April 16, 1940. A. H. DALL ET AL 2,197,538

METAL FINISHING MACHINE

Filed July 31, 1939 7 Sheets-Sheet 1

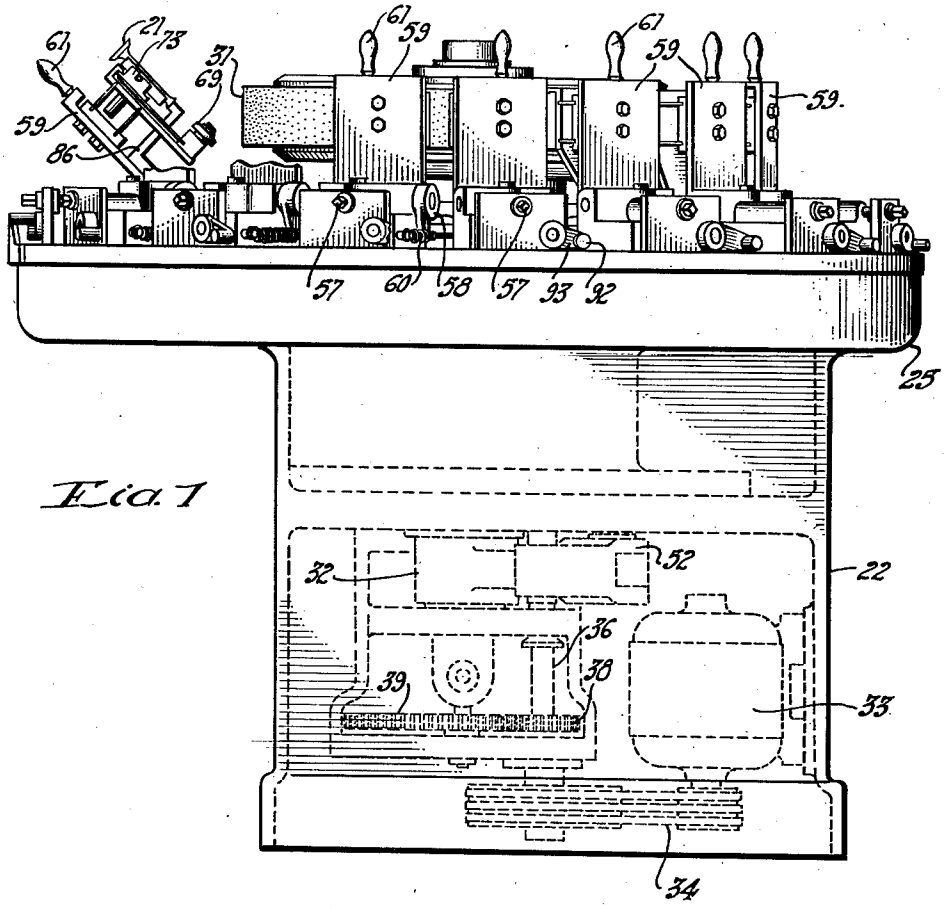


Fig. 1

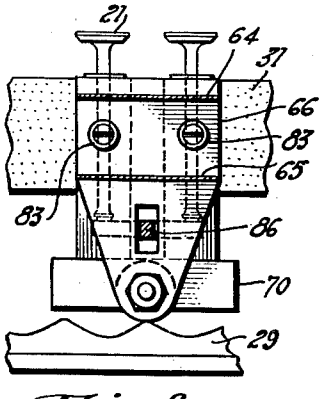


Fig. 8

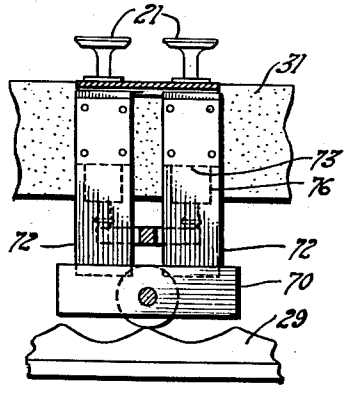


Fig. 9

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Filed July 31, 1939 7 Sheets-Sheet 2

Fig. 2

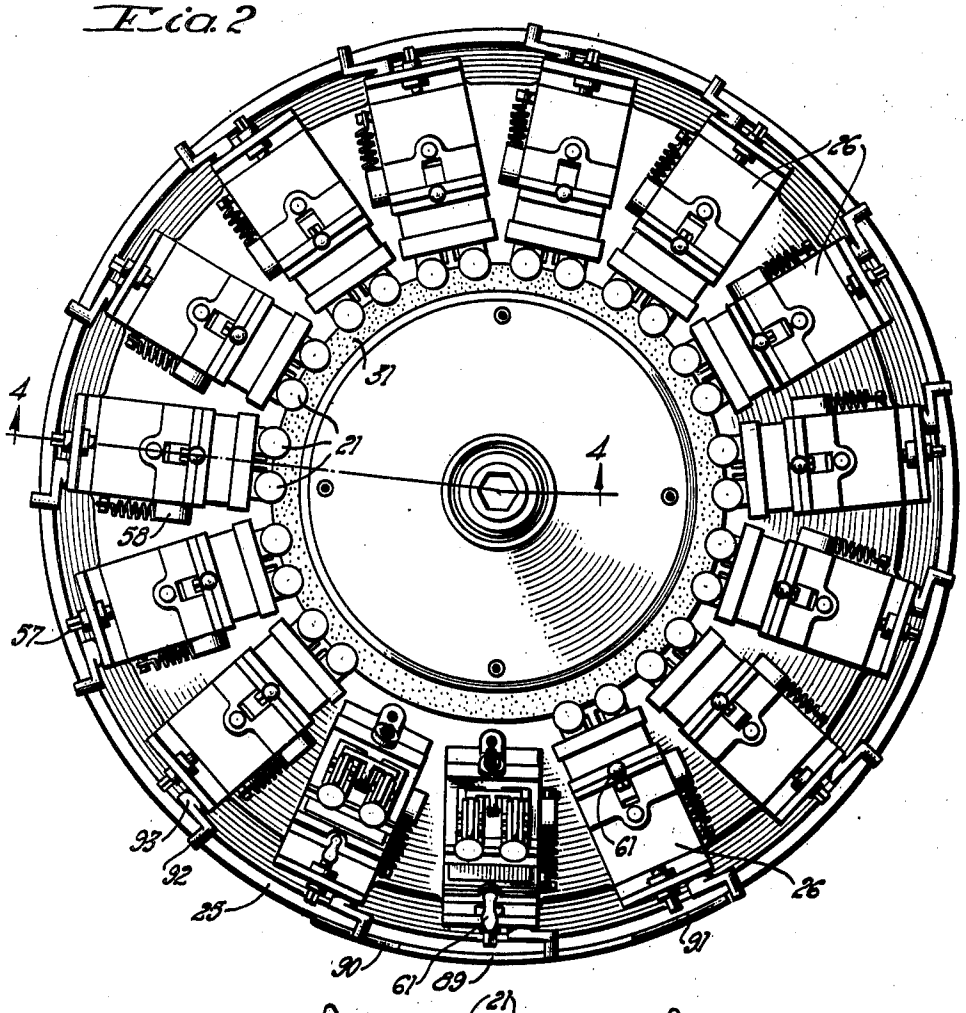
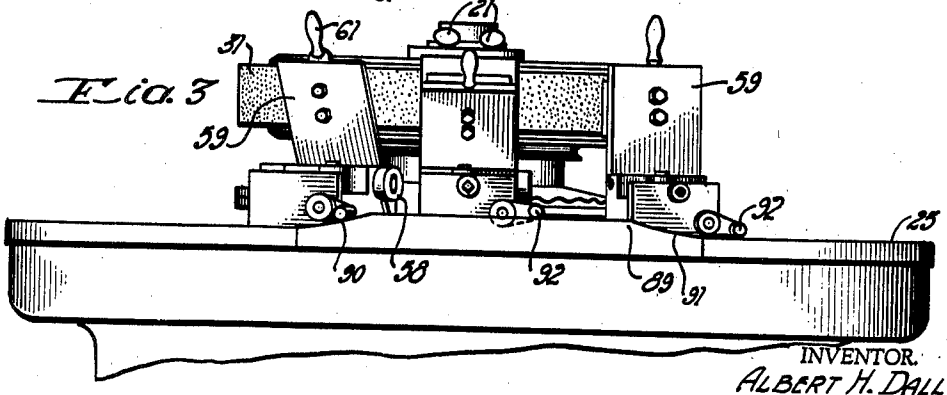


