April 15, 1941. D. A. WALLACE 2,238,761

SURFACE FINISHING MACHINE FOR CYLINDRICAL SURFACES

Filed May 22, 1939 2 Sheets-Sheet 1

Fig. 1.

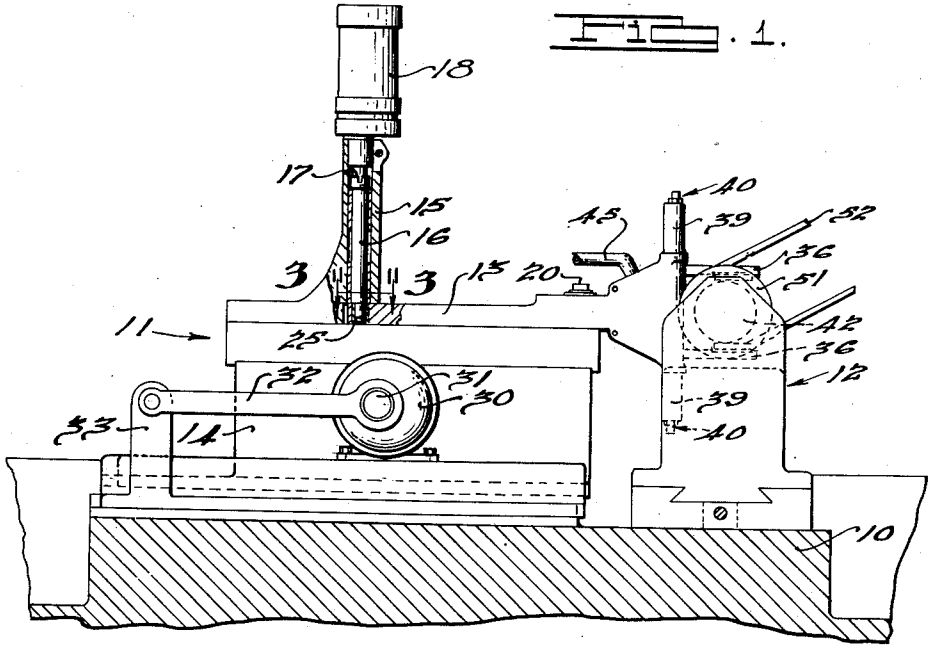
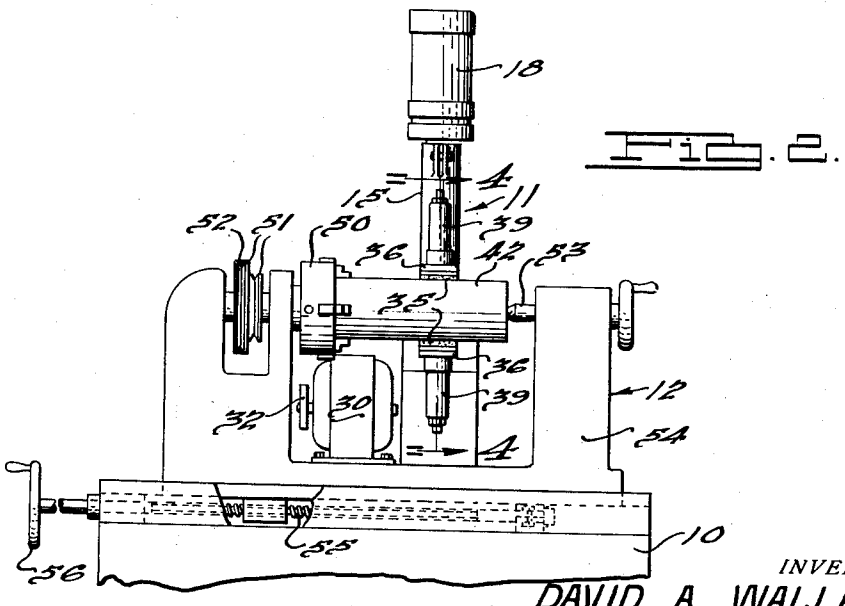


Fig. 2.



