Feb. 8, 1938. K. W. CONNOR 2,108,029

METHOD OF HONING

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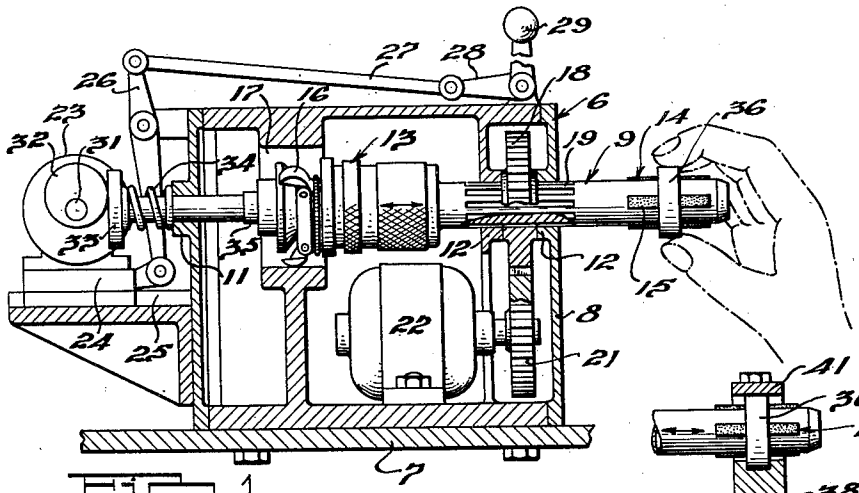


FIG. 1

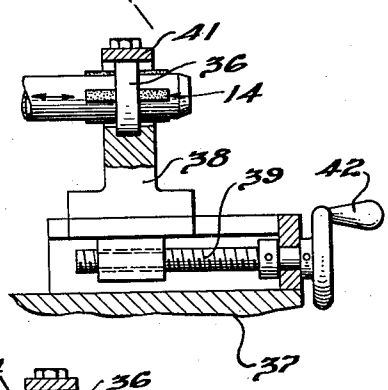
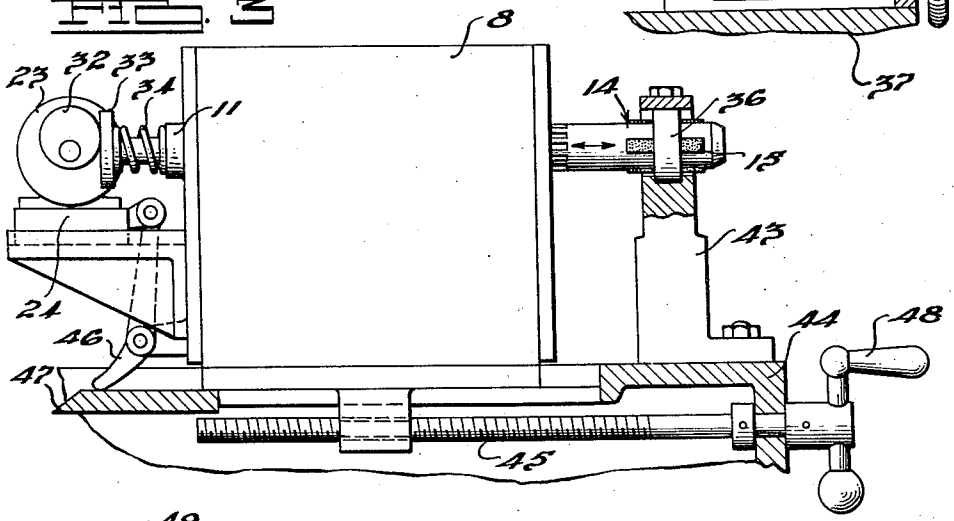


FIG. 2

FIG. 3



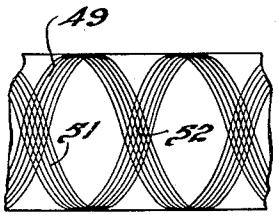


FIG. 4

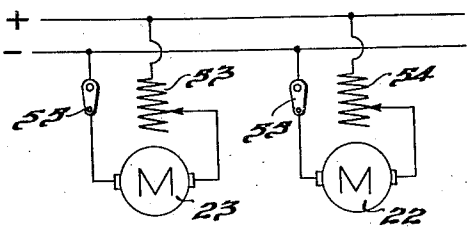


FIG. 5

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METHOD OF HONING

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7 Claims. (Cl. 51—278)

My invention relates to methods and apparatus for producing a honing operation, and particularly to a method and device for accurately and rapidly honing the surface of an element to an exceedingly fine finish.

