Jan. 6, 1970 TAKASHI HATUKANO 3,487,582

APPARATUS FOR PROCESSING MATERIALS BY ULTRASONIC WAVES OSCILLATION

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Fig 1

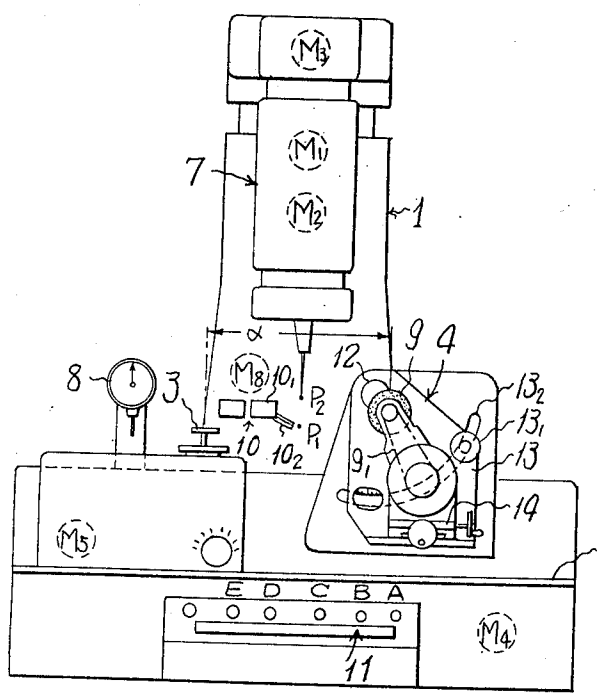


Fig 2

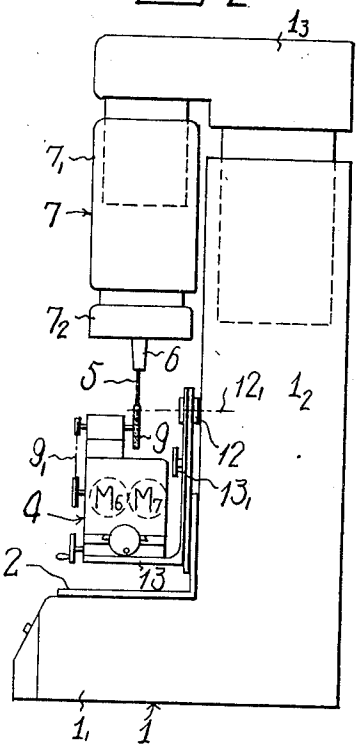
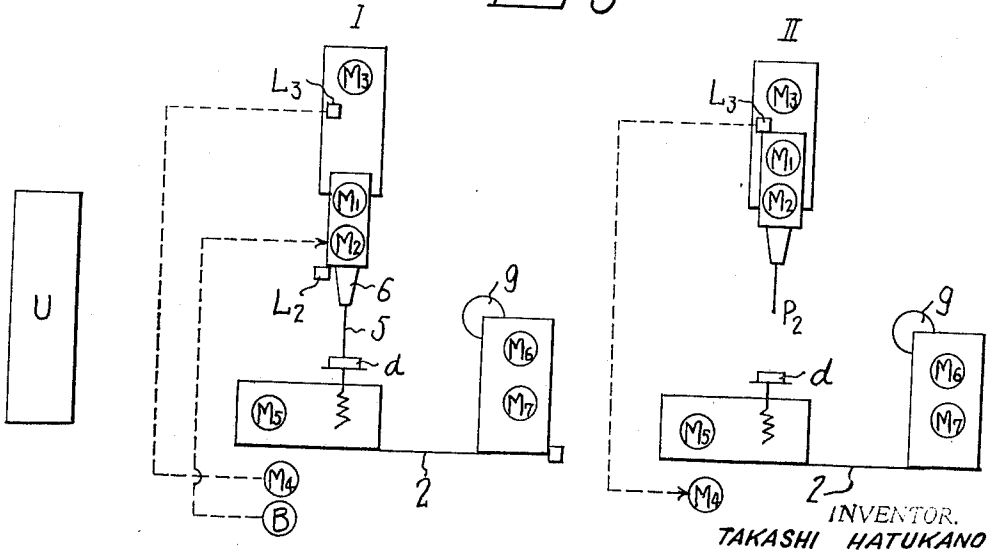