Fig. 3



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Filed July 31, 1939 7 Sheets-Sheet 3

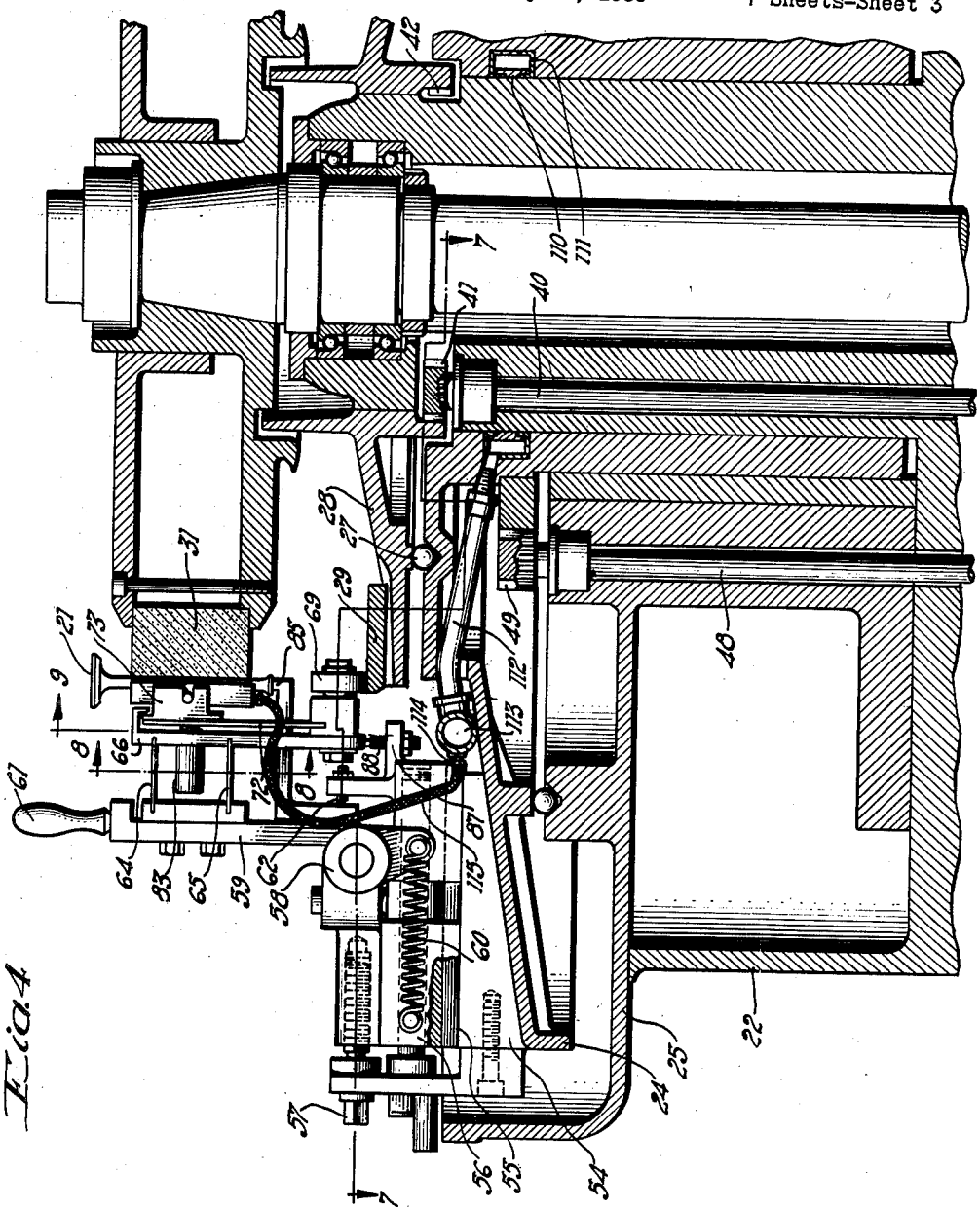


Fig. 4

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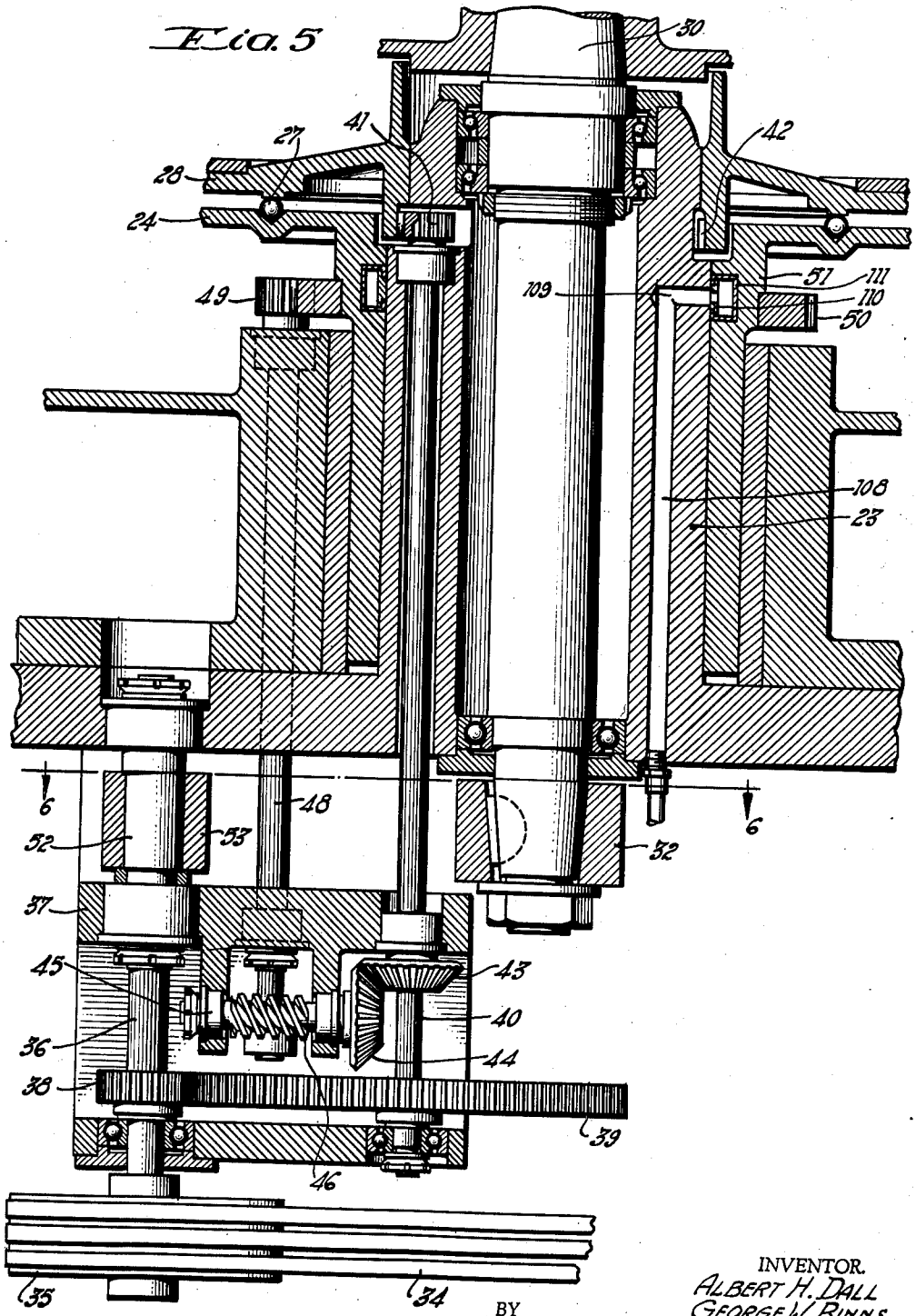
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METAL FINISHING MACHINE

