

May 26, 1942.

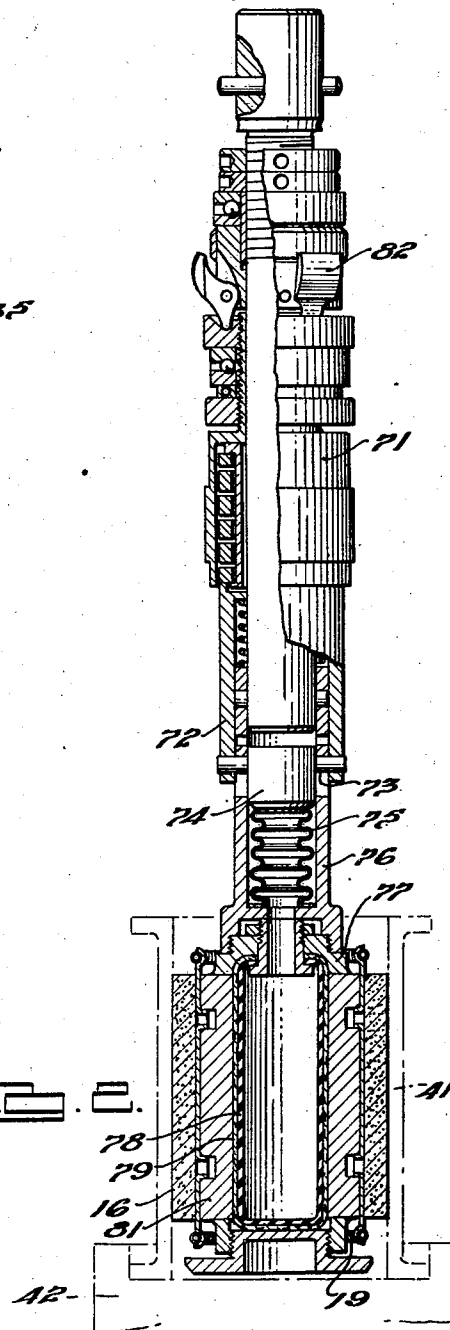
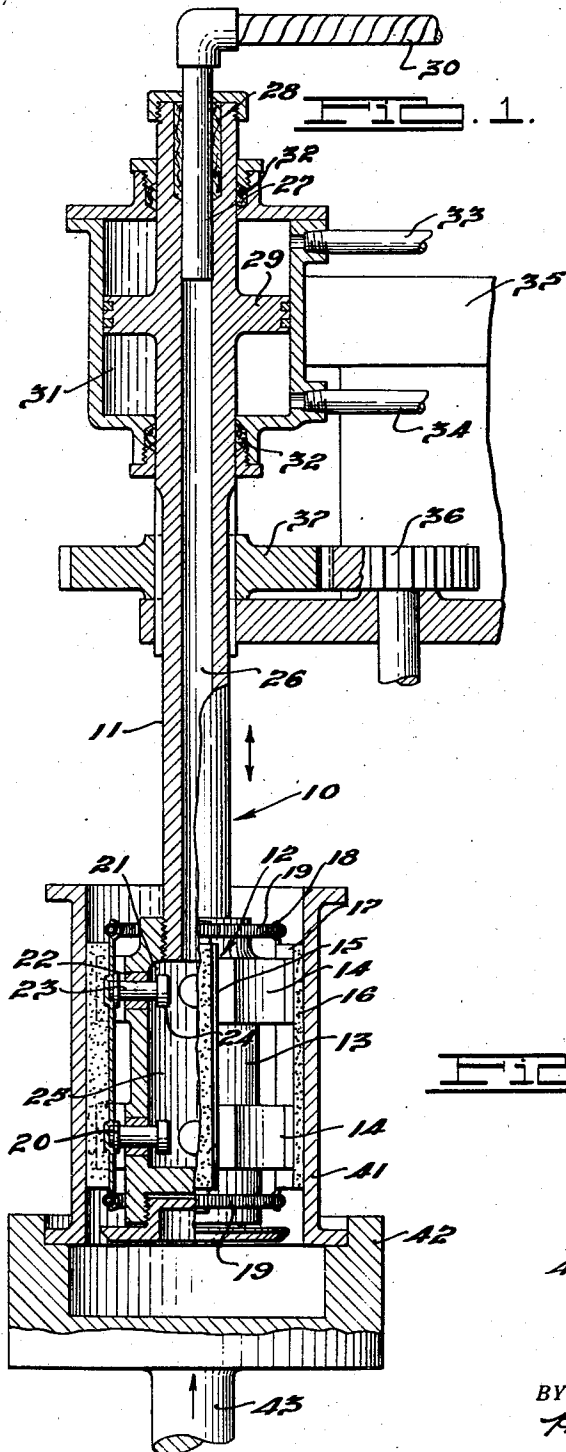
K. W. CONNOR

