Nov. 16, 1971 C. W. GEHRING 3,619,956

HYDRAULIC FEEDING DEVICE FOR A HONING TOOL

Filed April 14, 1970 3 Sheets-Sheet 1

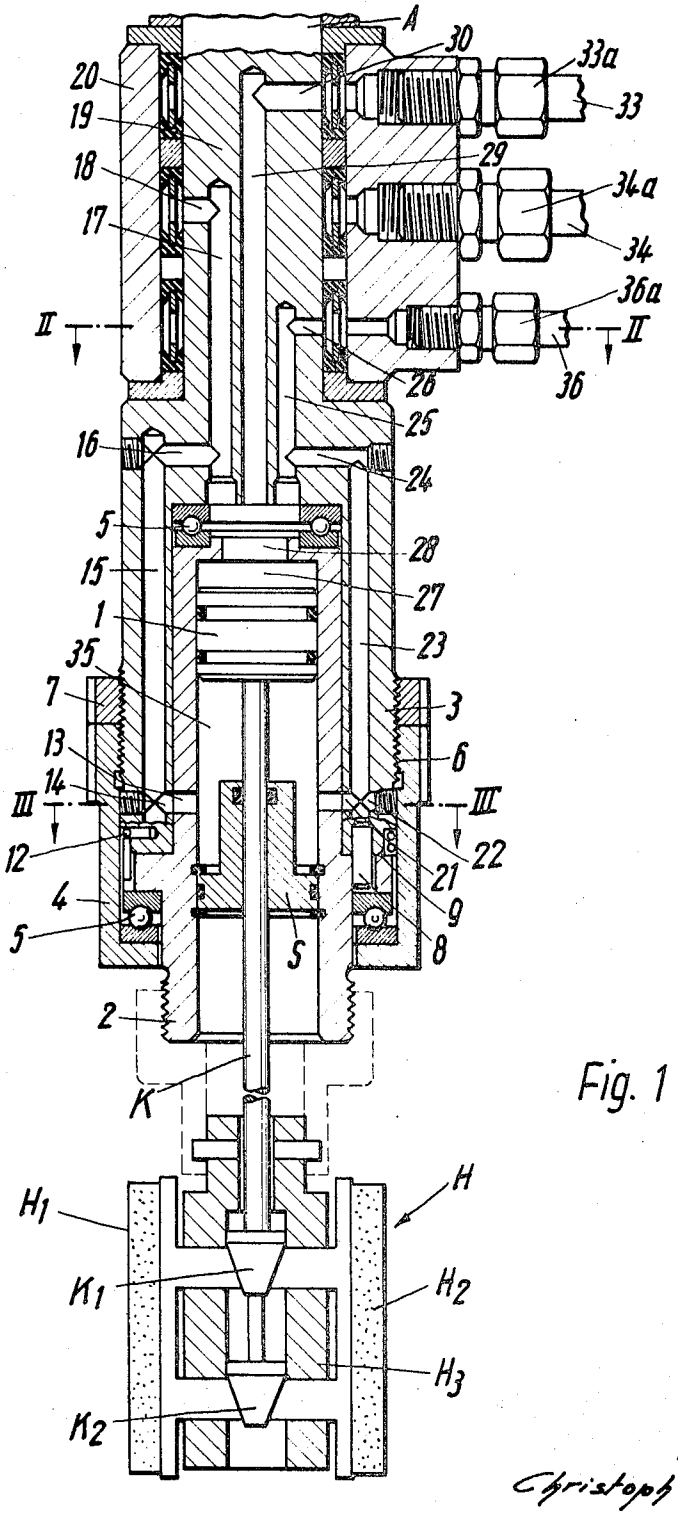

Fig. 1

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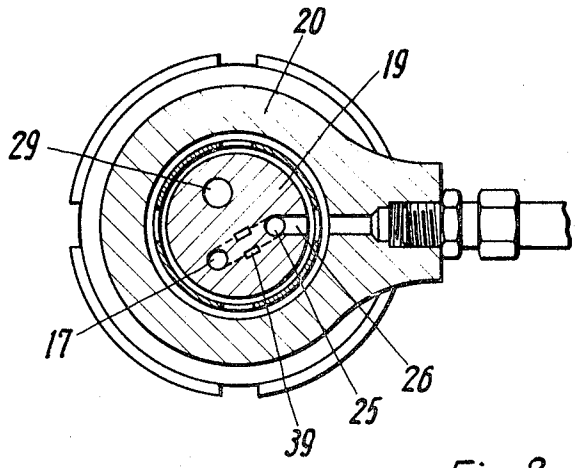