Fig 3



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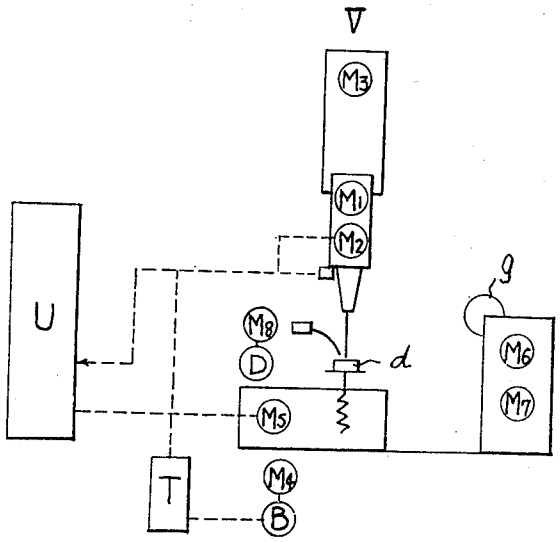
BY

McGlew & Toren
ATTORNEYS

Jan. 6, 1970 TAKASHI HATUKANO 3,487,582

APPARATUS FOR PROCESSING MATERIALS BY ULTRASONIC WAVES OSCILLATION

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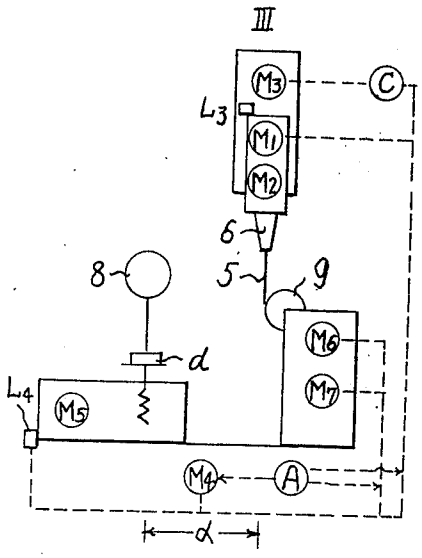
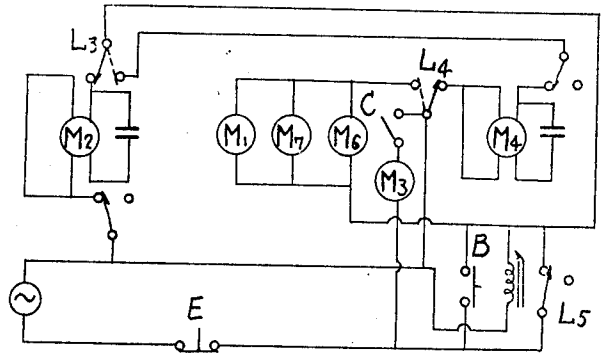


Fig 4



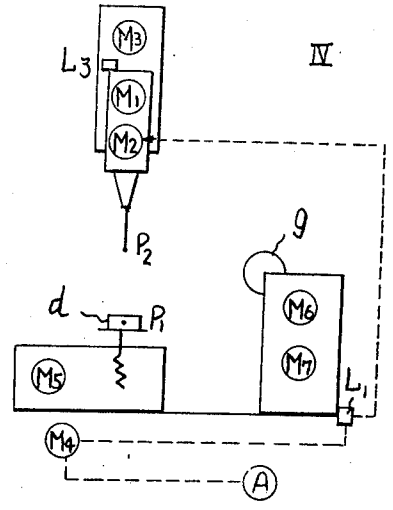
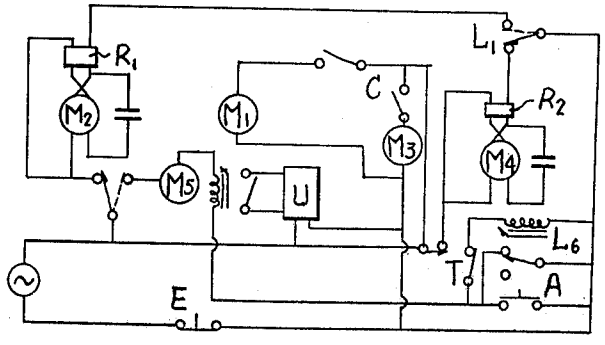


