Jan. 13, 1942. H. ARTER 2,269,805

GRINDING MACHINE

Filed Feb. 29, 1940 4 Sheets-Sheet 1

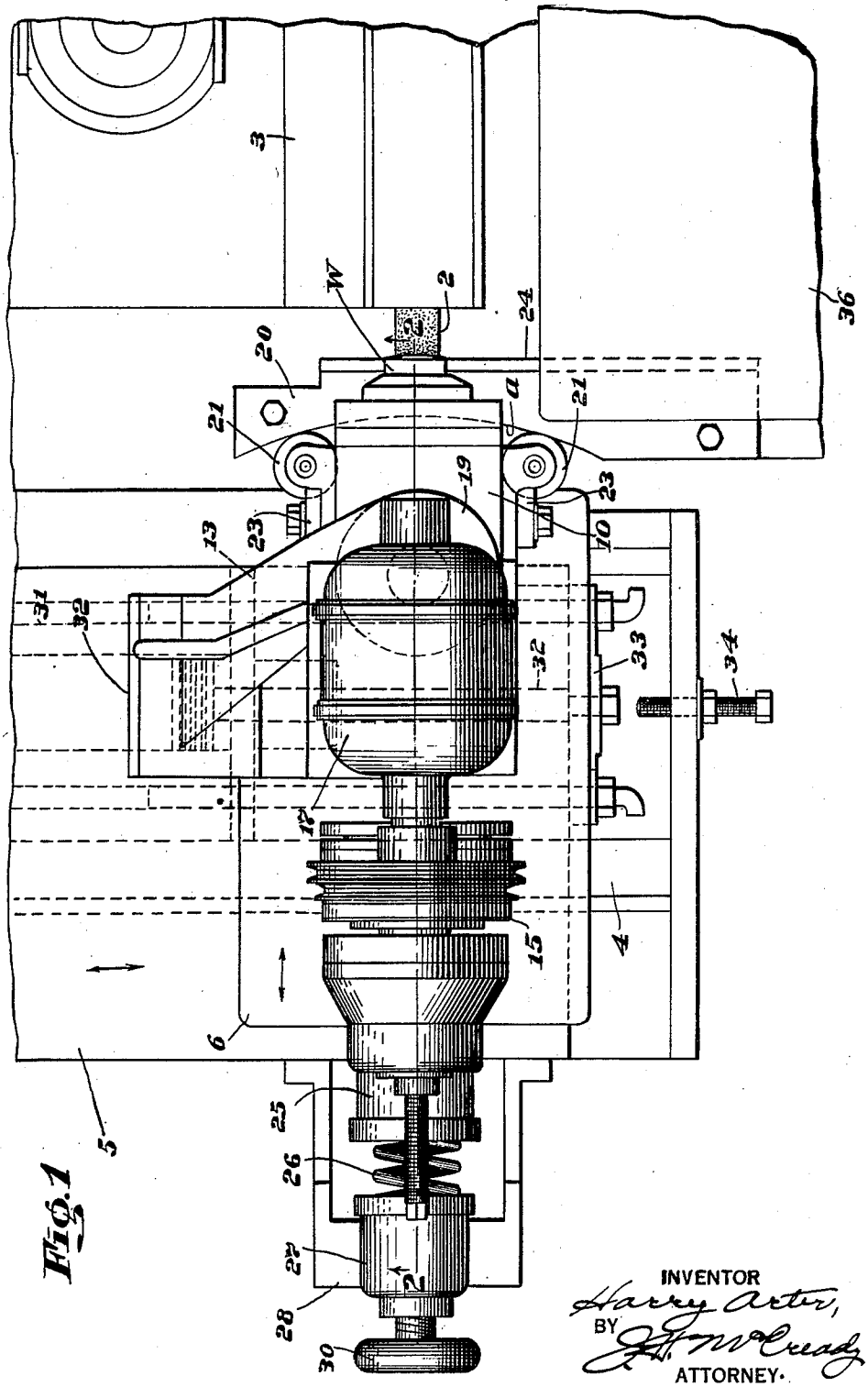