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Fig. 5



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METAL FINISHING MACHINE

Filed July 31, 1939 7 Sheets-Sheet 5

Fig. 6

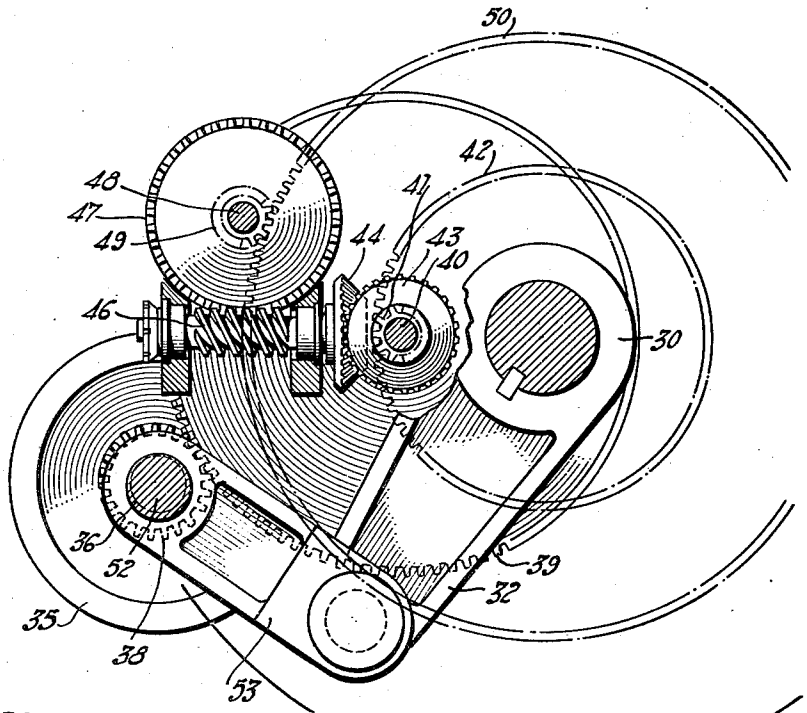


Fig. 10

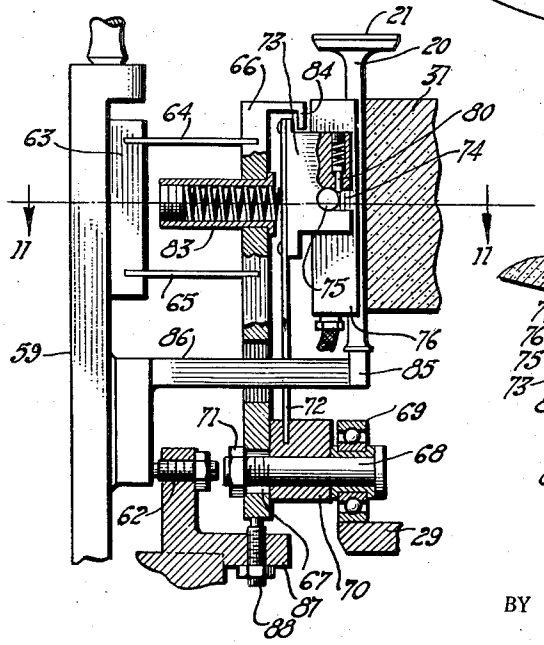
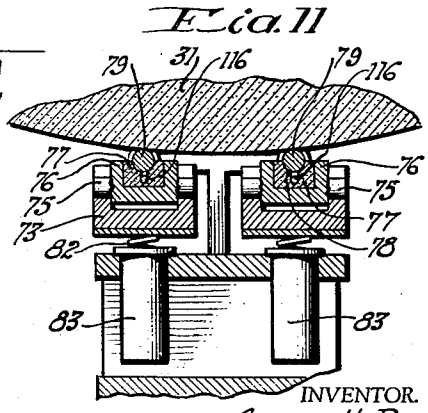


