusting rod 43 transmits this movement to the adjusting bar 40 of the tool. Upon introduction of pressure fluid through the duct 54, the piston and adjusting rod are shifted toward the upper end of the cylinder, thereby removing the pressure from the adjusting bar 40 and permitting the tool to be contracted as above explained.

Means is provided for holding the adjusting rod in its upper or tool contracting position when the machine is idle. In its preferred form, this means comprises a coiled tension spring 56 encircling the upper end of the rod. The spindle 19 is counterbored to receive the spring and to provide a shoulder 57 for seating the lower end thereof. The upper end of the spring bears against a collar 58 formed on the rod and thus tends to shift the rod upwardly relatively to the spindle.

Pressure fluid for reciprocating the piston 47 is supplied to the cylinder 48 by the pump 17 through a hydraulic circuit including a reversing valve 61 (Fig. 8) and an extensible connection adapted to accommodate itself to the reciprocatory movements of the tool head. As shown in Fig. 8, the valve 61 comprises the usual casing 62 fitted with a movable member or plunger 63 shiftable between two positions to connect pressure and return ducts 64 and 65 with outgoing ducts 66 and 67 selectively.

The ducts 66 and 67 extend to the extensible connection which, in its preferred form, comprises an elongated member 69 (Fig. 5) having two longitudinally extending passages 70 and 71. The member 69 is rigidly secured to the column 11 with the passages disposed in a substantially vertical position. Extending through the passage 70 is a tubular member 72 closed in its upper end and communicating at its lower end with the duct 55 leading to the upper end of the cylinder 48. A similar tubular member 73 is disposed in the passage 71 and communicates with the duct 54 leading to the lower end of the cylinder 48. The members 72 and 73 extend entirely through the respective passages which are closed at opposite ends by suitable packing rings 73a which provide sliding bearing support for the members and prevent leakage of pressure fluid from the passages. The lower ends of the members are screw-threaded to the casing 50 and consequently the members reciprocate with the head. Ports 74 and 75 in the members are arranged to communicate with the passages 70 and 71, said ports being located so that communication is maintained in all positions of the head.

It will be apparent that with the above construction, pressure fluid may be supplied to the

cylinder 48 for expanding or contracting the tool while the head is reciprocating. Moreover, the tool may be expanded or contracted selectively by actuation of the valve 61. While any suitable means may be employed for actuating the valve, it is preferred to employ quick acting power actuated means operative to impart substantially instantaneous movements to the valve member. The power actuated means provided in the machine herein disclosed comprises a solenoid 81 (Fig. 8) adapted upon energization to quickly shift the plunger 63 to the right end of the valve casing. A spring 82 acting on the plunger returns it to the left end of the valve casing substantially instantaneously when the solenoid is deenergized. A switch 83 is arranged to open and close the circuit of the solenoid.

Means is provided for automatically operating the switch 83 to effect expansion of the tool when it has been moved into operative engagement with the work and to contract the tool just before it is retracted from the work. As herein shown, this means comprises a control rod 84 (Fig. 2) journaled in bearings formed in brackets 85 projecting laterally from one side of the column 11 so as to hold the rod substantially parallel to the path of movement of the head. Mounted on the rod 84 are oppositely facing cam members 87 and 88 adapted to be engaged by a rearwardly projecting arm 89 on the carriage. The cams are faced in opposite directions so that when the arm 89 engages the cam 87 the rod 84 is shifted or rocked in one direction while engagement of the arm with the cam 88 rocks the arm in the opposite direction. This rocking action serves to actuate the switch 83 through the medium of a crank arm 90 fast on the lower end of the rod. A spring actuated detent 86 mounted in the lower bracket cooperates with the crank arm 90 to hold the rod in either position.

The cam members 87 and 88 are preferably mounted on the rod 84 for adjustment longitudinally thereof to determine the points at which the tool is expanded and contracted. The cam 88, for example, may be positioned for engagement by the arm 89 when the carriage moves into its working range and the tool 21 is fully inserted in the work. Thus, upon engagement by the arm, the switch 83 is closed and solenoid 81 energizes and shifts the valve plunger to direct pressure fluid through the duct 66, passage 70, port 74, tubular member 72 and duct 55 to the upper end of the cylinder 48. The pressure fluid forces the piston 46 toward the lower end of the cylinder 48, thereby expanding the tool. Spent pressure fluid is exhausted from the lower end of the cylinder through the duct 54, tubular member 73, port 75, passage 71, duct 67, valve 61 to the return line 65.