Fig. 2

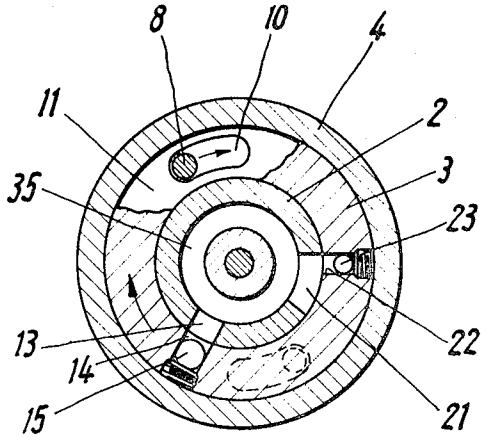

Fig. 3

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HYDRAULIC FEEDING DEVICE FOR A HONING TOOL

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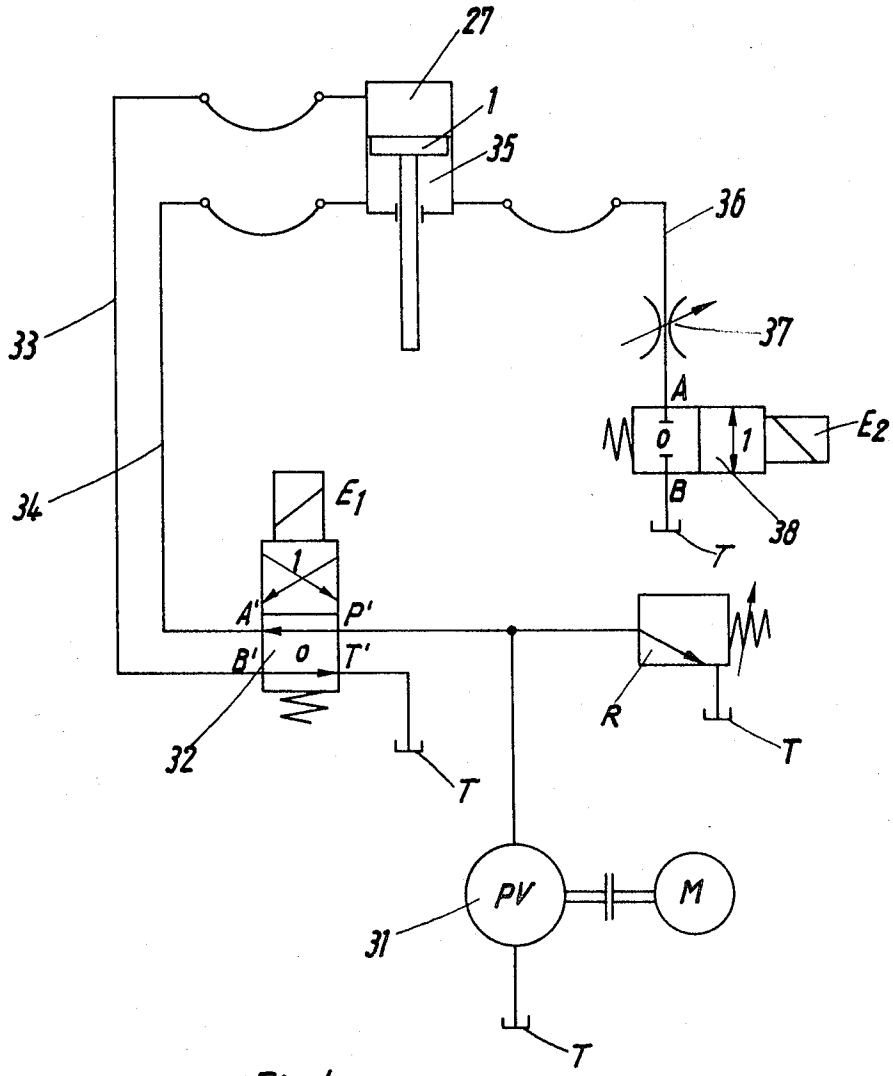