Heretofore, in honing cylindrical and like articles, the honing tools were reciprocated during their rotation without any particular relationship existing between the two movements. When the honing tool was equipped with abrading elements which were shorter than the length of the surface to be machined, a slow reciprocation was employed to spread the abrading operation over the entire length of the cylindrical surface. The reciprocation in this instance was in the nature of a feed movement between the tool and work. On short cylindrical objects, reciprocation was employed to spread the wear over the entire length of the abrading stones. The speed of reciprocation in either instance was not selected relative to the speed of rotation for the purpose of controlling the abrasive action.

In practicing the present invention, the length of the object to be ground does not enter into the choice of the degree of reciprocation or into the relation of the speed of reciprocation to that of rotation. Instead, the relation between tool reciprocation and rotation is determined in accordance with the desired abrasive action. Preferably, the relation is such that the helical lines of abrasion effected by the reciprocation of the tool in one direction will cross the lines of abrasion produced when the tool is reciprocated in the other direction at an angle between 20 and 70 degrees. A more desirable abrading action is obtained when the cycle of reciprocation and the speed are retained in this relation. For certain types of work and materials a 45 degree angle of intersection is desirable. For others, a lesser or greater angle is preferred. In each instance, a highly polished surface, known as a "mirror finish", is produced.

In addition to the related cycle of reciprocation and the rotation of the abrading head, a feed may be introduced between the work piece and the stones to spread the abrading operation over the entire surface of a work piece when its length is greater than that of the stones and, when honing a short work piece, to spread the wear evenly from one end of the abrading stones to the other.

Accordingly, the main objects of my invention are: to provide a method of producing a "mirror finish" on honed articles by maintaining a related speed of reciprocation and rotation between a work piece and an abrading head during the time a feed movement is provided therebetween; to provide a honing device in which the cycle of reciprocation and the speed of rotation of the tool are variable to regulate the angle of intersection of the resulting paths of abrasion; to axially oscillate a honing head during its rotation and impart a feed movement between the head and a work piece; to provide means for varying the related speeds of oscillation and rotation; and, in general, to provide a device for accurately and rapidly producing a "mirror finish" upon surfaces of work pieces, which is simple in construction, positive in operation and economical of manufacture.

Other objects and features of my invention are 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 drawing, 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 broken sectional view of a device, similar to that illustrated in Fig. 1, showing 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 diagrammatic view of lines of abrasion which occur during a cycle of reciprocation of the tool; and

Fig. 5 is a diagrammatic view of a control circuit which may be employed with the devices illustrated in Figs. 1 to 3.

Referring to Fig. 1, the honing device 6 embodies a base 7, having a housing 8 in which a honing tool 9 is supported for reciprocation in bearings 11 and 12. The honing tool 9 may be of any well known construction, but is herein illustrated as being similar to that described and claimed in the F. M. Kern Patent No. 1,990,331, issued February 5, 1935, and assigned to the assignee of the present invention. The honing tool comprises an adjusting head 13 and an abrading head 14. The abrading head embodies a plurality of honing stones 15 which are radially movable relative to the tool axis. The adjusting head 13 comprises means for regulating the degree of extension of the stones 15 as well as control means for retracting and expanding the abrading stones relative to extended position. This is accomplished by the movement of a plurality of cam fingers 16 forming part of the head 13. To operate the fingers 16 the housing 8 is provided with a cylindrical surface 17 which engages the fingers 16 and retains them in actuated position

with the stones 15 extended so long as the fingers 16 are disposed within the surface 17.