FIG. 1

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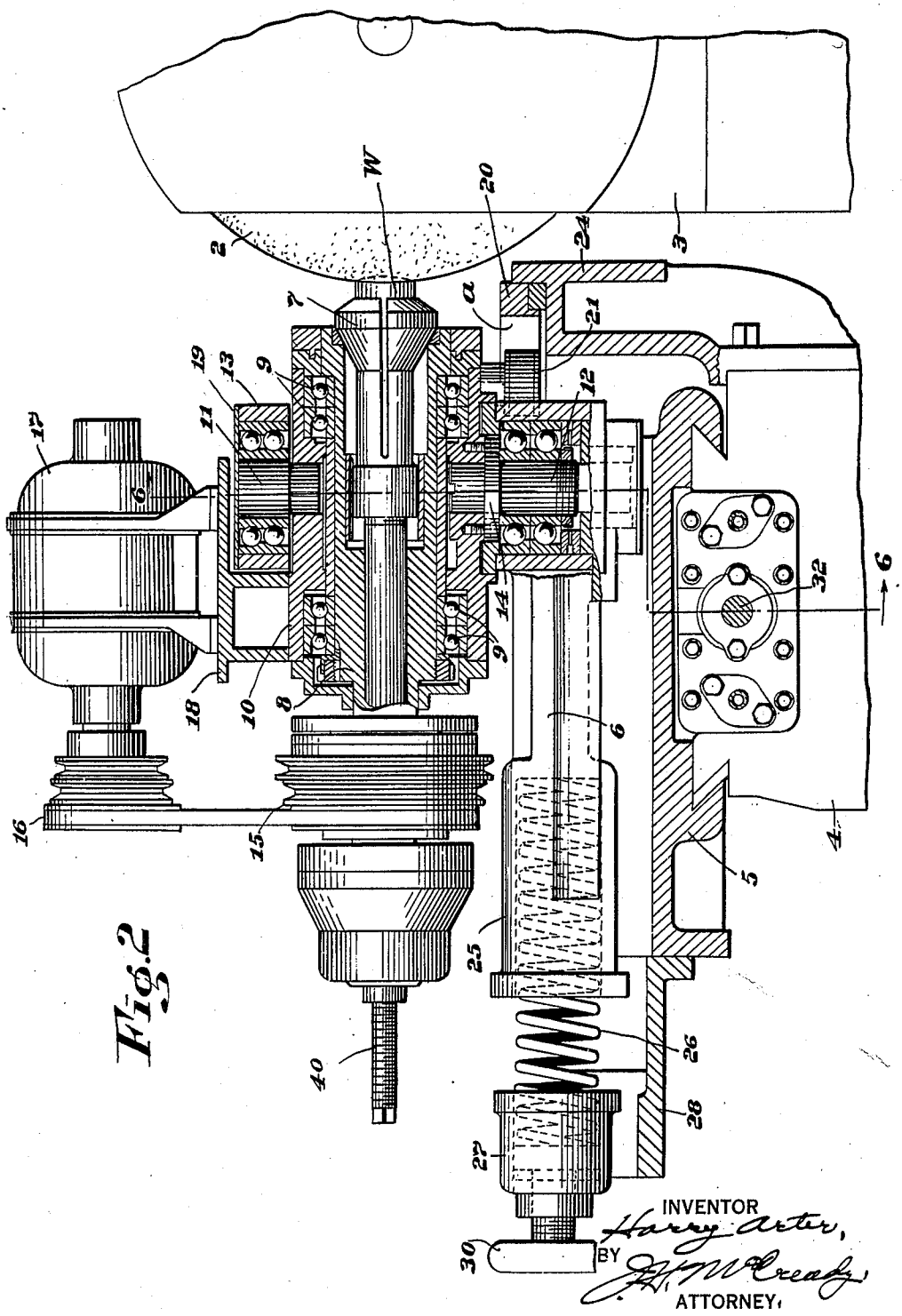