Fig. 11



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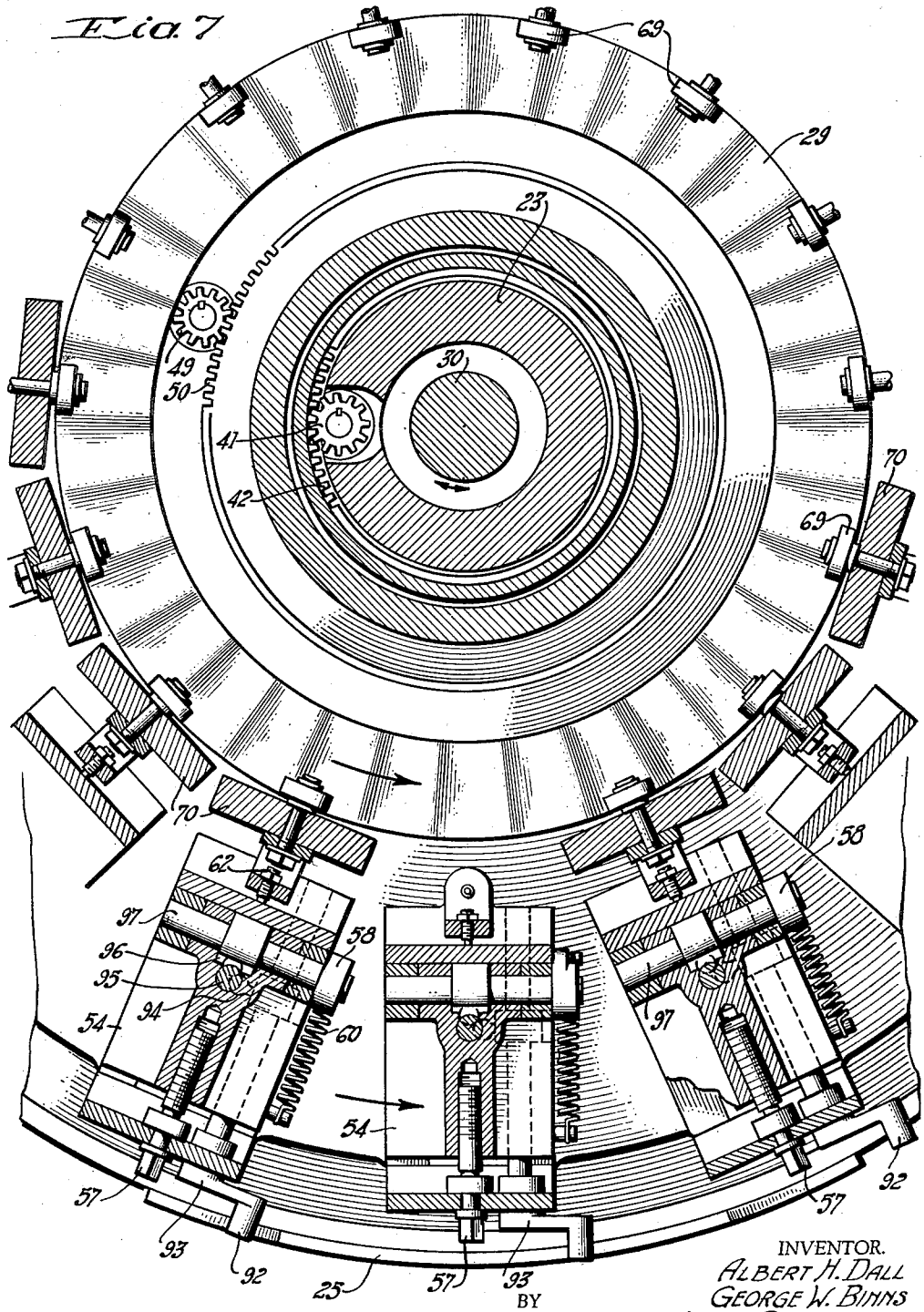
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METAL FINISHING MACHINE

Filed July 31, 1939 7 Sheets-Sheet 6

Fig. 7



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METAL FINISHING MACHINE

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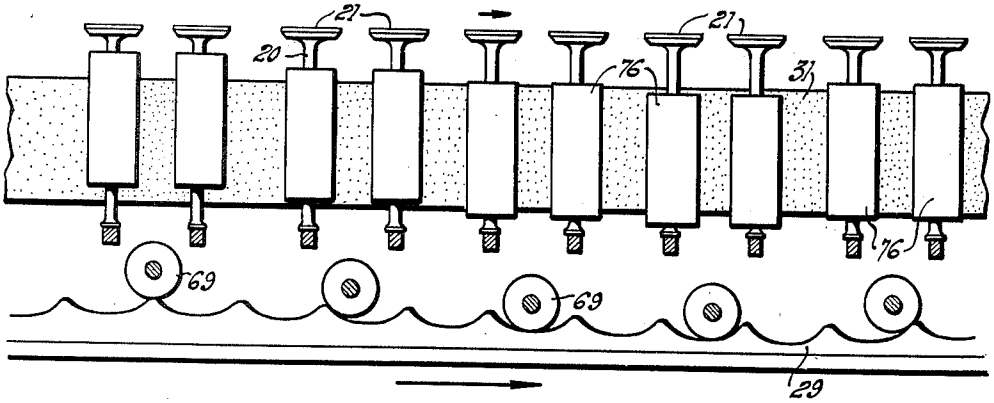