2,284,134

HONING DEVICE

Filed April 27, 1936

2 Sheets-Sheet 1



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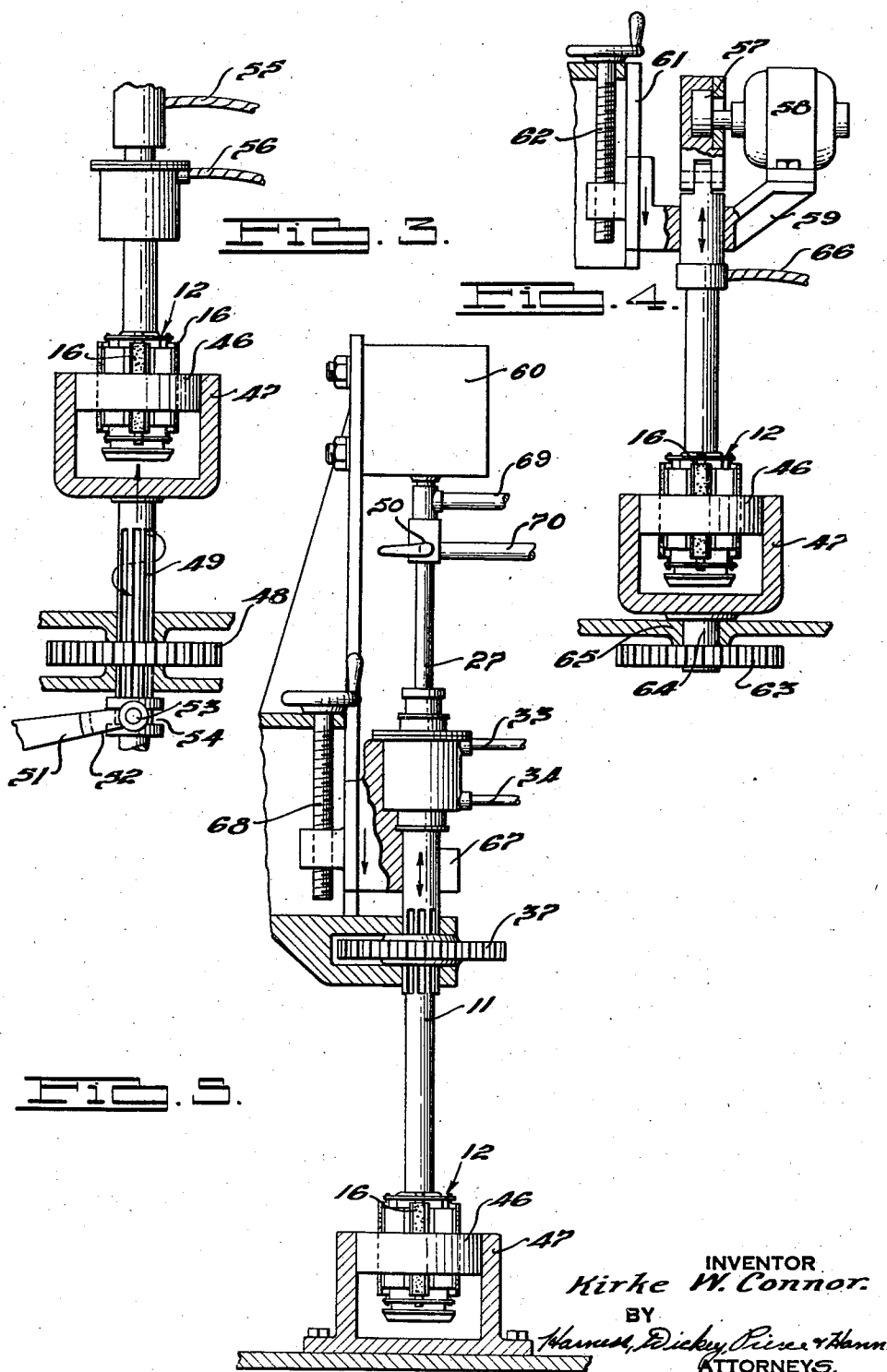
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UNITED STATES PATENT OFFICE