Fig. 2

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Fig. 3

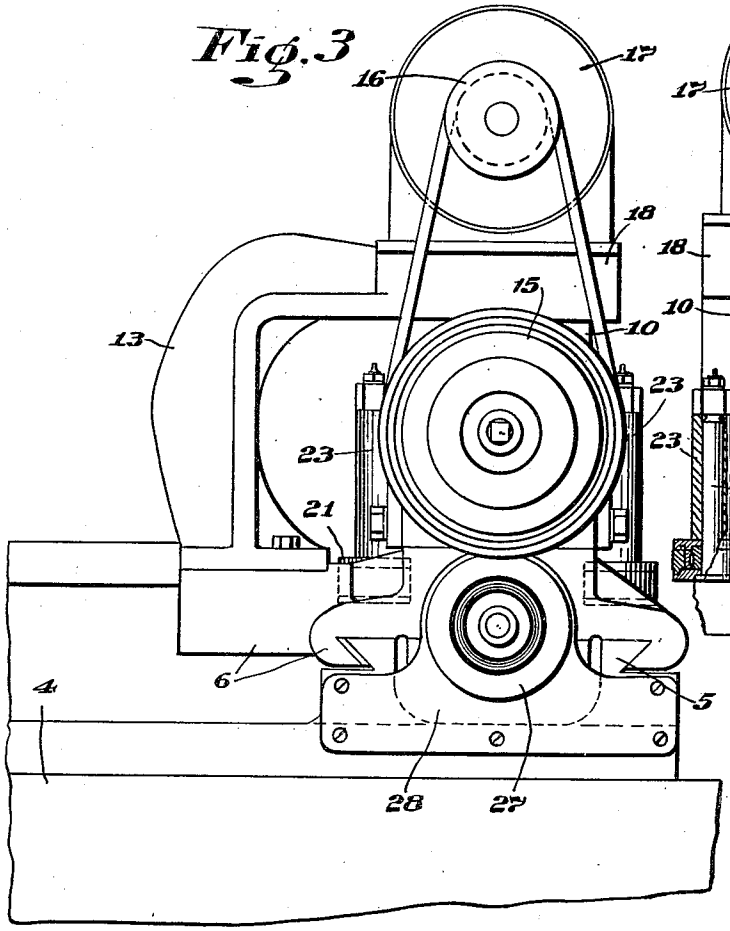
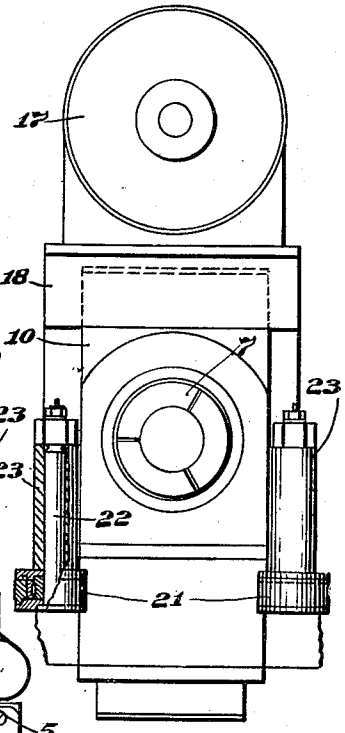


