

- [54] AUTOMATIC HONING STONE EXPANSION
-
- DEVICE

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- [30]
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- [51] **Int. Cl.²** **B24B 33/06**

- [58] **Field of Search**..... 51/165.9, 165.93, 349,
51/352, DIG. 32

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[57] **ABSTRACT**

A honing stone expansion device for use in a honing machine in which a plurality of hone holders are radially outwardly disposed around a main body fixedly mounted on a rotatable shaft. Each of the hone holders to be expanded synchronously by hydraulic pressure is further provided with a honing stone extrusion device and locking means for the honing stone also operated by hydraulic pressure for easy adjustment of the height of the honing stones to be projected from the hone holders and for securely locking the same to the holders.

7 Claims, 9 Drawing Figures

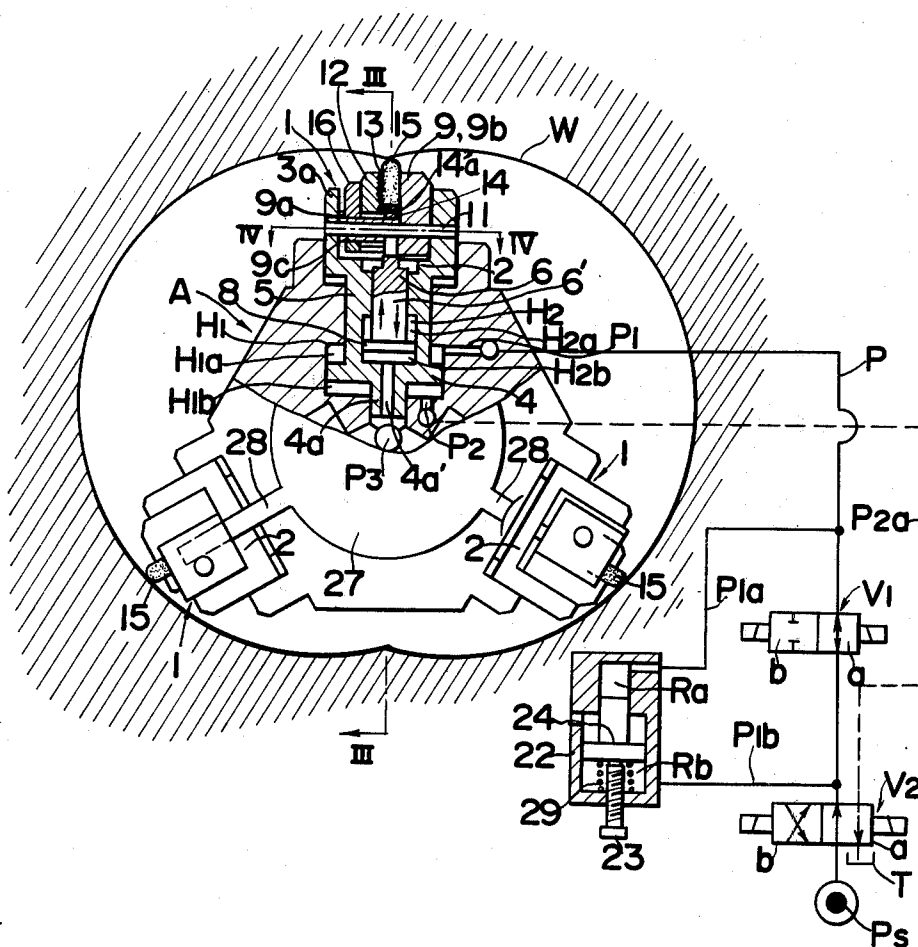


FIG. 1

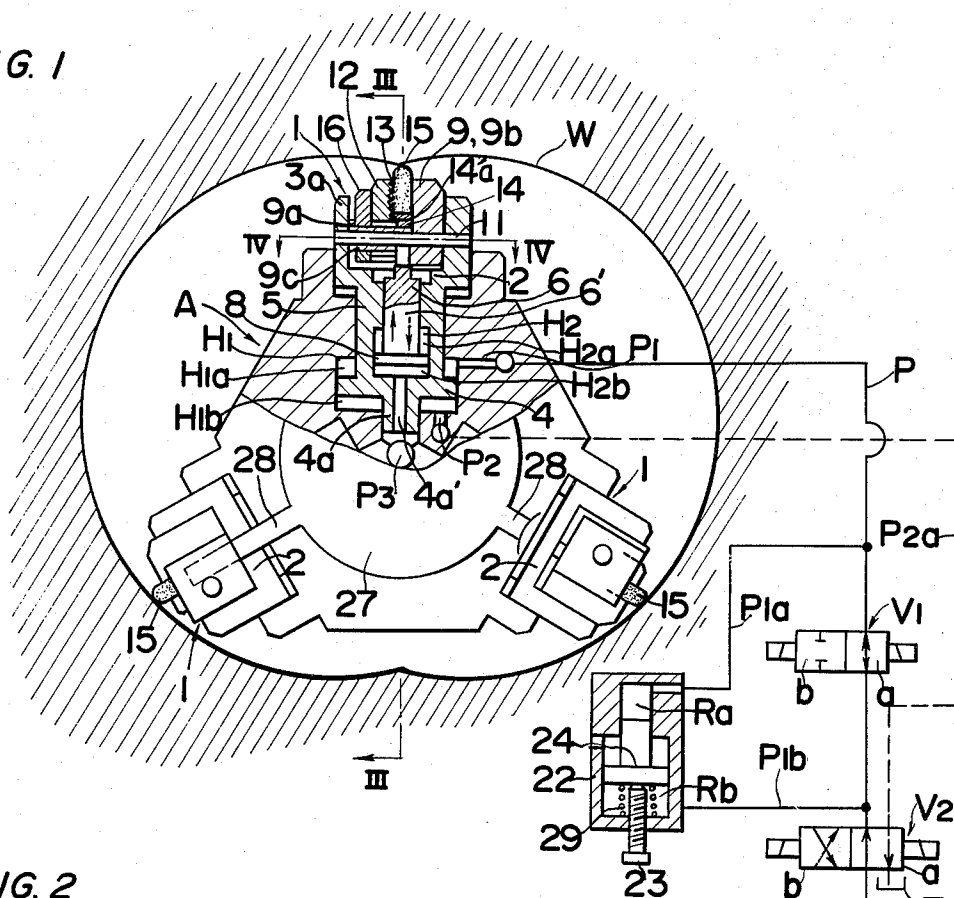


FIG. 2

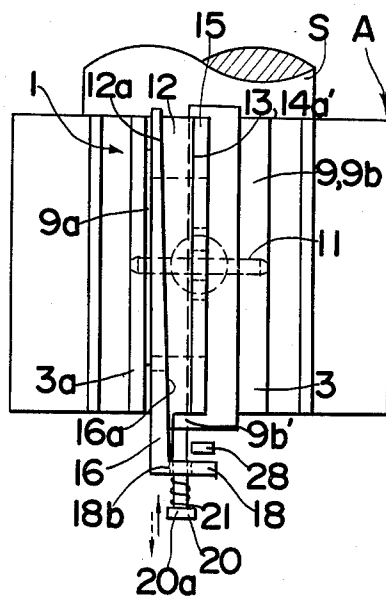


FIG. 5

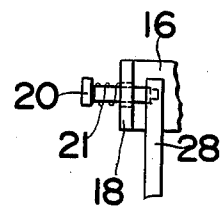


FIG. 3

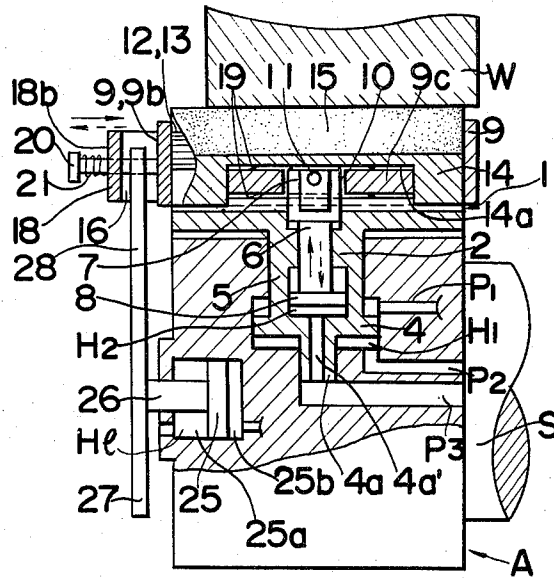


FIG. 4

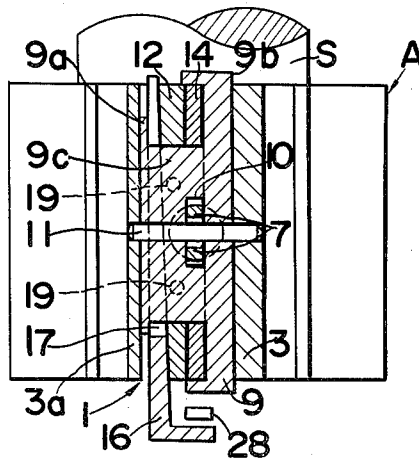


FIG. 9

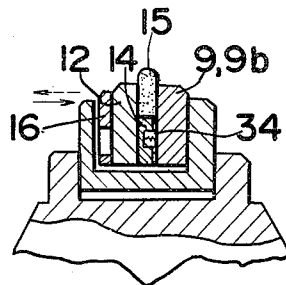


FIG. 6

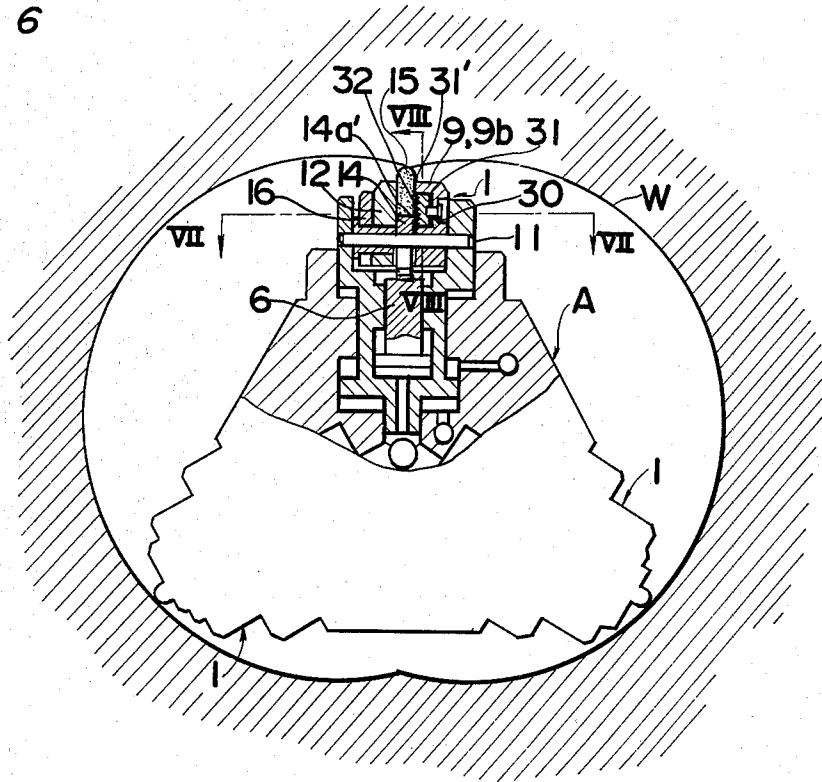


FIG. 7

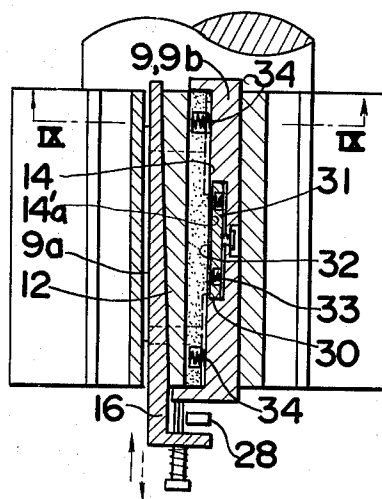
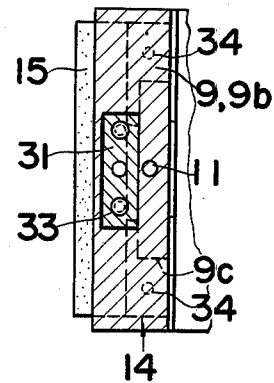


FIG. 8



AUTOMATIC HONING STONE EXPANSION DEVICE