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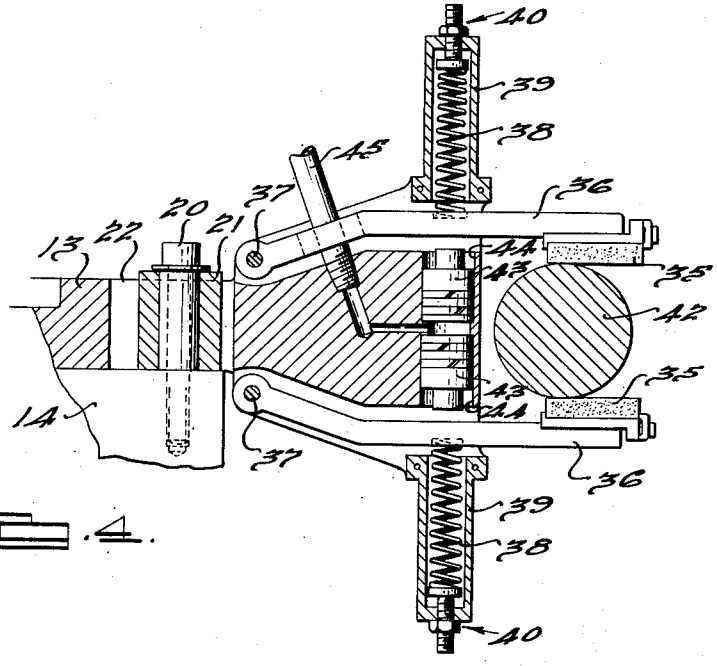


FIG. 4.

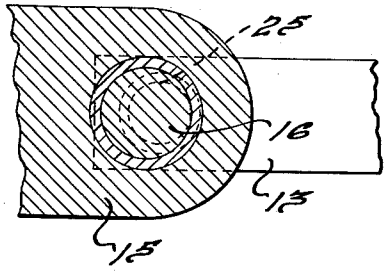


FIG. 3.

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UNITED STATES PATENT OFFICE

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SURFACE FINISHING MACHINE FOR CYLINDRICAL SURFACES

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Application May 22, 1939, Serial No. 275,020

9 Claims. (Cl. 51—67)

The present invention relates to the art of finishing surfaces, having particular regard to the finishing of the surfaces of a work piece having at least a portion thereof substantially cylindrical in shape. The invention is of particular utility in finishing the exteriors of members such as plungers intended to fit a cylindrical bore within very close tolerances, or in finishing the stems of tappet valves, or the bearing surfaces of cranks or other articles designed to rotate in bearings. The object of the present invention is to provide means for rapidly finishing the surfaces of such members to a degree heretofore thought impossible and at speeds heretofore impossible to achieve.

Another object of the present invention is to provide means for accomplishing the finishing of cylindrical surfaces, which means are simple in construction, inexpensive, and easily operated by the average machine operator.

The function of the present invention is to impart to a finishing tool, such as a natural or artificial stone or abrading member, a plurality of motions including compound reciprocations, such compound reciprocations being achieved simultaneously with rotation of the work surface and relative longitudinal movement of the work surface and the tool.

Another object of the present invention is to provide means whereby the amplitude and frequency of the reciprocations compounded by the apparatus may be readily varied, together with means whereby the relative movement of the work surface and the tool may be varied, and means whereby the speed of rotation of the work surface may be varied.

The objects and advantages of the present invention will be more readily understood following a study of the following specification and the accompanying drawings wherein like numerals refer to like parts throughout.

In the drawings, Fig. 1 is an end elevation of a machine embodying the present invention;

Fig. 2 is a front elevation of the machine;

Fig. 3 is a cross section on an enlarged scale of a part of the machine taken along line 3—3 of Fig. 1; and

Fig. 4 is a vertical section on an enlarged scale of a portion of the tool holding device taken along line 4—4 of Fig. 2.