Fig. 4

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HYDRAULIC FEEDING DEVICE FOR A HONING TOOL

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Int. Cl. B24b 9/02
U.S. Cl. 51—349 7 Claims

ABSTRACT OF THE DISCLOSURE

The specification discloses a device for honing in which a honing tool is rotated and, while rotating, is expanded into engagement with the work. A hydraulic motor effects expansion of the honing tool and when the honing tool engages the work and is retarded in rotation thereby, a rotary valve is closed to interrupt the draining of fluid from the hydraulic motor and thereby halt the expansion of the tool. Further expansion of the tool during a work operation is effected by another valve which permits controlled incremental draining of fluid from the hydraulic motor. Reversing of the supply of fluid to the hydraulic motor permits collapsing of the tool at the end of a work operation.

The present invention relates to a hydraulic feeding device for controlling the feeding movement of a honing tool which comprises a hydraulic cylinder piston system connected to the honing tool and at least one control device for effecting a shiftover from fast traverse to fine feeding movement.

The fast traverse movement necessary for reducing the auxiliary process time has to be maintained until the honing strips of the honing tool engage the workpiece. According to a heretofore known design of the feeding device, the fast traverse feeding movement is checked by means of an adjustable abutment. Such abutment, however, brings about the drawback that it must be adjusted in conformity with the smallest drill diameter, and therefore will not be satisfactory when the workpiece prior to the honing operation has major tolerances. Moreover, especially when small series are involved, the drawback inherent thereto consist in that the abutment has to be readjusted when shifting over to other diameter sizes.

According to another heretofore known embodiment of the hydraulic feeding device, the increase in pressure occurring when the honing tool engages the workpiece is employed as signal for shifting from fast traverse to fine feeding movement. With this embodiment the fine feeding movement is carried out by means of magnetic valves in such a way that small adjustable quantities of oil are either intermittently or continuously conveyed to the pressure chamber of the hydraulic cylinder. The employment of a pressure control device as feeling means for the above mentioned increase in pressure, however, brings about the drawback that said pressure control must respond only at a relatively high pressure because considerable frictional resistance is encountered by the piston reciprocable in the hydraulic cylinder and also between the feeding rod, the cone, and the honing strips of the honing tool. These resistances add up and thus make impossible a fine sensitive cutting of the honing stone on the workpiece. Particularly with honing tools having a small diameter, a precise feeding movement is very important because otherwise, due to the relatively low resistance against rotation, the tool may easily break. The employed feeding movement with these heretofore known devices by dosing out very small quantities of pressure fluid, additionally has the advantage that with the low pressure

prevailing at the start of a feeding impulse, the obtained additional force is frequently insufficient to overcome the entire friction of the feeding system. As a result thereof, no feeding movement is effected during such first feeding impulse, only during the second and third impulse, a feeding movement will be obtained, the extent of which, however, is in view of the smaller sliding driving value considerably greater than corresponds to an impulse, Therefore, an exact defined feeding step cannot be assured by these known devices.

It is, therefore, an object of the present invention to provide a hydraulic feeding system of the above mentioned type which will assure a precise dosing of the feeding and will require a minimum of space while being simple in construction.

These and other objects and advantages of the invention will appear more clearly from the following specification, in connection with the accompanying drawings, in which:

FIG. 1 shows an axial longitudinal section through the feeding device according to the invention.

FIG. 2 is a section taken along the line II—II of FIG. 1.

FIG. 3 is a cross section taken along the line III—III of FIG. 1.

FIG. 4 diagrammatically illustrates the hydraulic circuit of the feeding device.

The above outlined objects have been realized in conformity with the present invention which is characterized primarily in that the fluid cylinder piston system connected to the honing tool forms a rotary valve for the outlet of the piston chamber which decreases during the feeding movement. The frictional entrainment occurring during the starting of the honing tool on the workpiece is taken advantage of for rotating the hydraulic cylinder serving as rotary valve, about its longitudinal axis so that said rotary valve will close a control bore which makes possible the return of the pressure fluid during the fast traverse feeding movement. The hydraulic cylinder may in this instance be formed by a rotatable bushing which is rotatable over a limited rotary angle in a housing against a return force, especially against the force of a return spring. According to a preferred embodiment of the invention, the said bushing comprises an outlet bore for the second piston chamber which decreases during the feeding movement, said discharge bore being intended for releasing the pressure fluid acting upon the rear side of the piston. This bore will, in view of the relative rotation between bushing and housing as it occurs by the frictional engagement, move over and shut off the control bore arranged in the housing and connected to a return conduit.