Fig. 12

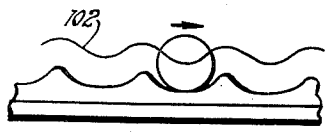


Fig. 13

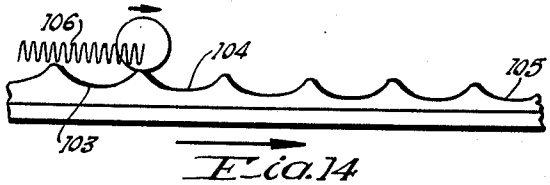


Fig. 14

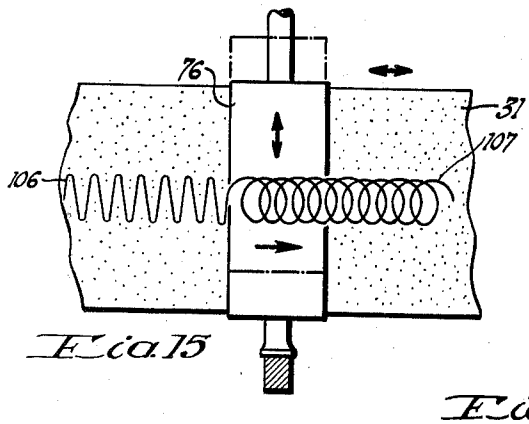


Fig. 15

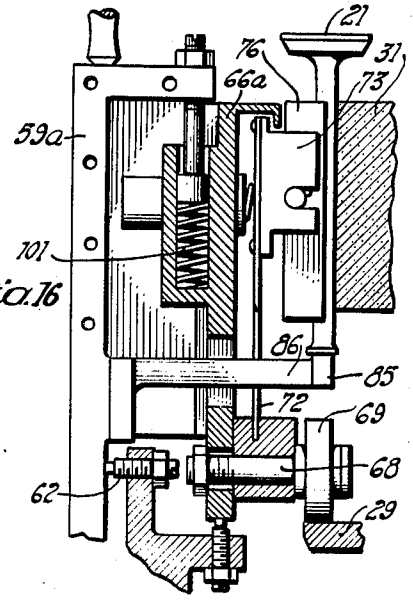


Fig. 16

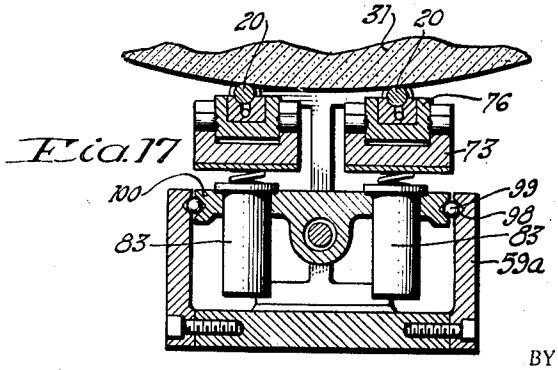


Fig. 17

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Patented Apr. 16, 1940 2,197,538

UNITED STATES PATENT OFFICE

2,197,538

METAL FINISHING MACHINE

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Application July 31, 1939, Serial No. 287,480

19 Claims. (Cl. 51—59)

This invention relates to improvements in metal surfacing and has particular reference to a novel and improved method for producing a final finish of extremely accurate character on the surface of a work piece or multiplicity of work pieces.

A principal object of the present invention is the provision of a novel method for rapidly producing a surface of maximum smoothness on an individual work piece or for simultaneously producing surfaces of this type on a multiplicity of work pieces.

A further object of the invention is the provision of an improved method of surface finishing of articles of circular form in cross section by a continuous process which will greatly increase the output capacity of an individual operator.

A further object of the present invention is the provision of a novel and improved mechanism substantially automatic in character for performance of the aforesaid metal finishing operation.

An additional object of the present invention is the provision of a mechanism of this character capable of handling an appreciable number of work pieces in which the finishing operation shall be performed in a manner substantially individual as respects the work piece units.

Other objects and advantages of the present invention should be readily apparent by reference to the following specification, considered in conjunction with the accompanying drawings forming a part thereof and it is to be understood that any modifications may be made in the exact structural details there shown and described, within the scope of the appended claims, without departing from or exceeding the spirit of the invention.

Referring to the drawings in which like reference numerals indicate like or similar parts:

Figure 1 is a side elevation of a machine for attainment of the foregoing objects.

Figure 2 is a plan view thereof.

Figure 3 is a fragmentary front elevation illustrating the functioning of the automatic work holder controlling cam.

Figure 4 is a fragmentary vertical sectional view taken as on the line 4—4 of Figure 2.

Figure 5 is a similar section extended through the complete drive mechanism.

Figure 6 is a transverse sectional view as on the line 6—6 of Figure 5.

Figure 7 is a sectional view as on the line 7—7 of Figure 4, showing a portion only of the individual work and tool holders.

Figure 8 is a detail section view as on the line 8—8 of Figure 4.

Figure 9 is a corresponding view on the line 9—9 of Figure 4.

Figure 10 is a vertical section through one of the work and tool holders of Figure 2.

Figure 11 is a transverse section on the line 11—11 of Figure 10.

Figure 12 is an expanded view illustrating the action of the vibratory cam on the individual tool holders.

Figure 13 is a fragmentary view illustrating the variation of roller axis effected by the roller movement only.

Figure 14 is a similar view indicating the combined effect of the roller and cam movements.

Figure 15 is a composite diagrammatic view illustrating the relative path of movement of an individual abrasive particle with respect to the work under the influence of the combined multi-directional relative movements simultaneously effected between work and tool during the abrading or finishing operation.

Figure 16 is a vertical sectional view similar to Figure 10 of a slightly modified construction of tool and work holding mechanism, and

Figure 17 is a transverse section as on the line 17—17 of Figure 16.

The present invention, as previously pointed out, relates to an improved method of producing the final or commercially utilized surface on various forms of metal or like articles in which it is desired to remove the fine hills and valleys, scratches or gooves produced by grinding or similar previous tooling or metal forming operations.

To facilitate an understanding of the method, it has been illustrated in Figures 12 to 15 inclusive as employed in connection with the surfacing of the stem 20 of a valve 21 of the poppet type such as employed, for example, in large quantities in connection with internal combusion engines.

It is to be understood, however, that it is by no means limited to this particular use as it can be employed with equal facility in connection with tappets, piston pins, rollers for anti-friction bearings or other articles—especially those of cylindrical form in cross section and whose surfaces to be finished are of a character which will permit both relative rotary and axial movements of the work piece and abrading member.

The machine, as shown in Figure 1, is of the multiple type intended for continuous operation on a multiple number of work pieces and embodies as its essential features a bed portion 22

having a central cylindrical post 23 rotatably supporting a table member 24 which lies within the circumscribing drain flange 25 of the machine. This rotary table has mounted thereon for movement therewith and for oscillation relative thereto, the combined work and tool holding members designated as an entirety by the numeral 26—one form of which is shown in detail in Figure 10 and which will be hereinafter specifically described.

Rotatably mounted on the upper portion of the post 23 and supported in part by table 24 through suitable antifriction bearings 27 is the tool controlling cam 28 in the form of an annulus or disc having an undulating peripheral cam flange 29 for imparting vertical movements to the tool holders.

Journaled within the post 23 is a shaft 30 bearing on its upper end the work regulating wheel 31 and having keyed to its lower end crank arm 32.

The relationship of these several parts of the machine will be best understood by reference to the dotted lines in the bed of the machine in Figure 1 and the sectional views, Figures 4 and 5. By reference to these figures it will be noted that there is provided in the lower portion of the bed, a suitable driving motor 33 coupled as by belts 34 with the multiple sheave pulley 35 on the lower end of shaft 36, which is rotatably supported in a bracket 37 within the bed 22. This shaft is provided with a pinion 38 meshing with gear 39 on vertical shaft 40 which has at its upper end a pinion 41 meshing with the internal gear 42 on the rotary cam disc 28. It will thus be seen that rotation is imparted to the cam at a relatively high rate.

The shaft is further provided with a bevel pinion 43 meshing with bevel pinion 44 on the worm shaft 45 having a worm 46 meshing with the worm gear 47 on shaft 48 which carries at its upper end a pinion 49 in driving engagement with the peripheral gear 50 circumscribing the bearing sleeve 51 of table 24. Due to the reductions effected through the worm and worm gear and the relatively great difference in diameters of pinion 49 and gear 50 the table is rotated at a much slower rate than the cam disc but due to the relationship of parts both are advanced in a corresponding direction as is diagrammatically indicated in Figures 13 and 14. Additionally, shaft 36 is formed with an eccentric portion or crank as at 52 on which the pitman or link 53 is journaled, having its outer end pivoted to the arm 32 on the lower end of the regulating wheel spindle 30 whereby as power is applied to the drive mechanism the regulating wheel spindle will be given a back and forth oscillation of predetermined amplitude.