The cam 87 is ordinarily spaced above the cam 88 for engagement by the arm 89 as the carriage moves out of its working range, that is, just prior to the disengagement of the tool from the work. The arm thus rocks the control rod into switch opening position, whereby the solenoid 81 is deenergized and the valve plunger shifted to the left end of the valve casing to reverse the hydraulic connections to the cylinder 48. The piston 47 is thus shifted to the upper end of the cylinder and the tool is contracted as hereinbefore explained.

The general operation of the machine may be readily seen by reference to Fig. 8. Pressure fluid from the pump 17 is supplied alternately to the upper and lower ends of the cylinder 16 under control of a reversing valve 91 to reciprocate the spindle head in well known manner through a cycle usually consisting of an approach stroke to operatively associate the tool and work, a plurality of working strokes to repeatedly traverse the tool over the work, and a withdrawal stroke to disassociate the tool from the work. The reversing valve 91 in turn is actuated by a pilot valve 92 operated by the usual stop bar 93 of the machine. A suitable shut-off valve 94 is interposed in the hydraulic circuit between the pump 17 and the reversing valve 91 for starting and stopping the machine.

In the present instance, pressure fluid for expanding and contracting the hone is derived from the pump 17 through the branch duct 64. A pressure regulator 93a, which may be of any suitable or well known type, is interposed in this duct for regulating the pressure of the fluid supplied to the tool expanding device. This permits quick and accurate adjustment of the pressure of the abrasive stones on the work to suit the particular requirements of the work being operated on.

Rotation of the spindle 19 and the honing tool is effected by the rotary hydraulic motor 30 as hereinbefore explained. The pressure fluid for operating the motor is supplied by the pump 31 and a suitable shut-off valve 95 is interposed in the circuit of the motor for starting and stopping the motor.

The modified form of the machine disclosed in Figs. 6 and 7 is provided with a spindle head 96 arranged to be reciprocated hydraulically by means including a pair of vertically disposed cylinders 97. The head 96 differs from the head 13 previously described primarily in that it is equipped with a plurality of tool spindles 98 similar in all respects to the spindle 19. Tool expanding and contracting means likewise similar to that previously described are provided for each individual spindle. In other words, each spindle 98 has an individual tool adjusting rod 43, and a piston 47 working in a cylinder 48 for reciprocating the rod. As herein shown, the cylinders are formed in a common casing 99 rigidly secured to the head.

Pressure fluid is supplied to the cylinders 48 through hydraulic circuits like those of the single spindle machine, although in this instance, the ducts 54 and 55 have branches connecting with the respective cylinders 48. Thus, all of the cylinders are supplied with pressure fluid from the same source, so that the tools mounted on the respective spindles are expanded and contracted simultaneously and with equal pressures.

It will be apparent from the foregoing that the invention provides a honing machine of novel and improved construction. Hydraulically operated means is incorporated in the machine for expanding and contracting the tool so that relatively high tool pressures are obtainable to enable the machine to operate efficiently on extremely hard metals and to remove a maximum amount of stock in a minimum of time. The pressure on the work remains uniform as the hone expands instead of gradually decreasing as in the case of spring expanded hones. This promotes efficient operation. Moreover, the tool may be contracted or expanded substantially instantaneously without interrupting its rotation or reciprocation and the pressure exerted on the work may be quickly and accurately adjusted to suit the particular requirements of the work being operated on. The invention also provides

novel controls for power actuated hone expanding means whereby hone expansion is initiated automatically as an incident to insertion in or operative association of the hone with the work and contraction of the hone is effected automatically prior to the withdrawal of or disassociation of the hone from the work.

I claim as my invention:

1. In a honing machine, in combination, a frame, a head mounted for reciprocation on said frame, a spindle journaled on said head adapted to carry an expansible and contractible honing tool, hydraulically actuated means for expanding and contracting the tool, a control rod mounted on said frame, a pair of spaced cams on said rod, an arm on said head engageable with said cams in the reciprocation of said head, said arm operating upon engagement with one cam to shift said rod in one direction and upon engagement with the other cam to shift the rod in the opposite direction, and means operated in response to the shifting of said rod to control the action of said hydraulically operated means.

2. In a honing machine, in combination, a frame, a head mounted for reciprocation on said frame, a spindle journaled on said head adapted to carry an expansible and contractible honing tool, a hydraulic cylinder and piston on said head, means operated by said piston for expanding and contracting the tool, a source of pressure fluid for said cylinder, a valve for directing the pressure fluid from said source into either end of said cylinder selectively to expand or contract the tool, and means for operating said valve comprising a control rod mounted on said frame, a pair of spaced cam members on said rod, an arm on said head engageable with said cam members in the reciprocation of said head, said arm cooperating with one of said cam members to shift the rod in one direction and with the other of said cam members to shift the rod in the opposite direction, and means rendered effective in response to the shifting of said control rod to operate said valve.