2,284,134

HONING DEVICE

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16 Claims. (Cl. 51—34)

My invention relates to methods and apparatus for honing cylinders, and particularly to a method and apparatus for uniformly controlling the expansion of honing elements and maintaining constant pressures on each element to thereby control stone wear and produce more accurate and more highly polished surfaces.

Heretofore, when a plurality of honing elements were disposed radially about a spindle, they were urged outwardly from an axial support from which the working surfaces of the elements were fixed. When constructing the honing elements, it was found impossible to retain the hardness of the elements uniform. As a result, when a plurality of abrading elements were placed in an abrading head, some wore away faster than others and the abrading surfaces were disposed at various radial distances from the central axis of the spindle. As a result, the surface of the harder elements or stones would be disposed at a greater distance from the tool center and would deflect the tool to have the other stones engage the cylindrical surface to be ground. The resulting binding or cramping of the abrading head reduced the accuracy and finish of the honed surface. This lack of concentricity of the stone surfaces would cause the stones to be tilted relative to the spindle axis, and, as a result, one end would wear away faster than the other and material stone loss resulted.

In practicing my present invention, I mount each stone in an abrading head in such manner that a balanced pressure urges the stones radially of the spindle. Should one stone wear away faster than another, no unsatisfactory result would occur, since the pressure on the stones would remain constant and the softer stone would be fed outwardly a greater amount than the harder stone, thus maintaining the stone surfaces concentric at all times with the spindle axis. To accomplish this I employ pistons or other fluid actuated means for urging the stones outwardly. The pressure of the fluid, being equal in all directions, will provide uniform abrading pressures on the stones irrespective of their hardness or varying thickness. A sealed fluid system may be employed in the abrading head to effect such balanced expanding pressures or such fluid may be conducted into the head by suitable means. The head is preferably rapidly reciprocated over a short distance during the time it is rotated in synchronism therewith and when the work piece and the abrading head are materially different in length, an additional feed movement is provided therebetween.

Accordingly, the main objects of my invention are: to provide a method and apparatus for uniformly balancing the pressure on a plurality of radially movable abrading stones; to provide fluid actuating means for providing a balanced pressure for radially moving abrading stones into contact with a surface to be machined; to provide a closed fluid system for individually adjusting each abrading stone with a constant pressure to maintain the stone surfaces concentric; to conduct a fluid into a reservoir in which a plurality of pistons are disposed for providing a balanced pressure thereon for independently expanding each abrading stone under uniform pressure; to employ a fluid system for individually adjusting the abrading stones in an abrading head, for rapidly reciprocating said head over a limited distance during the time the head is rotated in synchronism therewith, and for providing an additional relative feed between the abrading head and the work piece; and, in general, to provide a honing tool for producing accurate and highly polished surfaces, which is simple in construction, positive in operation and economical of manufacture.