According to a preferred embodiment of the invention, the bushing is non-displaceably guided in axial direction by two thrust bearings in the housing coupled to the driving rod of the honing machine and can only pass through an angular path relative to the housing, which angular path is limited by two abutments. During the feeding movement, the bushing is held by the return force against the first one of the two abutments while the return force is advantageously exerted by a spring. In this position, the double acting piston of the feeding device has its end face acted upon by a pressure fluid. The pressure fluid passes through a pressure conduit in to the first piston chamber, whereas the second piston chamber, located on the back side of the piston, communicates with the return conduit through the then open control bore. In view of the fact that at that time a counterpressure is lacking on the rear side of the piston, a fast feeding movement, which fast movement through the intervention of transmission elements known in connection with hydraulically feedable

honing tools brings about the widening of the honing tool. When the rotating honing strips of the tool, during the further course of the feeding movement, contact the tool which is at a standstill, a frictional moment builds up which is directed opposite to the direction of rotation and through which the bushing is turned against the second abutment. In view of this rotary movement, the outlet bore provided in the bushing is pivoted out of range of the control bore located opposite thereto so that said bushing moves over said bore with the result that it entirely or at least nearly entirely blocks the return conduit. In view of the counter pressure now building up on the rear side of the piston, the fast traverse movement will be stopped.

In order to be able subsequently to the completed fast feeding movement to effect the precisely dosed fine feeding movement, it is suggested according to a further development of the invention that the bushing which acts as a rotary valve has a second outlet bore which with all rotary turning adjustments of the bushing permits a passage from the second rearward piston chamber to a control passage serving as return conduit which latter leads to control means adapted to be actuated at random. By these control means, the pressure fluid may in a continuous manner or step wise be withdrawn from the piston chamber in small quantities and be used for the fine adjustment of the honing tool. As control means for the quantity of pressure fluid to be withdrawn from the second piston chamber, it is possible in the return conduit to provide either an adjustable fine throttle valve or an adjusting dosing valve. In both instances advantageously an electromagnet may be provided for controlling the valves. A minimum of space will suffice when, in conformity with the further development of the invention, the said control means are installed directly in the housing receiving the bushing or is connected thereto.

Referring now to the drawings in detail, the illustrated hydraulic feeding device is intended for a honing tool H of a honing machine which is not illustrated in detail. This honing machine through the intervention of a driving rod A imparts upon the honing tool H a rotary as well as an axially reciprocable movement. In order to move radailly toward the outside the honing strips H1 and H2 of the honing tool H to increase the machining diameter thereby, it is suggested by means of the core member H3 of the honing tool which core member serves for guiding the honing stones, to effect through the interchange of an intermediate member (indicated in dash lines) a pull and rotation resistant connection with the feeding device to be described further below, said feeding device comprising substantialy a double acting hydraulic piston 1 and a hydraulic cylinder 2.

In order to make sure that the piston can be operated in the vertical working way selected for the illustrated example, a stuffing box S is inserted into the lower portion of the bore of the hydraulic cylinder 2. The piston rod K is passed through said stuffing box S in a pressure-tight manner. The lower end of the piston rod K, which lower end is received in the honing tool H, is provided with an upper cone K1 and a lower cone K2. These cones drive the honing strips H1 and H2 radially outwardly when the hydraulic piston during its fast traverse movement or during a considerably lower and consequently more sensitively effected fine movement carries out its feeding movement toward the stuffing box S at which it deeper penetrates the core member H3.