The present invention relates to a honing machine to be used for polishing a trochoidal multilobed inner surface of a workpiece and more particularly, to an automatic honing stone expansion device for use therein.

Conventionally, in the honing stone expansion device of the above described kind, a plurality of hone holders for honing stones are radially disposed around a main body fixedly mounted on a rotatable honing shaft, each of which hone holders is adapted to be radially, outwardly extruded directly by piston and cylinder means associated therewith for polishing an inner surface of a workpiece.

However, such conventional devices of the above described type have such disadvantages that when the honing stones have been defaced to a predetermined level, they must be extruded by the defaced amount by manually loosening the honing stones, which procedure reduces the working efficiency to a great extent. In other words, in such conventional devices, in cases where the honing stones have been worn out by a predetermined amount, the hone holders are loosened for inserting spacers below the honing stones with the device stopped so as to extrude the stones outwardly step by step, in which adjustment, the manual insertion of the spacers is very complicated and troublesome, requiring considerable time for the correct setting of the spacers and resulting in low working efficiency.

Furthermore, when applied to honing of the trochoidal form inner surface of a workpiece, such conventional devices without proper locking means for the honing stones present many disadvantages since radius of curvature of the trochoidal inner surface to which the honing stones are applied continuously varies with large bending moment imparted to the honing stones due to friction between the surfaces of the workpiece to be polished and the honing stones. Moreover, the large bending moment applied to the honing stones necessitates the height of the honing stones projecting from the hone holders to be less than a predetermined degree, while simultaneously the projecting height of the honing stones from the hone holders must be more than a certain degree in order to reduce the number of replacements of the stones due to defacement thereof during polishing.

Such requirements for holding the honing stones securely to the hone holders and for maintaining approximately constant projection of the honing stones from the hone holders especially in the trochoidal form polishing can not be met by the conventional honing stone expansion devices.

Accordingly, an essential object of the present invention is to provide an automatic honing stone expansion device which is easy to operate and high in working efficiency with substantial elimination of the disadvantages inherent in the conventional devices.

Another important object of the present invention is to provide an automatic honing stone expansion device which is accurate in functioning with means for locking honing stones securely.

A further object of the present invention is to provide an automatic honing stone expansion device in which honing stones are easily replaced with the proper amount of honing stones constantly projecting above hone holders.