3. In a honing machine, in combination, a frame, a head mounted for reciprocation on said frame, a spindle journaled on said head adapted to carry an expansible and contractible honing tool, a hydraulic cylinder and piston on said head, means operated by said piston for expanding and contracting the tool, a source of pressure fluid for said cylinder, a valve for directing the pressure fluid from said source into either end of said cylinder selectively to expand or contract the tool, a solenoid for operating said valve, a circuit for said solenoid including a normally open switch, a switch operating member, and means on said head engageable with said member to open and close said switch incident to the reciprocation of the head.

4. A honing machine having, in combination, a reciprocatory head, means for reciprocating said head, an expansible honing tool reciprocable with the head, power actuated means operable to yieldably expand said tool, means acting to collapse said tool when said power actuated means is idle, control means for automatically initiating and terminating the operation for said power actuated means, said control means including a part movable between two positions, and means controlled by the head in its reciprocation for effecting a substantially instantaneous movement of said part from one position to the other.

5. A honing machine having, in combination, a reciprocatory head, means for reciprocating said head, an expansible honing tool reciprocable with the head, pressure fluid actuated means operable to yieldably expand said tool, means acting to collapse the tool when said pressure fluid actuated means is idle, control means for automatically initiating and terminating the operation for said pressure fluid actuated means, said control means including a valve, and power actuated means for operating said valve as an incident to the reciprocation of the head.

6. A honing machine having, in combination, a reciprocatory head, means for reciprocating said head, an expansible honing tool reciprocable with the head, pressure fluid actuated means operable to yieldably expand said tool, means acting to collapse the tool when said pressure fluid actuating means is idle, control means for automatically initiating and terminating the operation of said pressure fluid actuated means, said control means including a valve, a solenoid for operating said valve, a circuit for said solenoid, and means operated by the head in its reciprocation for opening and closing said circuit.

7. In a machine tool construction, in combination with a frame, a carriage movable in the frame, a head dismountable with relation to the carriage and movable therewith toward and from a position opposite but spaced from work to be operated upon, a working portion carried by said head and movable laterally into and from engagement with the work when said head is opposite the same, means for moving the carriage, separately controllable means, carried by the carriage, for moving said head and for moving the working portion laterally, the head, by dismounting the same from the carriage, being separable from said means for moving the working portion, said means for moving the working portion including an electric circuit for controlling such lateral actuation of the working portion, and means responsive to movement of the carriage for controlling said electric circuit.

8. In a honing machine, a frame, a hone assembly reciprocable therein, said hone assembly having a working portion movable laterally into and from engagement with the work, means for reciprocating the hone assembly, separately controllable means for moving said working portion laterally, and control means responsive to reciprocation of said hone assembly for controlling said means for moving the working portion laterally, said control means including an electric circuit and a controller therein.

9. Means as set forth in claim 7 in which said means for moving the working portion comprises a motor device carried by the carriage and capable of exerting variable effort upon said working portion to force said portion laterally into engagement with the work with different pressures.

10. A honing machine having, in combination, a support for an expansible and contractible honing tool, a support for work to be operated on by the tool, one of said supports being reciprocable to effect a relative traverse of the tool and work through a working range of predetermined length, a pressure fluid actuator operable to expand the tool into engagement with the work, a valve controlling said actuator to govern the expansion and contraction of the tool, power actuated means operative to impart substantially instantaneous movements to said valve, and a control device operative in response to the movement of the reciprocating support into and out

of said working range to control said power actuated valve operating means.

11. A honing machine having, in combination, a support for an expansible and contractible honing tool, a support for work to be operated on by the tool, one of said supports being reciprocable to effect a relative traverse of the tool and work through a working range of predetermined length, a pressure fluid actuator operable to expand the tool into engagement with the work, a valve controlling said actuator to govern the expansion and contraction of the tool, an electro-magnetic actuator for said valve adapted to impart rapid movements to the valve, and means operative as an incident to the movements of the tool into and out of its said working range to control said electro-magnetic actuator.

12. In a honing machine, in combination, a support for an expansible and contractible honing tool, a support for work to be operated on by the tool, one of said supports being reciprocable to effect a relative traverse of the tool and work through a working range of predetermined length, power actuated means operable to expand and contract the tool, control means for said power actuated means including a device shiftable into one position to initiate the expansion of the tool and into an alternate position to initiate contraction of the tool, said device having a pair of spaced operating elements, and a member carried by the reciprocating support and arranged for coaction with said elements, said member being engageable with one of said elements to shift the device into said one position in response to movement of the tool into said working range, the other of said elements being conditioned by said shifting of the device for engagement by said member upon movement of the tool out of said working range whereby to shift the device to said alternate position.

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