In order to be able to use the hydraulic piston 2 as rotary switch or rotary valve, in conformity with the present invention, the hydraulic piston 2 forms a bushing which in the housing 3 that forms the lower end section of the driving rod A by means of two axial groove ball bearings in non-displaceable in axial direction but is rotatably journalled with regard to the housing 3 for a rotation to a limited extent. For purposes of adjusting the axial bearing play of the bushing 2 in the housing 3,

there is provided a threaded sleeve 4 similar to a box nut, the threaded connection 6 of which with regard to the housing 3 can be arrested by a counter nut 7. Bushing 2 is, with small radial play, fitted into the bore of the housing 3 and is adapted to carry out a relative rotary stroke with regard to housing 3 which stroke is limited by two abutments. According to FIG. 3, two cylinder pins 8 may form these abutments which are firmly located in the lower end face 9 of the housing 3 and engage two grooves 10 which are located in a collar on the bushing 2. In order to make sure that the bushing can during the fast traverse feeding movement be held in one of its two end positions, a torsion spring 12 is provided which causes one end of the grooves 10 of the bushing to engage the respective cylinder pin 8. In this position which is illustrated in FIG. 3, an outlet bore 13 provided in the lower portion of the bushing 2 and extending transverse to the axis of the bushing coincides with a control bore 14 in the housing 3. This control bore 14 communicates through two axis parallel longitudinal bores 15 and 17 and through a transverse bore 16 interconnecting said bores 15 and 17, with a pressure fluid distributor 20 which is located above the housing 3. In the distributor 20, the control bore 13 communicates with a connection 34*a* of a pressure fluid conduit 34 which during the fast traverse feeding movement serves as return conduit for the pressure fluid displaced from the second rearward piston chamber.

As will be more clearly seen from FIG. 3, there is provided in bushing 2 a second outlet bore 21 which is offset by 120° with regard to the outlet bore 13. Said second outlet bore 21 has an oblong shape and extends in the circumferential direction of the bushing. The bore 21 is associated with the traverse bore 22 in the housing in such a way that in each position of the bushing 2, the bore 22 remains open and thus permits a passage from the second piston chamber 35 to a control passage 23, 24, 25 and 26, serving as return line while in the distributor 20 through a connecting passage 36*a* communication exisits with the second return conduit 36. Associated with this second return conduit 36 there is provided a fine throttle means 37 which is equipped with an electromagnetic control valve 38. An electromagnet E2 of said valve 38 is adapted when in energized condition to occupy the control position 1 at which a communication between the return conduit 36 and the pressure medium reservoir T is established.

In order to be able to exert upon the end face of the piston the pressure necessary for the feeding movement, the upper piston chamber 27 located above the piston is through an axis parallel bore 28 in bushing 2 and a longitudinal bore 29 and furthermore by a transverse bore 30 in communication with the uppermost connecting section 33*a* for a pressure medium conduit 33. Through this conduit 33 the upper piston chamber 27 is, during the feeding movement in conformity with the hydraulic circuit of FIG. 4 supplied with a pressure medium.

The liquid pressure medium, in the present instance oil, is withdrawn from the supply reservoir T by a pump 31 driven by a motor M and at a practically constant pressure is held at approximately from six to ten atmospheres above atmospheric pressure by a control valve R. Between the pump and the two pressure fluid conduits 33 and 34 there is interposed a four-way valve 32 which in FIG. 4, similar to the control valve 38 occupies its zero position 0 as long as the pertaining electromagnet E1 is not energized.

When the electromagnet E1, for purposes of carrying out a feeding movement of the honing tool is connected to a source of current (not illustrated), its four-way valve spool moves into its effective position indicated by the number 1, in which the pump connection P' communicates with the second discharge B' of the four-way valve from where the pressure fluid delivered by the pump 31 passes through a conduit 33 to the upper piston chamber 27. In view of the pressure now being built up, the

piston 1 is pressed downwardly while the pressure fluid in the second piston chamber 35 below the piston 1 is displaced from this chamber and passes through conduit 34 to the connection A' from where the pressure fluid is adapted in view of the position of the valve spool to return through the tank connection T' to the pressure fluid reservoir T. Inasmuch as the pressure fluid can escape from the lower piston chamber 35 practically without being braked, a very fast downward movement of the piston 1 and consequently a feeding movement of the honing strips H1 and H2 of the honing tool H can be effected at high speed. This fast feeding movement is terminated only when the honing strips engage the workpiece and due to the then occurring frictional moment, bushing 2 is braked relative to the housing 3. In this way a relative rotation of bushing 2 is effected while the bushing lags relative to the housing and the torsion spring 12 is loaded until the cylinder pins 8 engage the oppositely located end of the groove 10. With this relative rotary movement, the outlet bore 13 provided in bushing 2 passes over the control bore 14 in housing 3 so that the passage which existed up to said point to the return conduit 34 is blocked. Inasmuch as up to this point the control valve 38 occupies its turned-off position shown in the drawing, the pressure fluid can no longer escape from the second piston chamber 35 so that here a counterpressure builds up very quickly which causes the downward movement of the piston 1 and consequently brings the feeding movement of the honing tool to a standstill. Further well dosed fine advance or feeding may then be obtained by a short temporary actuation of the control valve 38 while small quantities of oil are either continuously or intermittently withdrawn from the second piston chamber.