According to a preferred embodiment of the present invention, the automatic honing stone expansion device comprises three hone holders radially, outwardly disposed at a predetermined angle to one another on a main body which is fixedly mounted on a rotatable hone shaft, each of which hone holders is adapted to be radially, outwardly extruded by expansion means incorporated in the main body, means for extruding the honing stones incorporated in each of the hone holders, means for securely locking the honing stones provided on the outer part of the hone holders, and automatic pressure cycle control means driven by hydraulic pressure for controlling the hone holder expansion means, the honing stone extruding means and the honing stone locking means.

In the above described device of the present invention, each of the hone holders is radially, outwardly movable by the expansion means operated by hydraulic pressure from piston and cylinder mechanisms incorporated in the main body, while the honing stones are also radially, outwardly extruded by the extrusion means, through hydraulic pressure, incorporated in the hone holders with the honing stones securely locked at the extruded position or readily released from the hone holders by simple wedge action between two tapered plates disposed along the honing stones, which arrangement not only makes it possible to readily extrude the defaced stones to a necessary extent by the extrusion means very efficiently, but also is very effective for constantly maintaining proper height of the honing stones especially in polishing a trochoidal form surface without the complicated procedure of manually inserting spacers for adjusting the height of honing stones as required in the conventional devices.

These and other objects and features of the present invention will become apparent from the following description taken in conjunction with the preferred embodiment thereof with reference to the accompanying drawings, in which;

FIG. 1 is a schematic diagram showing a front view, partly in section, of an automatic hone expansion device and hydraulic system associated therewith,

FIG. 2 is a top plan view of the device of FIG. 1,

FIG. 3 is a sectional view taken along the line III — III of FIG. 1,

FIG. 4 is a sectional view taken along the line IV — IV of FIG. 1,

FIG. 5 is a schematic diagram showing a side view of a modification of a locking pin arrangement in FIG. 2,

FIG. 6 is a schematic diagram showing a front view of a modification of the device of FIG. 1,

FIG. 7 is a sectional view taken along the line VII — VII of FIG. 6,

FIG. 8 is a sectional view taken along the line VIII — VIII of FIG. 6, and

FIG. 9 is a sectional view taken along the line IX — IX of FIG. 7.

Before the description of the present invention proceeds, it is to be noted that like parts are designated by like numerals throughout the accompanying drawings.

Referring to FIGS. 1 to 4, the automatic hone expansion device of the invention generally comprises a hexagonal main body A fixedly mounted on the rotatable hone shaft *s*, and three hone holders 2 of approximately U-shape, each of which is slidably received in hone expanding means 1 disposed on every other side of the hexagonal body A at an angle of 120° to each other so

as to be synchronously moved radially outwardly or inwardly by the action of a pressure cycle.

It should be noted here that the description of the hone holders 2 of the invention is made on one of the three holders 2 for brevity, since the other two holders are exactly the same in construction, except for the hydraulic system which operates the three hone holders 2 simultaneously.

In FIG. 1, each of the three hone holders 2 is formed, on the outer part thereof, with a holding portion 3 of a channel shape extending in the axial direction of the hone shaft *s* with the inner part thereof formed into a flange portion 4 which is slidably received in a cylinder H1 bored in the body A and with a cylindrical portion 5 integrally formed between the holding portion 3 and the flange portion 4 which cylindrical portion 5 is also slidably received in a fitting bore concentrically communicated with the cylinder H1. In the cylindrical portion 5 of the hone holder 2, there is enclosed an extruding member 6 which is also formed with an U-shaped lifting fork 7 on its outer part with the inner part thereof formed into a flange portion 8 which is slidably received in a cylinder H2 bored in the cylindrical portion 5 of the hone holder 2 and with a cylindrical portion 6' of the member 6 also slidably received in a corresponding bore concentrically communicated with the cylinder H2.

A honing stone clamping member 9 of an approximately channel configuration with an U-shape cross section has its one side wall axially cut in the direction of the hone shaft *s* to form a thin and low wall 9a with the bottom connecting portion 9c of the member 9 formed with a slit 10 (FIGS. 3 and 4) at the middle portion adjacent to the other side wall 9b of the member 9 to receive the U-shaped lifting fork 7 of the extruding member 6. The member 9 is received in the holding portion 3 of the holder 2 and connected to the hone holder 2 by a pin 11 inserted through corresponding openings formed in the holding portion 3 of the hone holder 2 and the bottom portion 9c of the member 9 in a direction normal to the axis of the hone shaft *s*. A locking plate 12 having many pointed projections or pawls 13 at one side face thereof adjacent to a honing stone 15 and a tapered surface 12a at the other side face thereof is adapted to press or release the honing stone 15 against or from the side wall 9b of the clamping member 9 by forward or backward movement of a tapered pressure plate 16 mentioned later, the honing stone 15 being placed on and in parallel to the outer edge of an extrusion plate 14 which has an elongated cut-out portion 14a (FIG. 3) along the inner edge thereof and another notch 14a' in the portion between the outer edge thereof and the cut-out portion 14a and which is supported by the U-shaped lifting fork 7 of the extruding member 6.