For driving the honing tool 9 in rotation, the bearing 12 is split and a gear 18 is disposed between the split portions and over the end of the spindle of the tool 9 in engagement with a plurality of projecting splines 19 to provide a driving relation with the spindle, and to also permit the spindle to reciprocate relative to the gear. A gear 21 is disposed in meshed relation with the gear 18 and is driven by suitable means, herein illustrated as by a motor 22.

A second motor 23 is mounted on a carriage 24 which is movable on a table 25 secured to the housing 8. The carriage 24 is shiftable through the operation of a lever 26 interconnected by a link 27 to a bell crank 28 provided with an operating handle 29. The shaft 31 of the motor drives a cam 32 which engages a head 33 mounted on the end of the spindle of the tool 9. A spring 34 is disposed between the head 33 and the bearing 11 for urging the tool toward the cam. When the carriage 24 is shifted to the left, as viewed in the figure, the cam 32 moves therewith, permitting the spring 34 to move the tool 9 to the left. The cam fingers 16 move out of engagement with the cylindrical surface 17 to permit the abrading stones 15 to be retracted. Such movement is limited through the engagement of the shoulder 35 with the inner surface of the bearing 11, so that further movement of the cam 32 disengages it from the head 33. In normal operation, such latter disengagement is not necessary, as, preferably, the reciprocation of the tool is continued during its rotation and it is only necessary to retract the stones 15 after a machining operation, to disengage the work piece from the stones so that it may be removed without marring the machined surface. A new work piece may then be moved into position of engagement with the stones before the stones are expanded.

In Fig. 1, I have illustrated the work piece as being a small annular element 36 which may be supported in the hand and moved over the abrading head 14 during the time the head is rapidly reciprocated and rotated in predetermined relation.

In Fig. 2, I have illustrated a table 37 having mounted thereon a work supporting head 38 which is movable toward and from the housing 8 by a lead screw 39. Suitable clamping means 41 is provided for retaining the work piece 36 fixed to the work supporting head 38. The advancement of the work piece over the abrading head 14 is effected through the operation of a hand wheel 42 which drives the lead screw 39.

A device similar to that illustrated in Fig. 1, is shown in Fig. 3. In this construction, however, the work holder 43 is retained fixed to a supporting bed 44 and the honing element, along with its driving mechanism retained in housing 7, is movable relative to the work by a lead screw 45. The carriage 24 is operated by a lever 46 which is moved forward into desired position through the actuation of the end of the lever over the cam surface 47. In this construction the work piece 36 is mounted in the holder 43, and through the operation of a hand wheel 48 to drive the lead screw 45, the housing 8 is moved toward the work piece. After the tool 14 passes within the work piece, the lever 46 is actuated relative to the cam surface 47 to advance the carriage 24 to cause the cam fingers 16 to move into engagement with the cylindrical surface 17 and thereby expand the stones 15. The operation of the motors 22 and 23 produces the rapid reciprocation and rotation of the honing head 14 in the manner as hereinabove described.

Referring to Fig. 4, I have illustrated, by a plurality of lines 49, the paths of abrasion effected by the movement of the head 14 in one direction during its reciprocation, and, by the lines 51, the path of abrasion which occurs when the abrading head 14 is moved in the opposite direction, completing a cycle of reciprocation. The intersection of the lines 49 and 51 at the point 52 forms the angle of cross hatching produced by the abrading operation. This angle can be varied by changing the rate of reciprocation relative to the speed of rotation and it has been found that such variation is desirable for different types of work pieces and for different materials. It has been found that an angle of from 40 to 60 degrees is most desirable, but that such angle may vary as much as from 20 to 70 degrees. When such relation is provided between the speed of reciprocation and rotation, not only is very accurate machining provided, but an extremely highly polished surface is obtained. A highly polished surface, known as "mirror finish", is obtained in this manner.

It will be noted that the hand feed of Fig. 1 and the mechanical feeds provided by hand wheels 42 and 48 of Figs. 2 and 3 correspond generally to the axial feed expedients of the prior honing methods. The reciprocation produced, in the illustrated embodiments, by motor 23, is thus an additional work movement, and primarily an abrading movement, as distinguished from a feed movement. The rate of abrading reciprocation preferably bears a materially higher ratio to the rate of rotation than do the prior feed movements of which I am aware, in order to retain the abrading angle within the limits above mentioned. Reciprocatory rates of the order of 1000 per minute have been found satisfactory. Also, the length of each abrading reciprocatory stroke is, in most instances, materially less than the length of the usual feed stroke.