Fig 5



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United States Patent Office

3,487,582

Patented Jan. 6, 1970

3,487,582

APPARATUS FOR PROCESSING MATERIALS BY ULTRASONIC WAVES OSCILLATION

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Filed Feb. 7, 1967, Ser. No. 614,443
Claims priority, application Japan, Feb. 12, 1966, 41/8,216
Int. Cl. B24b 7/22
U.S. Cl. 51—3 2 Claims

ABSTRACT OF THE DISCLOSURE

A new method and apparatus using an ultrasonic waves oscillated needle is disclosed here for drilling gems, for example, diamond to form a hole therein and polishing or finishing the hold thus drilled.

The abovementioned method comprises repeating the steps of bringing an ultrasonic waves oscillated needle into contact with a material to be processed, supplying an abrasive between the needle and material to drill, grind or finish the latter while moving the former slightly downwardly, moving the needle thus handled upwardly for a predetermined distance, grinding the tip of the needle by rotating and moving it slightly downwardly while bringing a horizontally movable grinder into contact with the tip of needle having moved said predetermined distance, and separating the grinder from the tip of the needle by moving the former in a horizontal direction and simultaneously moving the needle downwardly for a predetermined distance to permit its tip to contact another material to be finished and giving ultrasonic waves oscillations to the needle.

According to this method, it is possible to grind the tip of the needle in rapid succession without removing it from its fixing member each time thereby obtaining satisfactory finished results with the ultrasonic waves oscillated needle in an efficient manner.

The accompanying drawings show an embodiment of apparatus of the present invention for carrying out the above mentioned method. This ultrasonic waves oscillatory finishing apparatus consists of a moving bed on which are provided a fixing plate for a material to be finished and grinding means disposed a distance apart from the former, ultrasonic waves oscillating means having a needle and its support or phone and being disposed in an up-and-down movable manner above said moving bed, movable means capable of moving said moving bed to the right and left against the needle in such a manner that when said moving bed comes to its stopping position at one side, said fixing plate is positioned right below the needle but when said moving bed comes to its stopping position at the other side, said grinding means is so positioned as to grind the needle, elevating means capable of moving up and down for the predetermined distance between a working point of the tip of the needle against the material to be finished and a grinding point of the grinder disposed a distance apart above and from said working point, and slightly descending means capable of slightly lowering said ultrasonic waves oscillating means at the time of finishing and grinding the material.

According to this apparatus, it is made easy to apply an automatic procedure to ultrasonic waves finishing of the material to be finished and grinding of the needle. Namely, as it is possible to arrange the tip of needle in a definite position always against the material, so is it possible to arrange an apparatus for supplying or recovering an abrasive in a fixed position and moreover, since a grinding point is arranged also in a definite position, it is made possible to fix any grinding angle of the needle against the grinder.

Brief summary of the invention

This invention relates to an ultrasonic waves oscillatory finishing method and more particularly, to a method and apparatus for drilling gems in particular and grinding and finishing the hole thus drilled.