It should be noted here that the extrusion plate 14 and the honing stone 15 described above are slidably mounted in the holding portion 3 of the hone holder 2 so as to be movable toward the surface to be honed of a work piece W in FIG. 1.

The pressure plate 16 is provided with an elongated notch 17 (FIG. 4) in the middle portion thereof which engages the bottom connecting portion 9c of the clamping member 9 with sufficient axial play of the plate 16, and is disposed along one side wall 9a of the channel shaped clamping member 9 in a position adjacent to and approximately in parallel with the locking

plate 12 with one side face 16a of the plate 16 tapering toward one end of the plate 16 in the opposite direction to the taper 12a on the corresponding surface of the locking plate 12. Accordingly, by pushing forward the pressure plate 16 between the side wall 9a of the clamping member 9 and the locking plate 12, the locking plate 12 is pressed against the honing stone 15 for clamping the same, while by drawing the plate 16 backward, the honing stone 15 is released. A pair of compression springs 19 (FIGS. 3 and 4) are disposed between the locking plate 12 and the connecting portion 9c of the honing stone clamping member 9 for urging the locking plate 12 in the direction of expansion of the honing stone 15. A locking pin 20 (FIG. 2) is threadedly attached at one end thereof, through an opening 18b formed in the projection 18 extending at right angles from one end of the pressure plate 16 toward the locking plate 12, to a projection 9b' extending at right angles from the corresponding end of the side wall 9b of the clamping member 9 toward the pressure plate 16, with a compression spring 21 disposed around the pin 20 between the projection 18 of the plate 16 and a knob 20a formed at the other end of the pin 20 so as to constantly urge the pin 20 in the direction shown by a dotted line arrow and consequently to bias the pressure plate 16 in the direction of a real line arrow.

Referring particularly to FIG. 3, a honing stone locking piston 25 is reciprocatingly disposed in a cylinder H1 formed in the main body A with the piston rod 26 thereof fixedly connected to a circular disc 27 having three arms 28, each radially, outwardly extending therefrom toward the corresponding projection 18 of the pressure plate 16 so that the outer end of the arm 28 is located adjacent the inner surface of the projection 18.

Accordingly, when the piston 25 is moved outward, the end of the arm 28 engages the projection 18 of the pressure plate 16, drawing the plate 16 outward against the force of the spring 21.

It should be noted here that in the hone expansion device of the invention the clamping members 9, the locking plates 12, the honing stones 15, the pressure plates 16 and the locking pins 20 are adapted to rock about the pins 11 so that the honing stones 15 can follow the surface of the workpiece W during polishing.

Referring back to FIG. 1, a passage P1 for hydraulic fluid leading from a pipe *p* to a chamber H1a above the flange portion 4 of the hone holder 2 in the cylinder H1 formed in the main body A is adapted to communicate with a pressure source Ps through switching valves V1 and V2. The cylinder, moreover a branch piping P1a of the pipe P is communicated with a regulating cylinder 22 which is also in communication with another branch piping P1b connected to the two way switching valve V2. The regulating cylinder 22 has a piston 24 reciprocatingly enclosed therein with its lower limit of stroke determined by an adjusting bolt 23 threadedly attached to the lower portion of the cylinder 22 and with the piston 24 urged upward by a compression spring 29 disposed between the lower surface of the piston 24 and the lower inner surface of the cylinder 22, and is adapted to pass the hydraulic fluid into an upper chamber Ra thereof above the piston 24 through the switching valves V1 and V2.

A passage P2 for the hydraulic fluid leading from a branch pipe P2a into a chamber H1b in the cylinder H1 of the main body A below the flange portion 4 of the

hone holder 2 is communicated with the pressure source Ps and oil tank T through the branch pipe P2a via the switching valve V2 for supplying hydraulic pressure to push the hone holder 2 upward so that each of the three honing stones 15 can be extruded toward the surface to be polished of the workpiece W.

Another passage P3 of the hydraulic fluid is provided in the main body A in a position below and in communication with a central bore 4a' formed in a tubular projection 4a extending inward toward the axis of the shaft s from the flange portion 4a of the hone holder 2 for supplying hydraulic pressure into the chamber H2b below the flange 8 of the extruding member 6 in the cylinder H2 formed in the hone holder 2, which passage P3 is also communicated with the pressure source Ps and the oil tank T through a switching valve (not shown).

By this arrangement, where a new honing stone 15 is mounted in each of the three hone holders 2 as shown in FIG. 1, when the switching valves V1 and V2 are switched over to a respectively with the passage P2 communicated with the oil tank T for supplying hydraulic pressure to the passage P1, the hone holder 2 moves inward with the hydraulic pressure simultaneously supplied to the upper and lower chambers Ra and Rb of the regulating cylinder 22, so that the piston 24 is fully raised until it contacts the upper surface of the upper chamber Ra by the difference of the areas of the piston 24 subjected to the hydraulic pressure.