Instead of the control valve 38 provided with a fine throttle 37, it is also possible to employ a dosing valve, not shown in the drawing, which is actuated pulse-wise and which during each pulse permits an adjustable quantity of the pressure fluid to pass through and will result in a precise step feed. The control of the throttle valve or the dosing valve may be effected instead of electromagnetically as in the present example, also pneumatically, hydraulically, or manually.

When the first honing cycle provided for the machining of the workpiece has been completed, the four-way valve 32 and the control valve 38 are turned off. In this turned-off position illustrated in FIG. 4, the four-way valve establishes communication between conduit 34 which is connected to the lower pressure chamber 35, and the pump, whereas the conduit which previously serve for feeding the pressure fluid is now moved to a position for a non-throttled return to the tank T. Since also the second return conduit 36 is kept in blocked position with regard to the control valve 38, the pressure built up in the second piston chamber 35 by pump 31 will be able quickly to return the piston 1 to its starting position so that a new honing cycle can start.

According to other embodiments within the scope of the invention, but not shown in the drawing, the valve used for controlling the pressure fluid, which valve may be a fine throttle, a dosing valve or the like may be directly built onto the upper part of the housing 3 or built into the same. Small quantities of pressure fluid as they are necessary for fine feeding may be withdrawn from the lower piston chamber 35 through bores 21 and 22 which are always interconnected, and this withdrawal may be effected advantageously by a transverse bore which in FIG. 2 is indicated at 39 by dash lines, and will then connect the passage 25 serving as additional return line with the longitudinal bore 17. In this way, a very compact arrangement can be obtained for the control devices necessary for the fine feeding operations, particularly since also the pressure fluid distributor 20 requires only two connections which fact has a favorable influence upon the overall height of the device.

It is, of course, to be understood that the present invention is, by no means, limited to the particular showing in the drawings, but also comprises any modifications within the scope of the appended claims.

What is claimed is:

1. In a honing device: a radially expansible and contractable honing tool, a cylinder supporting said tool and a double acting piston in the cylinder movable in one direction therein by a supply of pressure fluid to one end thereof to expand said tool and movable in the other direction therein by a supply of pressure fluid to the other side thereof to permit said tool to contract, a source of pressure fluid, a reversing valve connecting said source to said cylinder on opposite sides of said piston, a normally closed control valve connecting said cylinder on said other side of said piston to drain, a drive member supporting said cylinder for rotation thereof together with said tool in one direction during work operations, said cylinder being rotatable on said drive member between circumferentially spaced limits and being biased on said member toward the leading one of said limits so as to rotate on said member toward the other of said limits in a direction opposite to said one direction when said tool engages the work during a work operation, and a rotary valve in the connection between said reversing valve and the end of said cylinder on said other side of said piston which closes in response to movement of said cylinder on said drive member in said opposite direction, said control valve being operable upon actuation to control expansion of said tool by release of fluid from said other side of said piston when said rotary valve is closed.

2. A honing device according to claim 1, in which said rotary valve comprises passage means in said member and cylinder which register when said cylinder is stopped at the leading one of said limits and which are out of register when said cylinder is stopped at the trailing one of said limits.

3. A honing device according to claim 2, in which the connection from said other side of said piston to said control valve comprises further passage means in said member and cylinder which are in registration in all positions of rotation of said cylinder on said member.

4. A honing device according to claim 3, in which said control valve is built into said drive member.

5. A honing device according to claim 3, which inincludes an adjustable throttle valve in series with said control valve to control the rate of fluid flow from said other side of the piston to drain when said control valve is open.

6. A honing device according to claim 3, in which said control valve is in the form of a dosing valve.

7. A honing device according to claim 4, in which the inlet side of said control valve communicates with said other side of said piston while the outlet side thereof communicates with the connection leading from the reversing valve to the rotary valve.

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