For this purpose, hitherto, such a machine has been used as provided with ultrasonic waves oscillating means including a needle and a support or phone thereof disposed above a fixing plate for a material to be finished. In such a case, for example, diamond as a die material is placed on said fixing plate and the needle is caused to descend against said material for drilling a die hole therein by supplying an abrasive between the needle and material while taxing the needle with ultrasonic waves oscillations. In this case, the tip of the needle is liable to become dull in a short period due to the action of the abrasive. Therefore, it is necessary to remove it from its support or phone and to grind it to resume its best angle by means of a grinder disposed separately. According to this kind of arrangement, it takes more time to grind the needle than drill or finish the die material and moreover, it needs some skill to grind the tip of the needle to give a suitable angle.

Therefore, it is an object of the present invention to provide a method and apparatus for repeating said ultrasonic waves finishing procedure and the grinding step of the needle in rapid succession.

Another object of the invention is to provide an ultrasonic waves oscillating and finishing method for repeating the steps of bringing an ultrasonic waves oscillated needle into contact with a material to be finished, supplying an abrasive between the needle and material to drill, grind or finish the latter while moving the former slightly downwardly, moving the needle thus handled upwardly for a predetermined distance, grinding the tip of the needle by rotating and moving it slightly downwardly while bringing a horizontally movable grinder into contact with the tip of needle having moved said predetermined distance, and separating the grinder from the tip of the needle by moving the former in a horizontal direction and simultaneously moving the needle downwardly for a predetermined distance to permit its tip to contact another material to be finished and giving ultrasonic waves oscillations to the needle.

Still another object of the invention is to provide an ultrasonic waves oscillatory finishing apparatus consisting of a moving bed on which are provided a fixing plate for a material to be finished and grinding means disposed a distance apart from the former, ultrasonic waves oscillating means having a needle and its support or phone and being disposed in an up-and-down moveable manner above said moving bed, moveable means capable of moving said moving bed to the right and left against the needle in such a manner that when said moving bed comes to its stopping position at one side, said fixing plate is positioned right below the needle but when said moving bed comes to its stopping position at the other side, said grinding means is so positioned as to grind the needle, elevating means capable of moving up and down for the predetermined distance between a working point of the tip of needle against the material to be finished and a grinding point of the grinder disposed a distance apart above and from said working point, and slightly descending means capable of slightly lowering said ultrasonic waves oscillating means at the time of finishing and grinding the material. A further object of the invention is to provide an ultrasonic waves oscillatory finishing apparatus where-

in there is provided a drill-depth measuring gauge on the frame of the apparatus above said fixing plate for the die material and said gauge can be positioned right above said fixing plate when the needle is placed in position for grinding purposes. Other objects, mechanism, action and effect of the present invention will become self-explanatory with reference to the following preferred embodiment of the invention.

Brief description of the drawings

In the drawings, FIG. 1 is a front view of an embodiment of ultrasonic waves oscillatory finishing apparatus according to the present invention. FIG. 2 is a right-side view of the same. FIGS. 3I–V are illustrative views of action of the apparatus according to the present invention. FIG. 4 shows an electric circuit for grinding the needle. FIG. 5 shows an electric circuit for ultrasonic waves finishing purposes.

Detailed description

Firstly, reference is made to FIGS 1 and 2. In the drawings, the body of the present apparatus is indicated at **1**, and on its horizontal portion 1_1 is provided a moving bed **2** freely movable to the right and left in a horizontal direction. On said moving bed are provided a fixing plate **3** for a die material and needle-grinding means **4** disposed a predetermined distance α apart from said fixing plate. The upright portion 1_2 of the body **1** has a member 1_3 provided thereon, in which is provided ultrasonic waves oscillating means **7** having a needle **5** and support or phone **6** thereof. In this case, the member 1_3 is adapted to be slidable up and down against the upright portion 1_2 while said means **7** is adapted to be slidable up and down against the member 1_3. Reference **8** is a drill-depth measuring gauge which is secured to the horizontal portion 1_1 of the body **1**. Reference **9** is a needle-grinder provided on said grinding means **4**. In this case, such arrangements are made that when the grinder **9** is in position for grinding the needle **5**, the gauge **8** will be positioned right above said fixing plate **3**. The needle **5** and its support or phone **6** of said means **7** are so adapted as to move up and down for a predetermined distance by means of conventional mechanism with a motor M_2 against the main body of said means **7**.