When the switching valves V1 and V2 are switched over to b respectively for supplying the hydraulic pressure to the chamber H1b of the hone expansion cylinder H1 through the passage P2, the oil in the chamber H1a enters the upper chamber Ra of the regulating cylinder 22 through the passage P1 and the branch pipe P1a, consequently pushing the piston 24 downward against the force of the spring 29 until the under surface of the piston 21 contacts the tip of the adjusting bolt 23 with each of the three hone holders 2 expanded to a predetermined extent toward the surface to be worked of the workpiece W. In other words, the degree of expansion of the hone holders 2 is restricted by the length of the portion of the adjusting bolt 23 projecting into the regulating cylinder 22.

Referring back to FIG. 3, when the hydraulic pressure is imparted to the chamber 25b of the hone locking cylinder H/ through a hydraulic system (not shown) for moving each of the arms 28 associated with the piston 25 in the direction shown by an dotted line arrow, the arm 28 engages the projection 18 of the pressure plate 16 to push the latter also in the direction of the dotted line arrow with the plate 16 drawn in the same direction against the urging force of the spring 21, in which case the presence of the tapered surfaces 16a and 12a on the plates 16 and 12 releases the locking plate 12 pressed against the honing stone 15 and the extrusion plate 14. In this state, when the hydraulic pressure is introduced into the chamber H2b of the hone extrusion cylinder H2 through the passage P3 via the bore 4a', the extrusion member 6 is moved in the direction shown by a real line arrow to extrude the plate 14 and consequently the honing stone 15 in the same direction. Meanwhile, since the locking plate 12 is released from being pressed against the honing stone 15 and the plate 14, the plate 14 having the longated cut-out portion 14a and the notch 14a' passes over the pawls 13 formed on the corresponding side face of the

locking plate 12, thus forcing the honing stone 15 outward to such an extent that the outer edge of the stone 15 contacts the surface of the workpiece W to be polished, in which case the amount of extrusion of the honing stone 15 is predetermined to be an optimum level in a manner described earlier.

After the honing stone 15 has been extruded as described above, the hydraulic pressure is introduced into the chamber 25a of the hone locking cylinder H/ to move each of the arms 28 in the opposite direction shown by a real line arrow by operating the hydraulic circuit mentioned earlier. Thereupon, the arm 28 moves away from the projection 18 of the pressure plate 16 with the pressure plate 16 rapidly moving in the direction of the real line arrow by the action of the spring 21 so as to move the locking plate 12 toward the side wall 9b of the clamping member 9 by a wedge action between the surfaces 16a and 12a tapering in the opposite directions to each other of the pressure plate 16 and the locking plate 12 and to hold the honing stone 15 securely between the side wall 9b and the locking plate 12 with the honing stone 15 fixed to the hone holder 2. In this case, if the pointed tips of the pawls 13 of the plate 12 and the pointed tips of the notch 14a' formed on the corresponding side of the plate 14 should coincide with one another, the locking plate 12 supported by the springs 19 moves upward or downward so that pawls 13 and the notch 14' on the plates 12 and 14 engage with one another for positive locking therebetween.

In the above state, the supply of the hydraulic fluid through the passage P3 is suspended and simultaneously the switching valve V1 is switched over to a for communicating the passage P1 with the oil tank T so that the hone holders 2 can be expanded by the hydraulic pressure applied to the chambers H1b of the expansion cylinders H1, while the honing shaft s is rotated by a driving means (not shown) so as to polish the inner surface of the workpiece W.

On the other hand, when the honing stones 15 have been defaced, optimum amount of extrusion for the honing stones can be continuously obtained by repeating the extrusion procedure described above.

For replacing the honing stones 15, the workpiece W is removed from the main body A of the honing device with the hydraulic pressure introduced into the chamber 25b of the honing stone locking cylinder H/ for releasing the locking by the locking plates 12. After new honing stones 15 have been mounted in the holders 2, the hydraulic pressure is introduced into the other chambers 25a of the cylinders H/ for tightening the locking plates 12 and securing the stones 15 to the honing stone holders 2.

The tightening of each of the locking plate 12 described as effected only by the force of the spring 21 which presses the pressure plate 16 inward may be modified to be effected by the pressing force of the spring 21 and the inward pull of the piston 25 in the cylinder H/, in which case the locking pin 20 is directly connected to the arm 28 as shown in the modification in FIG. 5.

Referring now to FIGS. 6 to 9, there is shown a modification of the hone expanding device of FIG. 1. In this modification, the pawls 14a' formed on one side face of the extrusion plate 14 are adapted to engage the pawls 32 provided on the corresponding side face 31' of a holding member 31 received in a channel shaped

groove 30 formed in the side wall 9b of the clamping member 9. The member 31 is urged toward the pawls 14a' on the plate 14 by a pair of compression springs 33 suitably provided between the member 31 and the bottom of the groove 30, and the extruding plate 14 is also biased to the pawls 32 of the holding member 31 by a pair of compression springs 34 provided between the plate 14 and the side wall 9b of the clamping member 9.