Fig. 4



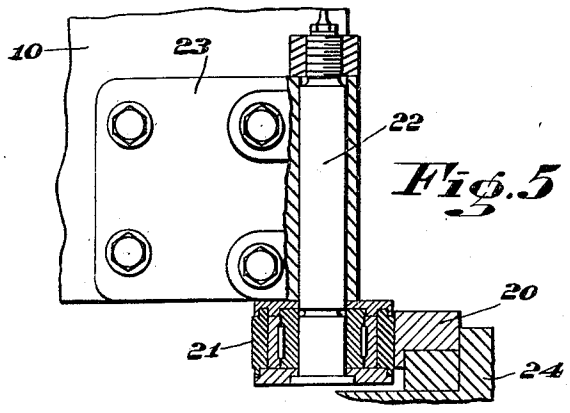


Fig. 5

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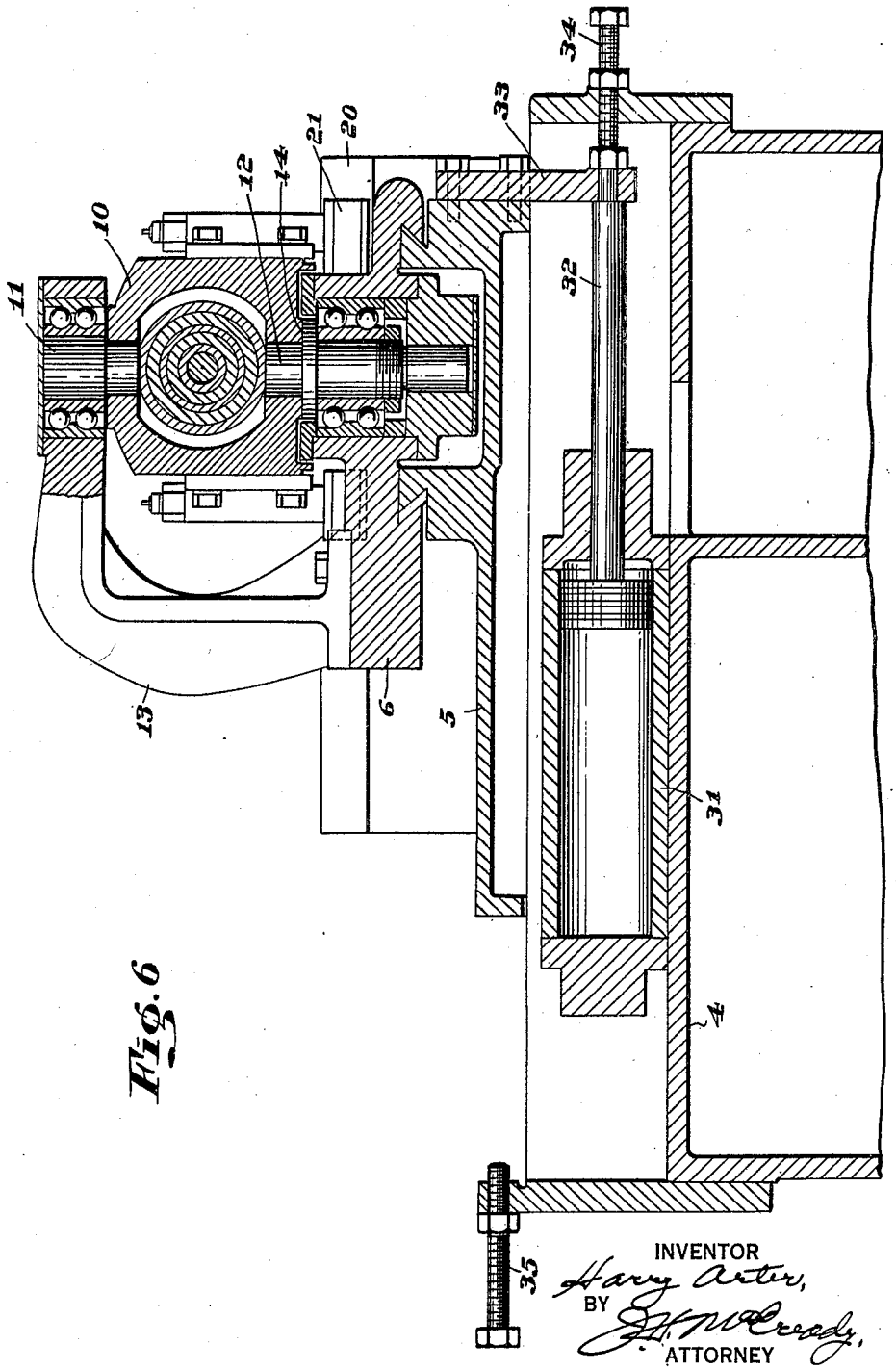


Fig. 6

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UNITED STATES PATENT OFFICE

2,269,805

GRINDING MACHINE

Harry Arter, Worcester, Mass., assignor to Arter Grinding Machine Company, Worcester, Mass., a corporation of Massachusetts

Application February 29, 1940, Serial No. 321,389

10 Claims. (Cl. 51—100)

This invention relates to grinding machines and is more particularly concerned with those machines of this general character designed to grind special shapes such, for example, as convex or concave surfaces on an article of work.

The invention aims to devise a grinding machine which will produce such shapes with a high degree of accuracy, will be automatic and efficient in operation, will not be liable to get out of order, and which can readily be adjusted or changed to grind to different curvatures.

The nature of the invention will be readily understood from the following description when read in connection with the accompanying drawings, and the novel features will be particularly pointed out in the appended claims.