The descending point P_1 of the tip of needle may assume its working point for the die material on one hand and the ascending point P_2 of the tip of needle may assume its grinding point for grinder **9** of needle-grinding means **4** on the other hand. The entire assembly of said means **7** is capable of slightly moving downwardly by means of a conventional mechanism with a motor M_3 against the body **1**.

The fixing member **3** is caused to tend toward said working point P_1 by means of a spring or the like and is made rotatable by means of a conventional mechanism with a motor M_5. Reference **10** is an apparatus for pouring or aspirating an abrasive agent, being opened for said working point P_1 and having a motor M_8, a pump 10_1 and an aspirating pipe 10_2.

In FIGS. 1 and 2, the character M indicates a series of motors, namely, M_1 is a motor for rotating the needle **5**, M_2 for elevating and lowering the needle **5** and its support or phone **6** for a predetermined distance, M_3 for slightly lowering the assembly of means **7** against the body **1** of apparatus, M_4 for moving the moving bed **2** in a horizontal direction, M_5 for pivoting the fixing plate **3**, M_6 for rotating the grinder **9**, M_7 for reciprocating the grinder **7** in the axial direction and M_8 for supplying an abrasive agent to the working point P_1 and recovering it therefrom. All the motors M_1 to M_8 are electrically connected to a push button device **11**.

FIGS. 4 and 5 show their connecting conditions. Each motor is connected to its driven member respectively through a mechanical element of conventional type. Said push button device **11** consists of a button A for initiating the finishing procedure for the die material, button B for actuating the grinding means, button C for energizing the motor M_3, button D for recovering the abrasive agent and button E for stopping the apparatus in any arbitrary position. Said needle-grinding means **4** consists of a support plate **13** capable of pivoting angularly around a support shaft **12** as the center thereof, a plate **14** so disposed on said support plate **13** as to be adjusted forward, backward, to the right and left toward FIG. 1, the motors M_6 and M_7 disposed thereon and the grinder **9** to be driven connectively by means of the motor M_6 and its transmission element 9_1.

The external circumferential edge of the grinder **9** is so arranged as to pass through the central line 12_1 of said support shaft **12** and hence it is made possible to adjust the angle of the tip of needle **5** by pivoting said support plate **13** around its support shaft **12**. Reference 13_1 is a fixing screw for said support plate **13**, and 13_2 a guide hole for said screw, said hole being formed in an extension 2_1 of the moving bed **2**.

The action of the present apparatus will be explained in detail with reference to FIGS. 3 to 5. In understanding what will be explained hereinafter, particular reference is made to the needle **5** standing still in contact with the diamond die *d*, namely, the electric circuits shown in FIG. 3I to FIG. 4.

When pushing the button B for actuating the needle-grinding means, a relay switch L_3 starts to work "on" so that the motor M_2 can rotate thereby causing the support **6** and the needle **5** to elevate. When the member 7_2 in support of the needle comes in contact with an upper limit switch L_3, said switch comes "off" as shown by the broken line in FIG. 4 thereby causing the motor M_2 to stop and energizing the motor M_4 for the purpose of reciprocating to the right and left. (See FIG. 3II.) Then the moving bed **2** is caused to move the distance α to the left toward the drawing until it comes into contact with a left-side limit switch L_4, which in turn comes "off" shown by the broken line in FIG. 4 thereby causing the motor M_4 to stop. At this stage, the needle **5** is understood to have reached the position to contact the grinder **9**. At the same time with the switch L_4 being switched over, the motor M_1 for rotating the needle, M_6 for grinding purposes and M_7 for reciprocating the grinder will start to rotate, thereby enabling the needle **5** to be ground. At this stage the motor M_3 for slightly moving the needle is actuated by opening and closing the switch C thereby causing the needle **5** to descend slightly. (See FIG. 3III).