Accordingly, in adjusting the extrusion for each of the honing stones 15 due to wearing out thereof, when the pressure plate 16 is drawn in the direction of the dotted line arrow (FIG. 7) by means of the arm 28 as in the embodiment in FIG. 1, the extrusion plate 14 and the locking plate 12 are moved in the direction of a dotted line arrow (FIG. 9) by the repulsion of the springs 34 with the pawls 14a' of the plate 14 disengaged from the pawls 32 of the member 31 for loosening the honing stone 15. In this state, when the extrusion member 6 is moved outward toward the surface of the workpiece W in the same manner as that described in the embodiment in FIG. 1, the honing stone 15 together with the plate 14 is projected radially, outwardly until the stone 15 contacts the surface to be worked of the workpiece W, during which movement the relative engaging positions between the pawls 14a' of the plate 14 and the pawls 32 of the member 31 are changed accordingly.

When each of the honing stones 15 has been extruded to a predetermined extent, the pressure plate 16 is moved in the direction shown by the real line arrow in FIG. 7 in the same manner as that described in the embodiment of FIG. 1 so that the pawls 14a' of the plate 14 are positively engaged with the corresponding pawls 32 of the member 31 for positioning the honing stone 15 toward the expanding direction thereof and also for pressing the stone 15 against the side wall 9a of the clamping member 9 by the locking plate 12 so as to securely hold the stone 15 between the locking plate 12 and the side wall 9a of the clamping member 9.

Although in the above modification, the description is mainly directed toward one of the three hone holders 2 for brevity as in the embodiment of FIG. 1, it is needless to say that other two hone holders 2 are exactly the same in construction.

As is clear from the foregoing description, according to the automatic hone expanding device of the invention, since the honing stone extruding means is provided in the honing stone holders having expansion means, the defaced honing stones can be readily extruded by a necessary amount so that the honing stones can economically be utilized to the utmost extent along the entire height thereof with the time required for setting or replacing the honing stones efficiently reduced to a large extent.

Furthermore, as the extrusion means can normally be locked by locking means, both of which means are operated by hydraulic pressure instead of extruding the honing stones by manually inserting spacers below the honing stones as in the conventional devices, not only the working efficiency is remarkably improved but it is possible to replace the honing stones automatically since the replacement can be made at the front of the honing stone holders by merely removing the worn out stones from the stone holders and mounting new stones thereon.

The adoption of the regulating cylinder for adjusting the amount of extrusion of the honing stones is very advantageous, since the honing stones can be projected from the honing stone holders by an optimum amount by merely adjusting the amount of projection for the adjusting bolt in the regulating cylinder.

Although the present invention has been fully described by way of example with reference to the attached drawings, it is to be noted that various changes and modifications are apparent to those skilled in the art. Therefore, unless otherwise such changes and modifications depart from the scope of the present invention, they should be construed as included therein.

What is claimed is:

1. In a honing stone expansion device for use in a honing machine for polishing a trochoidal form surface of a workpiece which comprises at least one honing stone holder having a honing stone mounted thereon and radially outwardly disposed around a main body fixedly mounted on a rotatable honing shaft, and means for extruding said honing stone holder radially outwardly from said main body, an improvement which comprises hydraulic pressure means communicating with said honing stone holder for expansion thereof with an inner part of said honing stone holder formed into a piston reciprocally received in a cylinder formed in said main body and with an outer part of said holder formed into a channel shaped holding portion, a clamping member of similar shape being received in said channel shaped holding portion and carried by said holder, a honing stone extrusion member disposed in said honing stone holder with an inner portion of said extrusion member formed into a piston reciprocally received in a cylinder formed in said honing stone holder for automatically extruding said extrusion member by said hydraulic pressure means with an outer portion of said extrusion member adapted to support an extrusion plate on which said honing stone is mounted, regulating means communicating with said hydraulic pressure means for extruding said extrusion member a predetermined amount for automatically adjusting the height of said honing stone, and means for automatically locking and releasing said extrusion plate and honing stone to and from said clamping member, said locking means being operated by said hydraulic pressure means.

2. In a honing stone expansion device for use in a honing machine for polishing a trochoidal form surface of a workpiece which comprises at least one honing stone holder having a honing stone mounted thereon and radially outwardly disposed around a main body fixedly mounted on a rotatable honing shaft, and means for extruding said honing stone holder radially outwardly from said main body, an improvement which comprises hydraulic pressure means communicating with said honing stone holder for expansion thereof with an inner part of said honing stone holder formed into a piston reciprocally received in a cylinder formed in said main body and with an outer part of said holder formed into a channel shaped holding portion, a clamping member of similar shape being received in said channel shaped holding portion, a honing stone extrusion member disposed in said honing stone holder with an inner portion of said extrusion member formed into a piston reciprocally received in a cylinder formed in said honing stone holder for automatically extruding said extrusion member by said hydraulic

pressure means with an outer portion of said extrusion member adapted to support an extrusion plate on which said honing stone is mounted, regulating means communicated with said hydraulic pressure means for extruding said extrusion member by a predetermined amount for automatically adjusting the height of said honing stone, and means for automatically locking or releasing said extrusion plate and honing stone to or from said clamping member, said locking means being operated by said hydraulic pressure means and provided with means for floating said honing stone in said channel shaped holding portion of said holder, said floating means being a pin movably connecting said clamping member to said channel shaped holding portion of said holder.