In the drawings,

Figure 1 is a plan view of those parts of an automatic grinder with which the invention is more especially concerned;

Fig. 2 is a vertical, sectional view approximately on the line 2—2, Fig. 1;

Fig. 3 is a rear elevation of a portion of the machine shown in Fig. 2;

Fig. 4 is a front elevation of parts of the tool holder assembly with some portions broken away;

Fig. 5 is a sectional view through the templet, the roll cooperating therewith and the adjacent parts; and

Fig. 6 is a sectional view approximately on the line 6—6, Fig. 2.

The drawings show a machine designed particularly for grinding convex or concave surfaces on the ends of rolls, large pins, plungers, or similar pieces of work.

Referring first to Figs. 1 and 2, the grinding wheel is indicated at 2 supported in a wheel head 3 which may be organized and operated in any convenient manner. An arrangement particularly suitable for use in the present machine for supporting and operating the wheel to move it toward and from the work in properly timed relationship to the other operations of the machine is shown in Patents Nos. 1,763,967 and 2,092,721.

The work supporting mechanism comprises a base 4 on which two tables or slides 5 and 6 are mounted, the latter being supported on the former. As is common in machines of this general type, the base 4 is provided with a dove-tail guideway, shown in Fig. 2, for supporting the lower slide 5, while the latter, in turn, is similarly constructed to support the upper slide 6 for movement at right angles to its own direction of adjustment.

The work head or work holder assembly is mounted on the upper slide 6 for oscillating movement about a vertical axis so that the work piece W, Fig. 2, can be oscillated through a curve suited to the requirements of the surface to be formed on it. This assembly comprises a chuck including a collet 7 of a common form and a spindle 8 in which the collet is mounted. Two sets of duplex ball bearings 9 support the barrel in a body 10 for rapid rotation around the axis of the chuck. In addition, the supporting member 10 is itself mounted to swing about a vertical axis determined by upper and lower pivot studs 11 and 12, respectively, the latter being supported in duplex ball bearings seated directly in the upper slide 6 while the former is mounted in similar ball bearings supported in the upper end of an arm 13, Figs. 1, 2 and 3, bolted rigidly to said upper slide 6. These studs are pressed into holes formed for them in the body 10 and the lower stud has a thrust collar 14 integral with it so that practically the entire weight of the work holder assembly and the parts mounted on it are carried by the lower set of ball bearings. A plate 19 covers the top bearing.

In order to rotate the chuck about its own axis, the chuck spindle is extended rearwardly from the barrel 8 and is equipped with a grooved pulley 15 by means of which it may be belted to a similar pulley 16 on the shaft of an electric motor 17. This motor is mounted on a stand 18 which is secured rigidly to the spindle housing or support 10.

An important feature of this invention resides in the means provided to oscillate the work holder about its vertical axis and to control the radius and the amplitude of its oscillating movement. These movements determine the action of the wheel on the work and the shape produced on the work piece. Referring to Figs. 1 and 2, it will be seen that a templet 20 is interposed between the wheel 2 and the work head or work support and that it is provided with a guiding surface *a* which is curved in the arc of a circle. Bearing on this guiding surface are two rolls 21—21 which are mounted securely on the chuck support 10 for bodily movement therewith. As best shown in Figs. 4 and 5, each roll is mounted on a stub shaft 22 secured in a bracket 23 which is bolted to the side of the support 10, roller bearings, or some other non-friction type of bearing, preferably being interposed between each shaft and its respective roll 21. The templet is removably secured by bolts to a bracket 24, Figs. 1 and 2, which is bolted to the machine frame.

In order to hold the rolls 21 firmly in engagement with the guiding surface *a* of the templet, the upper slide 6 is provided with a tubular section 25, Fig. 2, to receive one end and the body of a long compression spring 26, and the opposite end of this spring is similarly housed in a socket piece 27 which forms part of a bracket 28 that is secured to the edge of the lower slide 5, as best shown in Fig. 3. A hand screw 30 is threaded through the end of the part 27 where it backs up the spring 28 and may be manipulated to adjust the pressure which this spring transmits through the work holder assembly to the rolls 21—21.

It will be evident from an inspection of Figs. 1 and 2, more particularly the former, that the mounting of the work holder in the manner just described supports this entire assembly for oscillating movement around the vertical axis of the pivot studs 11 and 12, and that the pressure of the spring 26 is transmitted through the pivotal connection between the upper slide and this assembly to hold the rolls 21—21 constantly in engagement with the curved guiding surface *a*.