After completion of the grinding procedure, push the switch A and then relays R_1 and R_2 start to work for changing the direction of rotation of the motors M_2 and M_4, then the relay switch L_6 comes "on" so that the motors M_1, M_6 and $_7$ may stop while the motor M_4 starts to rotate thereby causing the moving bed **2** to move the distance α to the right and contact the right-side limit switch L_1.

By switching over said switch L_1, the motor M_4 is caused to stop, the motor M_2 actuated for lowering purposes until the descending limit switch L_2 is contacted to stop the motor M_2 thereby causing the needle **5** to descend a predetermined distance. In this descending position, the tip of needle **5** is so positioned at the working point P_1 as to contact the diamond die *d* under pressure. (See FIG. 3V). When the descending limit switch L_2 starts to work and an ultrasonic waves oscillator is actuated by relay switch L_7, the needle is taxed with ultrasonic waves oscillations. At the same time, by pushing the button D, the abrasive agent is supplied to the working site of the diamond die *d*. In this manner, the needle **5** is actuated to work for a suitable period, for example, about 2 minutes usually by means of a timer switch T so that the die *d* can be worked thereby. In this case, the motor M_5 is driven by means of the descending limit switch L_2 as well, so that the fixing plate **3** can be pivoted. (See FIG. 3V.) After 2 minutes have passed, the ultrasonic waves oscillator U and the motor M_5 are caused to stop by means of the

timer switch T to complete one cycle of working operation. On the other hand, since the diamond die *d* thus finished is positioned right below the drill-depth gauge **8**, it is made possible to measure the drilled depth of the die by said gauge **8**.

When pushing the button E for stopping the apparatus at a suitable point, the electric circuits formed in all operating steps are cut off from their electric source so that the apparatus comes to stop just at this point of time, but when releasing said button E, the electric circuits will be formed again. Accordingly, if it is desired to repeat the same operating steps, the button E has only to be actuated in combination with working the other buttons.

According to the present invention, it is made easy to adopt an automatic procedure for application to the ultrasonic waves finishing and needle grinding. Moreover, as it is possible to arrange the tip of needle in a definite position P_1 against the die material, so is it also possible to arrange the apparatus for supplying and recovering an abrasive agent in a fixed position. Furthermore, since the grinding point is arranged in a definite point P_2, it is also made possible to select any grinding angle of the needle against the grinder.

Thus, whlie the die material is being processed by the needle, the grinding means remains in a retracted position. On the other hand, while the needle is being ground by grinding means, the die material is arranged in such a position as its drill-depth can be measured by the drill-depth measuring gauge. Consequently, the present invention offers such an effect that all the steps of finishing, needle-grinding and drill-depth measuring can be carried out in a short period of time very efficiently.

What is claimed is:

1. An ultrasonic waves oscillatory processing apparatus consisting of a moving bed on which are provided a fixing plate for a material to be finished and grinding means disposed a distance apart from the former, ultrasonic waves oscillating means having a needle and its support or phone and being disposed in an up-and-down movable manner above said moving bed, movable means capable of moving said moving bed to the right and left against the needle in such a manner that when said moving bed comes to its stopping position at one side, said fixing plate is positioned right below the needle but when said moving bed comes to its stopping position at the other side, said grinding means is so positioned as to grind the needle, elevating means capable of moving up and down for the predetermined distance between a working point of the tip of needle against the material to be finished and a grinding point of the grinder disposed a distance apart above and from said working point, and slightly descending means capable of slightly lowering said ultrasonic waves oscillating means at the time of finishing and grinding the material.

2. An ultrasonic waves oscillatory processing apparatus, as set forth in claim **1**, comprising the provision of a drill-depth gauge secured to the body of apparatus above said fixing plate for a material to be finished, in such a manner that said drill-depth gauge can be positioned right above said fixing plate when the grinder of said grinding means is in position to grind the needle.

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JAMES L. JONES, JR., Primary Examiner

U.S. Cl. X.R.

51—59