Other objects and features of novelty of my invention will be either specifically pointed out or will become apparent when referring, for a better understanding of my invention, to the following description taken in conjunction with the accompanying drawings, wherein:

Figure 1 is a view, partly in section and partly in elevation, of a honing device embodying features of my invention;

Fig. 2 is a view, partly in section and partly in elevation, of a honing tool, illustrating a further form which my invention may assume;

Fig. 3 is a view of structure, similar to that illustrated in Fig. 1, showing a still further form which my invention may assume;

Fig. 4 is a view of structure, similar to that illustrated in Fig. 3, disclosing a further modified form of my invention; and

Fig. 5 is a view of structure similar to that illustrated in Fig. 4, showing a still further form which my invention may assume.

In Fig. 1, I have illustrated a honing device comprising a spindle 11 on which an abrading head 12 is secured. The head 12 is of conventional form comprising a body 13 having spaced spiders 14 which are slotted at 15 radially of the axis of the spindle 11. Honing stones 16 are disposed in the slots 15 for radial outward movement. The stones may be provided with a backing element 17, as illustrated in the Frank J.

Jeschke Reissue Patent No. 19,149, issued April 24, 1934, and assigned to the assignee of the present invention. Hooks 18, projecting from the ends of the elements 17, are engaged by garter springs 19 for urging the abrading stones 16 inwardly toward the axis of the tool body 13. A fluid reservoir 21 is provided interiorly of the body 13. High precision cylinders 22 are illustrated as being disposed in the body wall communicating with the base of the slots in the spiders 14. Such cylinders, however, may be machined directly in the wall. Accurately fitted pistons 23 are disposed within the cylinders 22 projecting into the bottom of the slots 15. Heads 24 may be provided on the pistons 23 to prevent the pistons from being forced out of the cylinders 22 and to provide a greater area of engagement with the fluid 25 within the reservoir 21 to increase the resulting pressure for urging the abrading stones 16 outwardly. Suitable washers 20, or other means, may be employed on the outer ends of the pistons 23 for limiting their inward movement.

The spindle 11 is provided with a central opening 26 into which a tube 27 communicates, being sealed at its upper end by suitable packing means 28 to permit the rotation of the spindle relative to the tube. The spindle 11 has a piston 29 threaded or otherwise secured to its outer surface to operate within a cylinder 31 to cause the spindle, and therefore the abrading head 12, to be reciprocated. Suitable packing means 32 are provided at each end of the cylinder for sealing the fluid relative to the spindle 11. The fluid is conducted into the cylinder on either side of the piston 29 by suitable conduits 33 and 34.

A supporting bracket 35, which supports the cylinder 31 and therefore the tool 10, also supports gears 36 and 37 which drive the spindle 11 in rotation. The gear 37 has a spline engagement with the spindle 11 to permit the spindle to reciprocate relative to the gear while providing a drive connection therebetween. A suitable motor (not illustrated) drives the gear 36 to produce the rotation of the gear 37 and of the spindle 11.

A work piece 41 is mounted in a suitable work piece holder 42 which is supported on a shaft 43 which may be moved longitudinally of its axis to provide a feed movement between the abrading head 12 and the work piece 41. This movement is also utilized for loading and unloading the work relative to the tool.

The operation of the honing tool 10 in reciprocation, in rotation and in providing a feed movement between the tool and work, is similar to that described and claimed in my co-pending application, Serial No. 76,519, filed April 27, 1936, which became Patent No. 2,108,029, February 8, 1938, and assigned to the assignee of the present invention. After the pressure has been relieved in the reservoir 21 and the abrading stones 16 are contracted by the garter springs 19, the work piece 41 may be removed. When a new work piece has been inserted in the holder 42, shaft 43 is moved upwardly to have the work piece 41 disposed about the abrading head 12. Thereafter pressure is introduced through a flexible conductor 30 to the tube 27 into the reservoir 21 to cause the expansion of the abrading stones 16. The alternate introduction and withdrawal of the fluid through the conductors 33 and 34 on either side of the piston 29 produces a rapid axial oscillation of the head 12 over a limited distance. The operation of the gear 36 causes the head to