In the drawings the numeral 10 refers to a base upon which the mechanism is mounted, the mechanism comprising tool operating structure 11 and work feeding structure 12. The tool operating structure comprises a tool holder 13, slidably mounted upon the flat surface of a sliding member 14 which is guided for longitudinal movement on the base 10 in the general direction of the longitudinal axis of the tool holder 13. The tool holder 13 is provided with a vertical extension 15 in which is mounted a shaft 16 detachably connected at 17 to a motor 18 carried by the extension 15. The tool holder 13 is pivotally guided upon the flat upper surface of the sliding member 14 by means of a pivot 20 having an antifriction collar 21 surrounding the pivot and engaging the edges of a slot 22 in the holder. The rear end of the tool holder is guided for lateral and longitudinal movement between the lower surface of the extension 15 and the flat upper surface of the sliding member 14 and is provided with a bearing journaling an eccentric extension 25 of the shaft 16. Rotation of shaft 16 by the motor 18 imparts longitudinal reciprocation of a certain amplitude and frequency to the sliding member 13, at the same time causing the tool holder 13 to rock about the shaft 20.

Simultaneously with the reciprocating movement previously described, the tool holder is caused to move longitudinally in substantially the same direction by mechanism producing reciprocal movements of a different amplitude and frequency, such mechanism preferably comprising a motor 30 mounted upon the sliding member 14 and driving crank 31 which, through the intermediary of a connecting rod 32 having its opposite end pivotally connected to a fixed abutment 33 on the base 10, causes the sliding member 14 to reciprocate.

The tool holder 13 supports a plurality of abrading members 35 in position to engage the cylindrical work surface. Preferably there are a pair of abrading members 35 mounted in opposed relation so as to engage substantially diametrically opposite portions of the cylindrical surface in substantially the same transverse plane. Each abrading member is detachably secured to an arm 36 pivoted to the tool holder at 37 and urged into working position by a compression spring 38 mounted in an extension 39 of the tool holder. The compression of each spring is preferably made variable by adjusting means 40, it being apparent that the force with which each abrading element is urged against the work surface may be different from, or substantially identical with, that of the other. In order to permit insertion and removal of the work piece 42 the abrading elements are preferably simultaneously separated as by means of the pistons 43 mounted in a vertical bore 44 in the extreme end of the

tool holder, the pistons being operated by the admission and release of fluid pressure through the connecting hose **45**.

Each abrading element is moved by the eccentric means **25** through a circular motion, the eccentric means obviously imparting such motion to the other end of the pivoted tool holder. The eccentric **25** therefore imparts a component of reciprocal motion to the tools in the direction of reciprocal movement of the sliding member **14**. Simultaneously the sliding member **14** is reciprocated by the motor **30**, thereby producing a compound reciprocal movement of the tool simultaneously with a component of reciprocal movement of the tool longitudinally of the work surface.

The work feeding structure **12** preferably comprises a structure including a chuck **50** connected to variable speed pulleys **51** driven by belt **52** from a suitable source of power (not shown), and a center point **53** engaging the opposite end of the work piece. By this or equivalent mechanism, the cylindrical work surface may be rotated about its longitudinal axis. In order to present successively different increments of work surface to the operating range of the abrading members, the chuck **50** and center point **53** are preferably mounted on an arbor **54** slidably guided in the support **10** and adapted to be moved longitudinally by a feeding device such as the screw **55** and operating wheel **56**.

It is to be appreciated that the abrading members and the work surface move relative to each other due to the lateral component of motion imparted thereto by the eccentric **25** even though the hand wheel **56** may not be rotated at the particular instant, and that rotation of the hand wheel **56** causes an additional relative longitudinal movement of the work piece and the abrading members.

It is to be realized that each section of the cylindrical surface is caused to be acted upon by the upper element **35** and then the lower element **35** in rapid alternation at a frequency determined by the speed of the belt **52** and the size of the pulley **51**. Each minute portion of the surface is therefore subjected to a tremendous number of abrading movements, but in all likelihood, no single increment of work surface is ever twice transversed in succession by the same increment of tool traveling in the same direction at the same speed. This is particularly obvious when it is realized that even though the entire tool holder **13** may be moving at the same speed, the effect of having opposing tools is that one of them is practically always moving in a direction such as to be moving with the work surface and the other is practically always moving so as to be moving in the opposite direction, and that the relative transition of each tool reverses with each half revolution of the shaft **16**.