It will be also observed that the points of contact of these two rolls with the surface of the templet form the opposite ends of a chord connecting said points, and that the perpendicular bisector of said chord always intersects the vertical axis about which the work holder swings, namely, the axis common to the two pivot studs 11 and 12. To state this geometrical relationship somewhat differently, the vertical axis just mentioned lies at the apex of an isosceles triangle, the base of which consists of said chord. Since the perpendicular bisector of a chord of a circle always passes through the center of that circle, this also is true of the arrangement here shown, and the bisector just referred to always passes through the center of the guiding surface *a* of the templet 20. As the slide 5 is reciprocated backward and forward in its ways, the movement of translation so imparted to the work holder assembly, combined with the fact that the pressure of the spring 26 maintains the rolls always pressed against the templet, results in oscillating the work holder about the vertical axis of the pivot studs 11 and 12. This, in turn, swings the work piece W in the arc of a circle and the radius of that circle is determined by the radius of the templet, while the amplitude of that swinging movement is controlled by the length of the reciprocating movement of the table 5. It should be noted also that the horizontal axis about which the chuck revolves always lies in the same vertical plane with said bisector.

In this particular arrangement a convex curved end face will be produced on the work piece W, but if the templet 20 is replaced with another having a convex curve, then the same arrangement would produce a concave face on the work piece W. Essentially the same geometrical relationship of the rolls to the guiding circle still would be maintained, the only difference being that the rolls and the work holder assembly then would be located at the outer side of the circle instead of at the inner side thereof, as in the construction shown in Fig. 1. Since the thrust of the spring 26 is transmitted primarily through the lower set of duplex ball bearings to the pivot stud 12 and in nearly the same horizontal plane as the guide rolls of the templet, there is practically no tendency to cramp any part and the mechanism is adapted to accommodate a relatively wide angle of swing of the work holder. In some cases it is preferable to replace the spring 26 with an hydraulic or fluid actuated means for applying the necessary pressure to hold the rolls in contact with the templet. This is particularly true when it becomes necessary to maintain the pressure of the rolls against the guiding surface of the templet substantially constant.

While any suitable mechanism may be employed for reciprocating the lower slide or table 5, I prefer to use some kind of a fluid actuated means for this purpose because of its flexibility and the ease with which it can be controlled to suit the requirements of different situations. As shown in Fig. 6, the cylinder 31 is mounted on the base 4 and the piston rod 32 of the piston working in the cylinder is fastened to a bracket 33 secured to the lower slide 5. Adjustable stop screws 34 and 35 are provided to limit the range of movement of the lower slide 5.

A machine organization of this character lends itself readily to incorporation in a completely automatic machine. For example, the collet may be, and preferably is, designed for operation hydraulically or by compressed air in the manner well known and widely used in this art, so that it may be controlled by a valve mechanism located at a point relatively remote therefrom. Also, the hydraulic mechanism for operating the lower slide may be so controlled as to move the whole work holder assembly toward the observer, Fig. 1, on to a straight part of the templet where it will be in line with a loading mechanism mounted on the table 36. The chuck may be operated to eject its work piece on the way to this table, receiving a new piece at the loading station and then being returned again to grinding position. The stop 34 may be adjusted to control the position of the work holder at the loading station and the other stop screw 35 should be adjusted to so limit the outward movement of the holder that the outermost roll 21 cannot run off the templet. In this connection it may be pointed out that in the machine shown the distance which the work piece projects beyond the collet can be adjusted by manipulating the screw 40. Chucks having provision for such adjustments are known in this art.

As will be readily understood by those skilled in this art, the face of the grinding wheel 2 must be dressed to a transverse contour complemental to that to be produced on the work. This is readily accomplished by clamping a dressing tool, such as a diamond point, in the collet 7, oscillating the work holder in the normal manner while advancing the grinding wheel into contact with it, and repeating this operation, if necessary, until the wheel face has been dressed down to the desired shape. The point of the dressing tool should be so adjusted that it will occupy the same position as the face to be produced on the work being ground.

By manufacturing and assembling such a machine as that shown in the drawings with precision, it can be made to operate with a high degree of accuracy, it is readily made completely automatic in operation in the manner above described, and when so constructed is extremely reliable. A further and important advantage of this organization is the fact that it may readily be made to produce a considerable variety of arcs and other curves merely by changing the templets.