Considering now the tool and work holding devices, as indicated, there are mounted upon the outer portion of the rotary table 24 a multiplicity of blocks or extensions 54 providing ways as at 55 for the individual slides 56 which are radially adjustable with respect to the regulating wheel as by adjusting screws 57. These slides are provided with individual trunnion bearings 58 to which are pivoted the brackets 59 inwardly urged as respects the upper portions thereof by the torsion springs 60 and reversely oscillatable manually as by grasping of the handles 61. An adjustable stop 62 carried by a lug on the slide 56 serves to limit the inward swinging movement of member 59 which constitutes the combined tool and work holder in the form shown in Figures 4 and 10 of the drawings.

As there illustrated, the member 59 carries a block 63 having extending inwardly therefrom the transversely disposed blade springs 64 and 65 whose inner ends vibratably support the plate 66 having a slot 67 receiving the guide stud 68 bearing roller 69 adapted to ride on cam track 29 and the spacing block 70. A nut 71 secured on the inner threaded end of stud 68 serves to clamp the several parts in vertically adjusted position as respects the member 66.

Block 70 carries the vertical blade spring or the like 72 supporting holder 73 notched as at 74 to receive trunnions 75 on holder 76 for the abradant element 77 having a groove 78 formed in its inner face adapted to receive and conform to an interposed work piece 79.

Means such as the spring pressed pins 80 may be employed for retaining the trunnions in position, while inward actuation of the holders 73 to urge the work against the regulating wheel may be effected as by the adjustable compression springs 82 carried in sockets 83 on the member 66. It will be noted that the member 66 is provided with an inturned flange as at 84 for interengagement with the member 73 to limit the extent of its inward movement under the influence of the spring or springs 82.

In use, the member 59 is swung into a retracted position as indicated at the left in Figure 1, for example, when the work piece 79 is dropped into position in the groove in the abrading member with its lower end resting upon the tip 85 of the work piece support 86 which, as clearly shown in Figures 4 and 10, extends inwardly from the member 59.

A bracket 87 carried by the slide 56 subtends the tool holder plate 66 and is provided with an adjustable stop 88 limiting the movement of roller 69 in direction of cam 29 when the parts are in work finishing position and serving to support the elements as an entirety, preventing undue flexion of springs 65 and 64 when the holder is swung into its retracted position.

While, as described, the holder can be at any time shifted into retracted position by grasping of the handle 61, it will be understood that this is against the tension of spring 60 normally urging the parts into position indicated in Figure 4. To facilitate utilization of the machine and minimize manual effort required on the part of the operator, means are preferably provided automatically to retract the tool and work holder at the front or loading position of the machine without stopping the rotation of the table and for a sufficient period to permit the operator to withdraw completed work pieces and substitute new pieces on which a finishing operation is to be performed.

As shown in Figure 3, the flange 25 of the bed is formed with an upwardly projecting portion 89 having the terminal inclined or cam faces 90 and 91. As the table rotates in a counterclockwise direction, as indicated in Figure 7, lug 92 on rock arm 93 rides up the surface 90 and reacts through finger 94 and plunger 95 on lug 96 of the trunnion member 97, rocking this member and thus the attached unit 59 into the position shown at the left of Figure 1. With the parts in this position the completed work pieces may be readily withdrawn and new ones laid in their place, when as the table progresses to the left the element 92 will ride downwardly on the inclined or cam surface 91 permitting the spring 60 to restore the parts to normal operative position with the work piece tightly gripped between

the surface of the regulating wheel on the one side and the surface of the groove in the abrading member 76 at the opposite side as most clearly shown in connection with Figure 11.

Figures 16 and 17 illustrate an alternative form of work holder in which the member 59a is provided with vertical extending ways 98 for the anti-friction bearings 99 supporting slide 100 for vertical movement. This slide corresponds in general with the member 66 of Figure 10, and like that member serves as a support for the tool holder units 76. The chief distinction resides in the fact that in place of the vibratory blade spring mounting of the parts the slideways just described are utilized and an adjustable tension compression spring 101 employed for urging the member 66a to maintain the vibration producing roller 69 in engagement with the cam 29. The results accomplishable by this machine in the fine finishing of various cylindrical articles and the machine operations in producing this finish have been indicated in Figures 12 to 15 inclusive.

In Figure 12 there has been diagrammatically shown a plurality of abrading members in varied relation to the work piece which is maintained at a constant height. These variable positions are the result of the reactions of the cam track on the roller 69 of the tool carrier or slide during circumferential movement of the work table and supported parts. The general effect thus produced has been shown as to its initial component by the undulatory line 102 in Figure 13. It has previously been mentioned, however, that the work table rotates at a much slower rate than does the rotary cam 29 which has this variable undulating surface of different heights for corresponding undulations at different points, such as at 103, 104, and 105 indicated in Figure 14.

Due to the much higher speed of movement of the cam than the table, the movement imparted to the tool holder will comprise a multiplicity of vertical vibrations for a unit length of advance of the work piece in a circumferential direction as brought out by the path indicating graph 106 in Figure 14, this graph indicating the creation of the dual conditions of vertical vibration plus general horizontal undulation resulting from the combined contour and speed of the cam member.

It has been pointed out that in addition to these vertical and general rotary or translatory relative movements of work and tool holder, the regulating wheel has imparted to it not a movement of rotation but one of rotary oscillation, it being understood that the pressures and rate of movement of the parts are such that the regulating wheel will interengage with the work surface and in its oscillatory movement impart identical oscillations to the work piece about its vertical axis except insofar as the nature of these oscillations progressively advances due to the circumferential movement of the work, rendering the action at some times additive and at others subtractive as respects the momentary direction of oscillation of the regulating wheel surface.

The combined effect of these movements—as indicated by the graph line 107 in Figure 15—changes the graph of combined relative movements of work surface and a particle of abrasive on the tool from a zig-zag or vibrating path 106 to the advancing helix of 107. It will be understood by those conversant with the art of grinding that the production of a relative path of abrasion, such as indicated by the graph 107, passing over all points of the work surface being operated upon results in a continuous change of direction of cutting of the individual abrasive particle so that at all times an absolutely free cutting action without formation of scratches due to balling up of the minute chips or dragging of the material is obtained. Also, such action eliminates a dragging effect of successive abrasive particles in a substantially uniform direction and prevents the formation of hills and valleys such as result from ordinary grinding operations, giving an extremely smooth, satisfactory wearing completed surface of maximum accuracy.