It is to be noted that the abrading elements **35** are moved bodily in a gyratory manner, so as to present each and every portion of the working surface of the abrading element to the surface of the member to be finished in order that the tool will wear evenly. Also, the radius of the circular path through which each increment of surface of the tool is moved increases directly in proportion to the distance of the increment from the pivot member **20**, so that the work surface is engaged by the same portion of the tool moving in continuously smaller or larger circles. When the work surface is fed longitudinally by the screw **55**, the effect is as if an abrading element were moved relative to a plane surface in a series of helical, overlapping zig-zag paths.

Having described the present invention, it should be apparent that the theory of the same may be carried out by means of apparatus differing in details and structural arrangement. All such modifications as come within the scope of the following claims are to be considered a part of my invention.

I claim:

1. A surface finishing machine including means for holding a work piece having a cylindrical surface, means for rotating said work piece about the longitudinal axis of said cylindrical surface, a surface finishing tool holder associated with said work holding and rotating means, a surface finishing tool carried by said holder in position to engage a portion of said cylindrical surface, a second surface finishing tool carried by said holder in position to engage another portion of said cylindrical surface, said tools engaging said cylindrical surface in substantially the same plane normal to the longitudinal axis thereof, and means for imparting compound reciprocal motion to said tool holder, consisting of relatively short, rapid movements and simultaneous relatively long, slow movements, during the rotation of said work piece.

2. A surface finishing machine including means for holding a work piece having a cylindrical surface, means for rotating said work piece about the longitudinal axis of said cylindrical surface, a surface finishing tool holder associated with said work holding and rotating means, a surface finishing tool carried by said holder in position to engage a portion of said cylindrical surface, a second surface finishing tool carried by said holder in position to engage another portion of said cylindrical surface, said tools engaging said cylindrical surface in substantially the same plane normal to the longitudinal axis thereof, means for imparting compound reciprocal motion transversely with respect to said axis to said tool holder, consisting of gyratory movement having a component of movement of a certain amplitude and frequency in a direction normal to the longitudinal axis of said cylindrical surface and simultaneous lineal movement having a different amplitude and frequency in the same direction as said component of movement, during the rotation of said work piece, and means for producing relative movement of said work piece and said tool holder substantially in the direction of the longitudinal axis of said work piece simultaneously with the previously described movements.

3. A surface finishing machine including means for holding a work piece having a cylindrical surface, means for rotating said work piece about the longitudinal axis of said cylindrical surface, a surface finishing tool holder associated with said work holding and rotating means, a surface finishing tool carried by said holder in position to engage a portion of said cylindrical surface, a second surface finishing tool carried by said holder in position to engage another portion of said cylindrical surface, said tools engaging said cylindrical surface in substantially the same plane normal to the longitudinal axis thereof, means for imparting compound reciprocal motion transversely with respect to said axis to said tool holder, consisting of gyratory movement having a component of movement of a certain amplitude and frequency in a direction normal to the longitudinal axis of

said cylindrical surface and simultaneous lineal movement having a different amplitude and frequency in the same direction as said component of movement, during the rotation of said work piece, and means to move said work piece longitudinally simultaneously with the rotation thereof.

4. A surface finishing machine including means for holding a work piece having a cylindrical surface, means for rotating said work piece about the longitudinal axis of said cylindrical surface, a surface finishing tool holder associated with said work holding and rotating means, a pair of surface finishing tools carried by said tool holder in position to engage substantially diametrically opposed portions of said cylindrical surface, resilient means for urging said tools into engagement with said cylindrical surface, and means for imparting reciprocal, transverse motion to said tool holder during rotation of said work piece, said means for imparting reciprocal motion to said tool holder comprising mechanism for producing reciprocal motion of one amplitude and frequency, and another mechanism for compounding said first reciprocal motion with another reciprocal motion of a different frequency and amplitude.