While mechanical means may be provided for varying the ratio between the rate of reciprocation and the speed of rotation, I have illustrated in Fig. 5 a wiring diagram wherein resistances 53 and 54 are inserted into the circuits for the motors 22 and 23 respectively, so that the speed of the motors may be varied to thereby vary the reciprocation and rotation one by the other. That is to say, either the reciprocation or the rotation may be increased or decreased to provide the proper speed relation therebetween. Switches 55 are illustrated for interrupting the flow of current to the motors. The wiring diagram thus illustrated is employed to show a method of varying the speeds of rotation and reciprocation to obtain the proper angle of intersection of the paths of abrasion due to the reciprocation, but I do not intend to be limited to this particular method. As pointed out hereinabove, mechanical or other means, well known in the art, may be employed to vary such relationship. In a similar manner the structure herein disclosed is that employing a commercial type of honing tool shown for purposes of illustration. It is to be understood that other designs of apparatus could be employed for producing the same movements.

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. The method of honing a work piece which includes the steps of, advancing a honing tool and work piece relative to each other, moving a honing element of said tool into engagement with the surface work piece to be abraided, rapidly reciprocating the honing element during the time it is rotated, and relatively advancing the honing tool and the work piece relative to each other along the tool axis during said rotation and reciprocation.

2. A method of honing a work piece which includes the steps of, advancing a honing tool and work piece relative to each other, moving a honing element of said tool into engagement with the surface of the work piece to be abraded, rapidly reciprocating the honing element during the time it is rotated, relatively advancing the honing element and the work piece during said rotation and reciprocation, and feeding said honing element toward said work piece during said rotation and reciprocation.

3. A method of honing a work piece which includes the steps of, advancing a honing tool and work piece relative to each other, moving a honing element of said tool into engagement with the surface of the work piece to be abraded, rapidly reciprocating the honing element during the time it is rotated, relatively advancing the honing element and the work piece during said rotation and reciprocation, feeding said honing element toward said work piece during said rotation and reciprocation, and stopping said feed movement at a predetermined set point.

4. A method of honing a work piece which includes the steps of, advancing a honing tool and work piece relative to each other, moving a honing element of said tool into engagement with the surface of the work piece to be abraded, rapidly reciprocating the honing element during the time it is rotated, relatively advancing the honing element and the work piece during said rotation and reciprocation, feeding said honing element toward said work piece during said rotation and reciprocation, stopping said feed movement at a predetermined set point, and collapsing the honing element to have it withdraw from the surface of the work piece before the work piece is removed.

5. The method of finishing a work piece which includes the steps of, advancing a finishing tool and work piece relative to each other, moving a plurality of abrading elements of said tool into engagement with the surface of the work piece to be abraded, rapidly reciprocating the abrading elements during the time the tool is rotated, and further advancing the abrading tool and the work piece relative to each other along the tool axis during said rotation and reciprocation.

6. The method of finishing a work piece which includes the steps of, advancing a honing tool and work piece relative to each other, adjusting a honing element of said tool into engagement with the surface of the work piece to be abraded, rapidly reciprocating the honing element during the time it is rotated, further advancing the honing tool and work piece relative to each other along the tool axis during said rotation and reciprocation, and withdrawing said honing element from contact with the surface of said work piece during the time the tool is reciprocating and rotating.

7. The method of honing a work piece which includes the steps of, advancing a honing tool and work piece relative to each other, adjusting a honing element of said tool into engagement with the surface of the work piece to be abraded, rapidly reciprocating the honing element during the time it is rotated, relatively advancing the honing element and the work piece during said rotation and reciprocation, feeding said honing element toward said work piece during said rotation and reciprocation, and withdrawing the honing element from contact with the surface of the work piece after the finishing operation while said tool is rotating and reciprocating.

KIRKE W. CONNOR.