be rotated, at a selected speed to produce a desired angle of intersection of the abrading paths, as pointed out in my above mentioned co-pending application. During the occurrence of this desirable abrading action, the work piece 41 and the head 12 are fed relative to each other to have the abrading operation occur uniformly over the entire surface of the abrading stones and the work piece. After the abrading operation has been completed, the pressure is relieved from the reservoir 21 permitting the stones 16 to be moved out of contact with the polished surface and the work piece is moved downwardly to clear the abrading head 12.

In Fig. 3, I have shown a further form which the invention, illustrated in Fig. 1, may assume. A work piece 46 is mounted in a suitable holder 47, which holder and work piece are reciprocated and rotated. The rotation is effected by a gear 48 which has a spline engagement with the supporting spindle 49 driven by suitable means (not illustrated). An arm 51 has a bifurcated end 52 provided with pins 53 which project into a peripheral groove 54 to effect the desired reciprocation of the work piece 46. A flexible conduit 55 may be employed for producing expansion and contraction of the abrading stones 16 in the head 12, while an additional conduit 56 may be employed for producing a slow feed movement between the abrading head 12 and the work 46, when this is desirable. In this particular construction, the abrading tool may be fixed when no feed movement is desired between the abrading head 12 and the work 46 or a limited axial movement may be provided when such feed movement is utilized. This materially simplifies the fluid connection between the pressure source and the tool. The predetermined oscillation and rotation between the abrading head and the work piece is produced entirely through the rotation and reciprocation of the work piece and may be effected mechanically.

In Fig. 4, I have illustrated another form which my invention may assume, wherein the abrading head 12 is rapidly reciprocated mechanically through a cam 57 operated by a motor 58 supported on a bracket 59. The bracket is carried in ways 61 and is raised and lowered by a lead screw 62 so that, in addition to the reciprocation of the honing tool, the tool may be advanced relative to the work piece 46. The work piece 46 is supported in a work holder 47 and driven in rotation by a gear 63 which is secured to a shaft 64 journaled in a suitable supporting bearing 65. The expansion and retraction of the honing stones 16 are effected by a fluid pressure controlled through a suitable flexible conduit 66.

In Fig. 5, a further form of my invention is disclosed, wherein the work piece 46 is secured in a fixed support 47. In this construction the reciprocation, rotation and the relative feed movement between the abrading head and work are all produced by the honing apparatus. The structure is similar to that illustrated in Fig. 1, with the exception that the work support 47 is fixed and the support 67 for the work is movable vertically by a lead screw 68 for providing a relative feed between the abrading head 12 and the work piece 46. A gear 37, as hereinabove described, drives the spindle 11 in rotation. Conduits 33 and 34 provide the rapid reciprocation of the spindle 11 and the tube 27 introduces the pressure to the abrading stones 16.

In this construction, the tube 27 is fixed so that the spindle 11 reciprocates over the tube.

This reciprocation varies with the volume of fluid in the passage 26 and would, under ordinary circumstances, vary the pressure on the stones 16. Above the tube 27 I have provided a sealed dome 60, in which fluid under pressure is introduced to provide a head under pressure to retain the pressure on the stones substantially constant in the face of the variation in volume. When a liquid is utilized, the air in the dome becomes compressed to supply the necessary pressure. The fluid is introduced into the system by the conduit 69 and bled from the tool by the conduit 70. A suitable valve 50 controls the passage of the fluid in the conduits 69 and 70 to control the position of the stones 16.

Figs. 1, 3, 4 and 5, above described, disclose the various arrangements which may be utilized for obtaining a balanced relation between the abrading stones, for producing the reciprocation of the stones during the time they are rotated and for introducing a relative feed movement between the work and abrading stones. All of such movements may be provided in the honing tool itself or in the work or in a combination thereof, as clearly illustrated.