5. A surface finishing machine including means for holding a work piece having a cylindrical surface, means for rotating said work piece about the longitudinal axis of said cylindrical surface, a surface finishing tool holder associated with said work holding and rotating means, a pair of surface finishing tools carried by said tool holder in position to engage substantially diametrically opposed portions of said cylindrical surface, resilient means for urging said tools into engagement with said cylindrical surface, and means for imparting reciprocal, transverse motion to said tool holder during rotation of said work piece, said means for imparting reciprocal motion to said tool holder comprising a sliding member carrying said tool holder, a motor carried by said sliding member, eccentric means connecting said motor and said tool holder for producing reciprocal motion of one amplitude and frequency, and means for imparting a reciprocal motion of another implitude and frequency to said sliding member.

6. A surface finishing machine including means for holding a work piece having a cylindrical surface, means for rotating said work piece about the longitudinal axis of said cylindrical surface, a surface finishing tool holder associated with said work holding and rotating means, a pair of surface finishing tools carried by said tool holder in position to engage substantially diametrically opposed portions of said cylindrical surface, resilient means for urging said tools into engagement with said cylindrical surface, and means for imparting reciprocal, transverse motion to said tool holder during rotation of said work piece, said means for imparting reciprocal motion to said tool holder comprising a sliding member carrying said tool holder, a motor carried by said sliding member, eccentric means connecting said motor and said tool holder for producing reciprocal motion of one amplitude and frequency, and means for imparting a reciprocal motion of another amplitude and frequency to said sliding member, said last means comprising a second motor mounted on said sliding member, a relatively fixed abutment, and a second eccentric means connecting said second motor and said abutment.

7. A surface finishing machine including means for holding a work piece having a cylindrical surface, means for rotating said work piece about the longitudinal axis of said cylindrical surface, a surface finishing tool holder associated with said work holding and rotating means, a flat, surface finishing tool carried by said holder in position to engage a portion of said cylindrical surface, a second flat, surface finishing tool carried on said holder in position to engage another portion of said cylindrical surface, said tools engaging said cylindrical surface simultaneously and continuously during operation of the machine in substantially the same plane normal to the longitudinal axis of said cylindrical surface, and means for imparting compound reciprocal movement to said tool holder consisting of relatively short, rapid components of lineal movement and simultaneous relatively long, slow components of lineal movement during the rotation of said work piece by said rotating means.

8. A surface finishing machine including means for holding a work piece having a cylindrical surface, means for rotating said work piece about the longitudinal axis of said cylindrical surface, a surface finishing tool holder associated with said work holding and rotating means, a flat, surface finishing tool carried by said holder in position to engage a portion of said cylindrical surface, a second flat, surface finishing tool carried on said holder in position to engage another portion of said cylindrical surface, said tools engaging said cylindrical surface simultaneously and continuously during operation of the machine in substantially the same plane normal to the longitudinal axis of said cylindrical surface, and means for imparting compound reciprocal movement to said tool holder consisting of components of lineal movement of one amplitude and frequency and simultaneous components of lineal movement of another amplitude and frequency in the same direction during the rotation of said work piece by said rotating means.

9. A surface finishing machine including means for holding a work piece having a cylindrical surface, means for rotating said work piece about the longitudinal axis of said cylindrical surface, a surface finishing tool holder associated with said work holding and rotating means, a flat, surface finishing tool carried by said holder in position to engage a portion of said cylindrical surface, a second flat, surface finishing tool carried on said holder in position to engage another portion of said cylindrical surface, resilient means carried by said tool holder and urging said tools toward each other, said tools engaging said cylindrical surface simultaneously and continuously during operation of the machine in substantially the same plane normal to the longitudinal axis of said cylindrical surface, and means for imparting compound reciprocal movement to said tool holder consisting of components of lineal movement of one amplitude and frequency and simultaneous components of lineal movement of another amplitude and frequency in the same direction during the rotation of said work piece by said rotating means.

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