It will be particularly noted that the present invention is adapted for employment in the finishing of metal or like articles by the centerless method in that the work is suitably supported for free rotation, a regulating wheel is employed having line contact, frictional engagement with the work surface in a manner to control the rotary and oscillatory movements of the work about an axis extending in the same general direction as that of the regulating wheel, while abrading members are employed having recessed portions partially embracing the work and movable in a direction substantially parallel with the work axis for effecting the finishing operation.

In practice it has been found best results can be accomplished by maintaining a film of oil or other coolant within the recessed face of the tool so that the work piece partially floats on this film and is engaged to an extremely slight depth only by the cutting particles of the tool which project through the film into engagement with the work.

A manner of applying such lubricant in connection with a multiple fixture rotary table of the type here described has been illustrated in the drawings as comprising a supply pipe 108 extending upward through post 23 and having a lateral connection 109 secured to annular plate 110 embracing the upper portion of the post. Interlocking with the offset flange portions of the member 110 is a rotary lubricant chamber or ring 111 connected by pipe 112 with the circular distributor ring 113 mounted upon the upper face of table 24 and rotatable therewith.

This ring, as indicated, may be supplied with fittings 114 coupled by flexible tubes 115 with the suitably disposed passages 116 individual to the respective abrading tools. These passages discharge the lubricant at the face of the tools, thus satisfactorily maintaining a continuous film intervening the recessed work receiving portion of the operative face of the tool and the work itself.

This lubricant is collected by the drain flange 25 and returned to a suitable chamber in the bed of the machine where it can be filtered and recirculated at low pressure by suitable pump mechanism.

What is claimed is:

1. In a machine for surface finishing articles of circular form in cross section, the combination with a regulating wheel, of a rotary table, a plurality of work holding fixtures carried by the table in circumscribing relation to the periphery of the regulating wheel, tool holders associated with and individual to the respective work holders, means for imparting rotary oscillation to the regulating wheel, means for effecting rotation of the table whereby the fixtures are shifted circumferentially of the regulating wheel, means for urging the tool holders in a direction toward the

regulating wheel for engagement of the work between said parts, and means to effect vibration of the tool holders in a direction axially of the work pieces supported by the work fixtures.

2. In a machine for surface finishing articles of circular form in cross section, the combination with a regulating wheel, of a rotary table, a plurality of work holding fixtures carried by the table in circumscribing relation to the periphery of the regulating wheel, tool holders associated with and individual to the respective work holders, means for imparting rotary oscillation to the regulating wheel, means for effecting rotation of the table whereby the fixtures are shifted circumferentially of the regulating wheel, means for urging the tool holders in a direction toward the regulating wheel for engagement of the work between said parts, means yieldingly mounting the tool holders for movement in an axial direction as respects the work pieces, and cam means cooperating with the individual work holders for effecting vibratory movement thereof.

3. A machine of the character described, including a regulating wheel, an opposed work holder, means for imparting relative bodily rotation and superimposed rotary oscillatory movements to the wheel and holder, a tool holder disposed in opposition to the periphery of the regulating wheel, a tool carried thereby, means for yieldingly urging the tool in a direction toward the periphery of the regulating wheel whereby a work piece carried by the work support will be engaged between the tool and regulating wheel, means resiliently supporting the tool holder for movement transversely of the regulating wheel, and means for imparting transverse vibrations to the tool holder.

4. A machine of the character described, including a regulating wheel, an opposed work holder, means for imparting relative bodily rotation and superimposed rotary oscillatory movements to the wheel and holder, a tool holder disposed in opposition to the periphery of the regulating wheel, a tool carried thereby, means for yieldingly urging the tool in a direction toward the periphery of the regulating wheel whereby a work piece carried by the work support will be engaged between the tool and regulating wheel, means resiliently supporting the tool holder for movement transversely of the regulating wheel, means for imparting transverse vibrations to the tool holder, and means for adjustably limiting the extent of said vibrations.

5. A machine of the character described including a rotatably mounted regulating wheel, means for imparting a rotary, oscillatory movement to said regulating wheel, a table rotatable concentric with said regulating wheel, a plurality of work supporting fixtures carried by the table, individual tool holders carried by the fixtures for movement in transverse planes with respect thereto, means for limiting the movement of the tool holders in one of said planes, and means for imparting vibratory movement to the individual tool holders in the other of said planes.

6. In a machine of the character described, including a regulating wheel and a table supported adjacent said regulating wheel, a plurality of work holding fixtures carried by the table in circumscribing relation to the periphery of the regulating wheel, means for imparting a combined movement of relative rotation and superimposed rotary oscillation to the fixtures and surface of the regulating wheel, one with respect to the other, individual tool holders carried by the respective fixtures, and means for effecting vibratory movement of the tool holders in a plane parallel with the axis of said relative rotation.

7. In a machine of the character described, including a regulating wheel and a table supported adjacent said regulating wheel, a plurality of work holding fixtures carried by the table in circumscribing relation to the periphery of the regulating wheel, means for imparting a combined movement of relative rotation and superimposed rotary oscillation to the fixtures and surface of the regulating wheel, one with respect to the other, individual tool holders carried by the respective fixtures, means for effecting vibratory movement of the tool holders in a plane parallel with the axis of said relative rotation, and means mounting the fixtures for individual oscillatory movement in a direction toward and from the periphery of the regulating wheel.

8. In a machine of the character described, including a regulating wheel and a table supported adjacent said regulating wheel, a plurality of work holding fixtures carried by the table in circumscribing relation to the periphery of the regulating wheel, means for imparting a combined movement of relative rotation and superimposed rotary oscillation to the fixtures and surface of the regulating wheel, one with respect to the other, individual tool holders carried by the respective fixtures, means for effecting vibratory movement of the tool holders in a plane parallel with the axis of said relative rotation, means mounting the fixtures for individual oscillatory movement in a direction toward and from the periphery of the regulating wheel, and means for sequentially effecting said oscillation of the individual fixtures.

9. In a machine of the character described, including a bed or support, a regulating wheel having a vertically disposed spindle journaled thereon, a table carried by the support for rotation about an axis concentric with said spindle, a rotary concentrically mounted cam member superimposed on said table, a multiplicity of work and tool holding fixtures carried by the table in circumscribing relation to the periphery of the regulating wheel, means for effecting a rotary oscillatory movement of the regulating wheel, means for effecting a relative rotational movement between the fixtures and the periphery of the regulating wheel whereby a combined rotary and superimposed rotary oscillatory movement is imparted to work pieces carried by the fixtures, cam engaging means carried by the tool holders, and means for effecting relative rotation between the cams and cam engaging members at a different rate than the rate of relative rotation between the fixtures and regulating wheel, substantially as and for the purpose described.