In Fig. 2, I have illustrated a still further form which my invention may assume, that wherein the fluid pressure is a self-contained portion of a honing tool. The upper portion 71 of the tool is similar to that illustrated and described in the patent to F. M. Kern, No. 1,990,331, issued February 5, 1935, and assigned to the assignee of the present invention. Instead of the sleeve 72 operating a cone through a pin 73, the pin operates a piston 74 which bears against one end of a bellows 75. The bellows is sealed within the end of a sleeve 76 which is screwed upon the end of an abrading head 77. The hollow portion of the abrading head 77 contains a rubber sack 78 which may be enclosed in a sack 79 of leather or other durable material, which is sealed in the end of the abrading head 77 in communication with the bellows 75. Fluid is provided within the sack 78 and bellows 75 and the pressure thereof may be varied through the action of the piston 74 upon the bellows. In this manner, the fluid within the sack 78 and bellows 75 is entirely enclosed and there is no possibility of the fluid escaping and varying the pressure or the operation of the tool. A plurality of abrading elements 16 are supported on shoes 81 which are movable radially within the head 77. When the pressure is removed from the bellows 75, the garter springs 19 cause the stones 16 and therefore the shoes 81 to be moved inwardly to collapsed position.

After the abrading head has been inserted within a work piece, the operation of the cam fingers 82 will compress the bellows 75 and provide a pressure on the stones 16 to cause their expansion. In this manner, a uniform pressure is provided on all of the stones irrespective of their thickness due to their varying degree of wear. The tool thus constructed operates otherwise in the same manner as the F. M. Kern tool above mentioned, which employed a wedge. Through the operation of the cam fingers 82, the stones are expanded and contracted relative to the central axis of the tool and a predetermined degree of the expansion may be set off on the tool to limit the size to which the head may be expanded. By employing the bellows and flexible sack, the fluid is completely sealed within the tool and no variation in the honing operation can occur due to leaking fluid. The 75

tool, compensating for the variation in stone wear, permits uniform pressure to be applied between each of the stone surfaces and the work and thereby produces extremely accurate and highly polished surfaces.

While I have described and illustrated several embodiments of my invention, it will be apparent to those skilled in the art that various changes, omissions, additions and substitutions may be made therein without departing from the spirit and scope of my invention, as set forth in the accompanying claims.

I claim as my invention:

1. A honing tool of the hydraulic type embodying a head having a plurality of fluid operated radially movable stones separated from the operating fluid, means for rapidly reciprocating said abrading head and work piece relative to each other, means for relatively rotating said abrading head and work piece, means for introducing a feed movement parallel to said reciprocation between said abrading head and work piece for changing the relative position thereof, and means for regulating the fluid pressure within said abrading head for controlling the position of said stones.

2. A hydraulic honing tool embodying a head having a reservoir therein, a plurality of radially movable abrading stones secured to the outer surface of said head, a plurality of pistons engaging said stones and projecting within said reservoir, and means for controlling the pressure within said reservoir for applying uniform radial pressure on said pistons.

3. A hydraulically actuated honing tool embodying a head having a hollow interior in which a flexible sack is disposed, radially adjustable abrading elements in engagement with said sack, spring means for urging said abrading elements toward said sack, a bellows disposed in communication with said head and sealed relative thereto for providing a closed fluid system, and means for collapsing and expanding said bellows for controlling the fluid pressure within said sack to thereby control the radial position of said elements relative to the axis of the head.

4. A honing tool having a head provided with a plurality of radially expansible elements, a flexible fluid containing member for controlling the expansion and contraction of said honing elements, a fluid in said member and means for changing the pressure on said fluid.

5. A honing tool having a head provided with a plurality of radially expansible elements, a flexible fluid containing member for controlling the expansion and contraction of said honing elements, a fluid in said member, means for releasing the pressure on said fluid for permitting the retraction of said elements, and means for applying a pressure to said fluid for causing the expansion of said elements after being introduced within a work piece.