3. A honing stone expansion device as claimed in claim 2, wherein said locking or releasing means for said extrusion plate and honing stone comprises a locking plate having a plurality of pawls on one side face thereof facing said honing stone and said extrusion plate provided with a notch at corresponding side face thereof, and which has a tapered surface on the other side face thereof, and a pressure plate having a side face thereof facing said tapered surface of said locking plate and tapering in an opposite direction to said tapered side face of said locking plate, said locking plate and said pressure plate together with said honing stone and extrusion plate being disposed between side walls of said clamping member so that when said pressure plate is inserted between one side wall of said clamping member and said locking plate, said honing stone is pressed against the other side wall of said clamping member with said notch of said extrusion plate engaged with said pawls of said locking plate.

4. A honing stone expansion device as claimed in claim 2, wherein said locking or releasing means for said extrusion plate and honing stone comprises a locking plate having one flat side face thereof facing said honing stone and said extrusion plate provided with a plurality of pawls on the side face thereof facing a first side wall of said clamping member, a holding member having corresponding pawls on a side face thereof facing said extrusion plate and slidably received in a groove formed in said first side wall of said clamping member, said holding member being urged toward said extrusion plate by spring means, said locking plate having a tapered surface on the other side face thereof, and a pressure plate with a side face thereof facing said tapered surface of said locking plate and tapering in an opposite direction to said tapered side face of said locking plate, said locking plate and said pressure plate together with said honing stone and extrusion plate being disposed between said first side wall of said clamping member and a second side wall thereof so that when said pressure plate is inserted between said second side wall of said clamping member and said locking plate, said honing stone is pressed against said first side wall of said clamping member with said pawls of said extrusion plate engaged with said pawls of said holding member.

5. In a honing stone expansion device for use in a honing machine for polishing a trochoidal form surface of a workpiece which comprises a plurality of honing stone holders having honing stones mounted thereon and radially outwardly disposed at a predetermined angle to one another on a main body fixedly mounted on a rotatable honing shaft, and means for synchro-

nously extruding said honing stone holders radially outwardly from said main body, an improvement which comprises hydraulic pressure means communicating with said honing stone holders for expansion thereof with an inner part of said honing stone holder formed into a piston reciprocatingly received in a cylinder formed in said main body and with an outer part of said holder formed into a channel shaped holding portion, a clamping member of similar shape being received in said channel shaped holding portion, a honing stone extrusion member disposed in said honing stone holder with an inner portion of said extrusion member formed into a piston reciprocatingly received in a cylinder formed in said honing stone holder for automatically extruding said extrusion member by said hydraulic pressure means with an outer portion of said extrusion member adapted to support an extrusion plate on which said honing stone is mounted, a regulating means communicated with said hydraulic pressure means for extruding said extrusion member by a predetermined amount for automatically adjusting the height of said honing stone, and means for automatically locking or releasing said extrusion plate and honing stone to or from said clamping member, said locking means being operated by said hydraulic pressure means and provided with means for floating said honing stone in said channel shaped holding portion of said holder, said floating means being a pin movably connecting said clamping member to said channel shaped holding portion of said holder.

6. A honing stone expansion device as claimed in claim 5, wherein said locking or releasing means for said extrusion plate and honing stone comprises a locking plate having a plurality of pawls on one side face thereof facing said honing stone and said extrusion plate provided with a notch at corresponding side face thereof, and which has a tapered surface on the other side face thereof, and a pressure plate having a side face thereof facing said tapered surface of said locking plate and tapering in an opposite direction to said tapered side face of said locking plate, said locking plate and said pressure plate together with said honing stone and extrusion plate being disposed between side walls of said clamping member so that when said pressure plate is inserted between one side wall of said clamping member and said locking plate, said honing stone is pressed against the other side wall of said clamping member with said notch of said extrusion plate engaged with said pawls of said locking plate.

7. A honing stone expansion device as claimed in claim 5, wherein said locking or releasing means for said extrusion plate and honing stone comprises a locking plate having one flat side face thereof facing said honing stone and the extrusion plate provided with a plurality of pawls on the side face thereof facing a first side wall of said clamping member, a holding member having corresponding pawls on a side face thereof facing the extrusion plate and slidably received in a groove formed in said first side wall of said clamping member, said holding member being urged toward said extrusion plate by spring means, said locking plate having a tapered surface on the other side face thereof, and a pressure plate having a side face thereof facing said tapered surface of said locking plate and tapering in an opposite direction to said tapered side face of said locking plate, said locking plate and said pressure plate together with said honing stone and extrusion plate being disposed

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between said first side wall of said clamping member and a second side wall thereof so that when said pressure plate is inserted between said second side wall of said clamping member and said locking plate, said hon-

ing stone is pressed against said first side wall of said clamping member with said pawls of said extrusion plate engaged with said pawls of said holding member.

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