10. In a machine of the character described, including a bed or support, a regulating wheel having a vertically disposed spindle journaled thereon, a table carried by the support for rotation about an axis concentric with said spindle, a rotary concentrically mounted cam member superimposed on said table, a multiplicity of work and tool holding fixtures carried by the table in circumscribing relation to the periphery of the regulating wheel, means for effecting a rotary oscillatory movement of the regulating wheel, means for effecting a relative rotational movement between the fixtures and the periphery of the regulating wheel whereby a combined rotary and superimposed rotary oscillatory movement is imparted to work pieces carried by the fixtures,

cam engaging means carried by the tool holders, means for effecting relative rotation between the cams and cam engaging members at a different rate than the rate of relative rotation between the fixtures and regulating wheel, substantially as and for the purpose described, and a single drive means differentially coupled with the several parts for effecting the respective movements thereof.

11. In a machine of the character described, including a bed or support, a tubular post rising therefrom, a regulating wheel spindle journaled within the post having a portion projecting thereabove, a regulating wheel mounted on said projecting portion, a table rotatably mounted exteriorly on the post, a superimposed rotary cam element circumscribing the post and intervening the regulating wheel and table, a plurality of work and tool holding fixtures mounted on the table in circumscribing relation to the periphery of the regulating wheel, said fixtures including individual depending actuators engaging the cam element, means for imparting a rotary oscillatory movement to the regulating wheel spindle and regulating wheel, additional means for imparting a bodily rotary movement to the rotary table whereby the fixtures are shifted circumferentially about the regulating wheel, and means for imparting rotary movement to the cam element at a speed in excess of the rate of rotation of the table whereby the cam will react on the individual tool holder elements to effect vibration thereof transversely of the face of the regulating wheel.

12. A combined work and tool holding fixture for a machine of the character described including a slidable base, a fixture pivoted to the base for oscillatory movement with respect thereto, a work support carried by the fixture, a tool support, means yieldingly connecting the tool support with the fixture for vibratory movement relative to the work support, a tool holder, and means yieldingly connecting the tool holder to the tool support for movement toward the work in a direction at right angles to the direction of potential vibratory movement of the tool support.

13. A combined work and tool holding fixture for a machine of the character described including a slidable base, a fixture pivoted to the base for oscillatory movement with respect thereto, a work support carried by the fixture, a tool support, means yieldingly connecting the tool support with the fixture for vibratory movement relative to the work support, a tool holder, means yieldingly connecting the tool holder to the tool support for movement toward the work in a direction at right angles to the direction of potential vibratory movement of the tool support, means for resiliently actuating the pivoted fixture as an entirety in one direction about its pivot, means for limiting the extent of said resiliently actuated movement, and a first manually actuable means for reversely oscillating the pivoted portion of the fixture.

14. A combined work and tool holding fixture for a machine of the character described including a slidable base, a fixture pivoted to the base for oscillatory movement with respect thereto, a work support carried by the fixture, a tool support, means yieldingly connecting the tool support with the fixture for vibratory movement relative to the work support, a tool holder, means yieldingly connecting the tool holder to the tool support for movement toward the work in a direction at right angles to the direction of potential vibratory movement of the tool support, means for resiliently actuating the pivoted fixture as an entirety in one direction about its pivot, means for limiting the extent of said resiliently actuated movement, a first manually actuable means for reversely oscillating the pivoted portion of the fixture, and a second retracting means for the fixture including a shaft journaled in the base, a cam actuable member carried by the shaft for oscillation thereof, and motion transmitting connections between the shaft and the swinging portion of the fixture for effecting retraction thereof upon oscillation of the shaft.

15. In a machine of the character described including a bed, a regulating wheel carried by the bed for oscillation about a vertical axis, a rotary table mounted on the bed, a plurality of combined work and tool holding fixtures mounted on the table and movable circumferentially of the regulating wheel upon rotation of the table, means mounting said fixtures for individual oscillatory movement in a direction toward and from the regulating wheel, work holding and tool holding means carried by the fixtures, means for yieldingly urging the fixtures as an entirety toward the regulating wheel, additional means for yieldingly urging the tool holder to press a tool and associate work piece in a direction toward the regulating wheel, means mounting the individual tool holders for axial vibratory movement with respect to the periphery of the regulating wheel, and a common actuator for effecting simultaneous axial vibrations of the tool holders of the several fixtures during their circumferential movement as respects the regulating wheel.

16. In a machine of the character described including a bed, a regulating wheel carried by the bed for oscillation about a vertical axis, a rotary table mounted on the bed, a plurality of combined work and tool holding fixtures mounted on the table and movable circumferentially of the regulating wheel upon rotation of the table, means mounting said fixtures for individual oscillatory movement in a direction toward and from the regulating wheel, work holding and tool holding means carried by the fixtures, means for yieldingly urging the fixtures as an entirety toward the regulating wheel, additional means for yieldingly urging the tool holder to press a tool and associate work piece in a direction toward the regulating wheel, means mounting the individual tool holders for axial vibratory movement with respect to the periphery of the regulating wheel, a common actuator for effecting simultaneous axial vibrations of the tool holders of the several fixtures during their circumferential movement as respects the regulating wheel, and means for automatically effecting retraction of the fixtures with respect to the regulating wheel at a predetermined point in the path of bodily rotary movement thereof.

17. A machine for performance of a centerless finishing operation including a regulating wheel disposed for peripheral line contact with the surface of a work piece, an opposed abrading stone having a work receiving recess providing a portion conforming to the transverse sectional contour of the article to be finished, means to effect formation of an oil film intervening the surface of the work and the inner face of the conforming portion of the abrading stone, means to effect relative rotary and oscillatory movements of the work engaging faces of the stone

and regulating wheel about a common axis, and additional means to effect relative movement of said parts in a direction parallel to said axis, whereby the line contact regulating wheel face controls the rotary and oscillatory movements of the work about its axis while the filmed contoured surface of the stone performs a finishing operation on the work.

18. A machine for performance of a finishing operation by the centerless method comprising a regulating wheel oscillatable about a vertical axis, a circumscribing table rotatable about said axis, multiple work fixtures carried by the table and mounted for oscillation about a horizontal axis, means to urge said fixture in a direction toward the regulating wheel, tool holders carried by the fixture individual to their respective work pieces, means for effecting individual movements of the tool holders in a direction parallel with the aforementioned axis of oscillation and rotation, and additional means for individually yieldingly urging the tool holders in a direction toward the regulating wheel to press the work pieces thereagainst.

19. A machine for performance of a finishing operation by the centerless method comprising a regulating wheel oscillatable about a vertical axis, a circumscribing table rotatable about said axis, multiple work fixtures carried by the table and mounted for oscillation about a horizontal axis, means to urge said fixtures in a direction toward the regulating wheel, tool holders carried by the fixtures individual to their respective work pieces, means for effecting individual movements of the tool holders in a direction parallel with the aforementioned axis of oscillation and rotation, additional means for individually yieldingly urging the tool holders in a direction toward the regulating wheel to press the work pieces thereagainst, said tool holders each having tools individual to the respective work pieces formed with portions conforming to the work surface, and means to maintain a coolant film between said conforming portion of the tools and the work surface.

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