6. In a honing tool, an abrading head, a plurality of abrading stones radially movable in said head, radially disposed pistons in the wall of said head communicating with the hollow interior thereof, fluid in said interior, and means for regulating the pressure of said fluid.

7. In a honing tool, an abrading head, a plurality of abrading stones radially movable in said head, radially disposed pistons in the wall of said head communicating with the hollow interior thereof at each end of said stone, fluid

in said interior, and means for regulating the pressure of said fluid.

8. In a honing tool, an abrading head, a plurality of abrading stones radially movable in said head, radially disposed pistons in the wall of said head communicating with the hollow interior thereof, fluid in said interior, and means for regulating the pressure of said fluid, the ends of said pistons communicating with said hollow interior being provided with heads.

9. A honing tool having a head provided with a plurality of radially expansible elements, flexible means containing a fluid engaging said elements the material of which means is capable of expansion and contraction, and means engaging the flexible containing means for said fluid for applying a pressure thereto.

10. A honing tool having a plurality of radially movable abrading elements, a flexible fluid containing member disposed centrally of said elements, and means for changing the pressure of said fluid for expanding the material of said container and controlling the position of said elements.

11. A honing tool having a plurality of radially movable abrading elements, a flexible fluid containing member disposed centrally of said elements, and means for changing the volume of said fluid and expanding the material of said member for controlling the position of said elements.

12. A finishing tool of the character described for finishing surfaces on the inside of a hollow part, comprising a body, a series of surfacing members more than two in number adjustable independently of one another in said body for substantially radial movement therein, an axially movable slide for each of said surfacing members, a common operating spring, and means operably interconnecting said spring to all of said slides to apply equal outward pressure on all of said surfacing members.

13. A device for forming true round and straight bores in cylinders comprising a rotary and reciprocating tool body having a plurality of longitudinally extending honing stones, stone mounting means slidable in and out of said body, a flexible tube inside said body and bearing on said stone mounting means, a fitting by means of which said tube may be expanded to force said stones outwardly uniformly against the work in all positions of said stones whereby

the stone pressure is uniform independently of stone wear.

14. An expansible hone comprising a substantially cylindrical member having a relatively thick wall through which a plurality of longitudinally extending radial slots extend and a central, longitudinally extending bore, the sides of said slots being substantially parallel to radii of said member whereby the cross-section of each of the fixed bars extending longitudinally between slots is substantially trunco-pyramidal with the truncated end extending inward, substantially rectangular, longitudinally extending tool holder bars movably mounted in said slots and guided by the sides thereof for radial movement, surface finishing tools carried by said tool holder bars, resilient means carried by said member and retaining said tool holder bars in said slots, and a fluid-expansive bag in said central bore and having a fluid transmitting opening thereinto whereby fluid pressure may be exerted against the interior surface of said bag in order to expand the same into said slots and force said tool holder bars radially outward against the restraint of said resilient means.

15. An expansible hone for use in finishing cylindrical bores comprising a core structure having an inlet and an outlet for the passage of fluids therethrough, a resilient, hollow, fluid-impervious, cylindrical shell retained on said core structure and having its interior in communication with the outlet from said core structure, a plurality of abrading elements of the honing stone type associated with said core structure in position to be movable outwardly radially of said core structure by expansion of said shell in response to fluid pressure therein, and means resiliently opposing outward movement of said abrading elements for causing inward radial movement thereof upon release of fluid pressure from the interior of said shell, said elements being spaced about the surface of said shell and extending substantially longitudinally thereof and parallel to the longitudinal axis of said core structure.

16. In an abrading head, a plurality of radially movable abrading stones, a body for supporting said stones, holders for said stones, pistons engaging said holders, and a unit supply of fluid for urging said pistons to independently actuate said holder and radially move said stones.

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