While I have herein shown and described a typical embodiment of my invention, it will be

evident that the invention may be embodied in other forms without departing from the spirit or scope thereof.

Having thus described my invention, what I desire to claim as new is:

1. In a grinding machine, the combination of a work holder assembly including a chuck and a support therefor, a grinding wheel for operating on the work held in said chuck, two rolls connected wtih said support for movement therewith while rolling along the arcuate guiding surface of a templet, mechanism for reciprocating said holder to traverse said rolls along said guiding surface of the templet, means supporting said assembly for pivotal movement about an axis lying within the range of oscillation of a perpendicular bisector of a chord connecting the points of contact of said rolls with said guiding surface as they are moved backward and forward along said surface, and means operating through said work holder to hold said rolls in contact with said guiding surface of the templet.

2. In a grinding machine, the combination of a work holder assembly including a chuck and a support therefor in which said chuck is mounted for rotation about a horizontal axis, a grinding wheel for operating on the work held by said chuck, a horizontal slide supporting said assembly, mechanism for reciprocating said slide in a general direction transversely to the axis of rotation of said chuck, a templete having a guiding surface curved in the arc of a circle, means supporting said assembly on said slide for pivotal movement about an axis intersecting a perpendicular bisector of a chord of said guiding surface, two rolls mounted on said chuck support for movement therewith while engaging said guiding surface of the templet at the opposite ends of said chord, and means for operating through said assembly to press said rolls against said guiding surface of the templet, whereby said reciprocating movements of said slide will oscillate the work holder and will rock the work about said axis while in contact with said wheel.

3. In a machine according to preceding claim 2, a construction in which said pivotal axis of said work holder assembly is positioned vertically and intersects the axis of rotation of said chuck.

4. In a machine according to preceding claim 2, in which the means for holding said rolls in contact with the guiding face of the templet acts through the axis about which said work holder assembly oscillated.

5. A machine according to preceding claim 2, in which the means for supporting said work holder assembly on said slide comprises a second slide supported on the first for movement toward and from said wheel, and also includes bearings supporting said work holder for said oscillating movement about a vertical axis, and a bracket mounted on said second slide for supporting one of said bearings.

6. A machine according to preceding claim 2, in which said axis of rotation of the chuck lies in the same plane as the perpendicular bisector of said chord.

7. A machine according to preceding claim 2, in combination with a motor mounted on said support for the chuck and oscillating with said work holder assembly, and connections between said motor and chuck for revolving the chuck about its axis.

8. In a grinding machine, the combination of a work holder assembly including a chuck and a support therefor in which said chuck is mounted for rotation about a horizontal axis, a grinding wheel for operating on the work held by said chuck, a horizontal slide supporting said assembly for movement toward and from said wheel, mechanism for reciprocating said slide in a direction at right angles to said movement, a templet interposed between the work support and said wheel and having a guiding surface curved in the arc of a circle, means supporting said assembly on said slide for pivotal movement about a vertical axis intersecting a perpendicular bisector of a chord of said guiding surface, two rolls carried by said assembly for movement therewith and adapted to engage the guiding surface of said templet at the opposite ends of said chord, and means for applying pressure to said slide to move it toward said wheel and thereby to operate through said axis to press said rolls against said guiding surface of the templet.

9. In a grinding machine, the combination of a work holder assembly including a chuck and a support therefor in which said chuck is mounted for rotation about a horizontal axis, a grinding wheel for operating on the work held by said chuck, means supporting said assembly for oscillation about a vertical pivot, two rolls connected with said assembly with their axes in fixed relationship to the axis of said pivot and forming the ends of the base of an isosceles triangle with the last mentioned axis at its apex, and means supporting said assembly and said pivot for movements of translation in directions transverse to each other in a horizontal plane.

10. In a grinding machine, the combination of a work holder, a templet having an arcuate guiding surface, means supporting and guiding said holder for pivotal movement about an axis intersected by the perpendicular bisector of a cord of said guiding surface of the templet, said means including guiding elements bearing on said surface at opposite ends of said cord, a support for the pivot for said holder, mechanism for moving said support to traverse said guiding elements along said surface of the templet and thereby oscillating the work held in said holder in an arcuate path, and a grinding wheel mounted for the engagement of its peripheral face with said work while the latter is so oscillated.

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