March 13, 1928. 1,662,079

O. SEVERSON

MACHINE FOR GRINDING HOB AND DISK CUTTERS

Filed Feb. 2, 1925 5 Sheets-Sheet 1

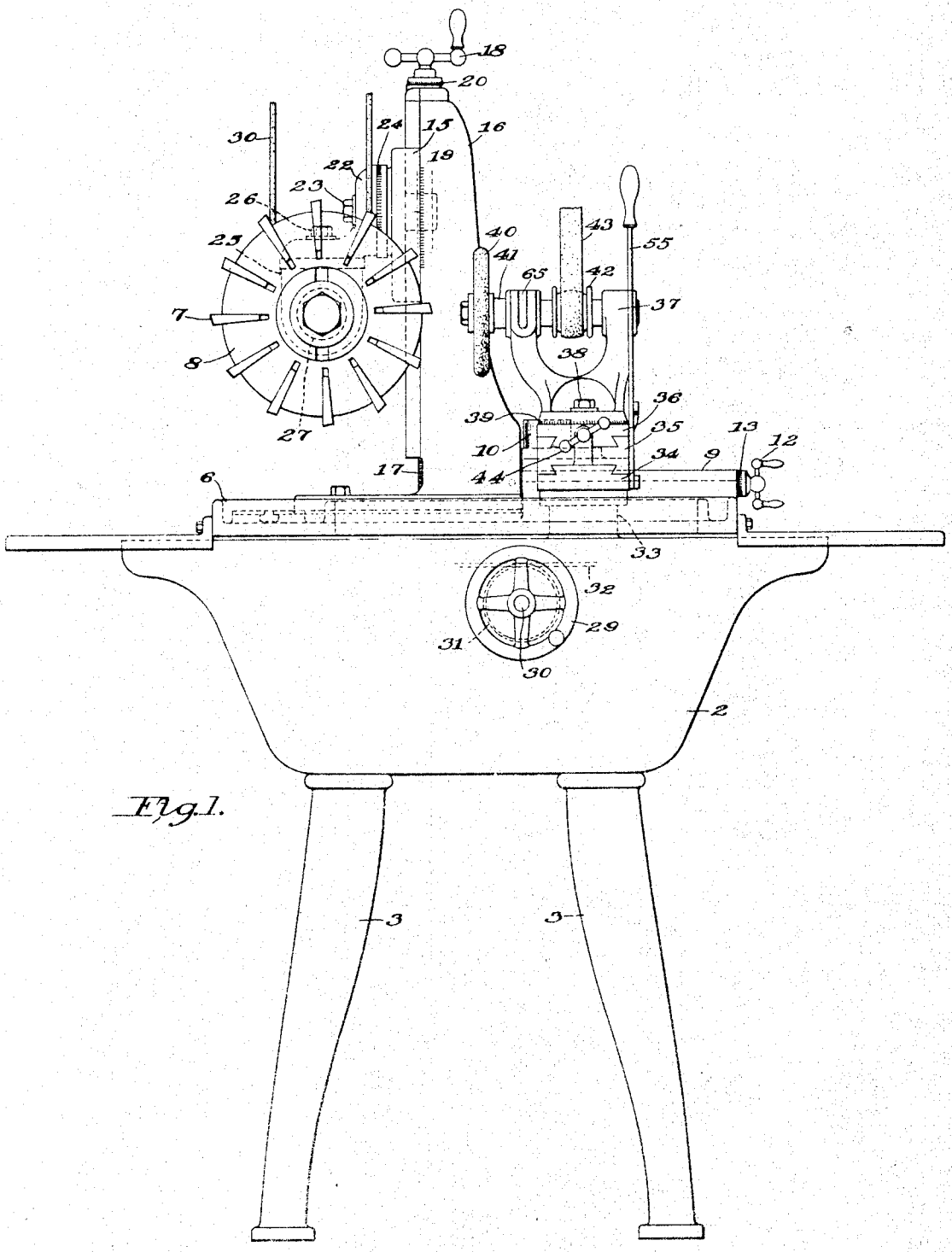

Fig. 1.

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MACHINE FOR GRINDING HOB AND DISK CUTTERS

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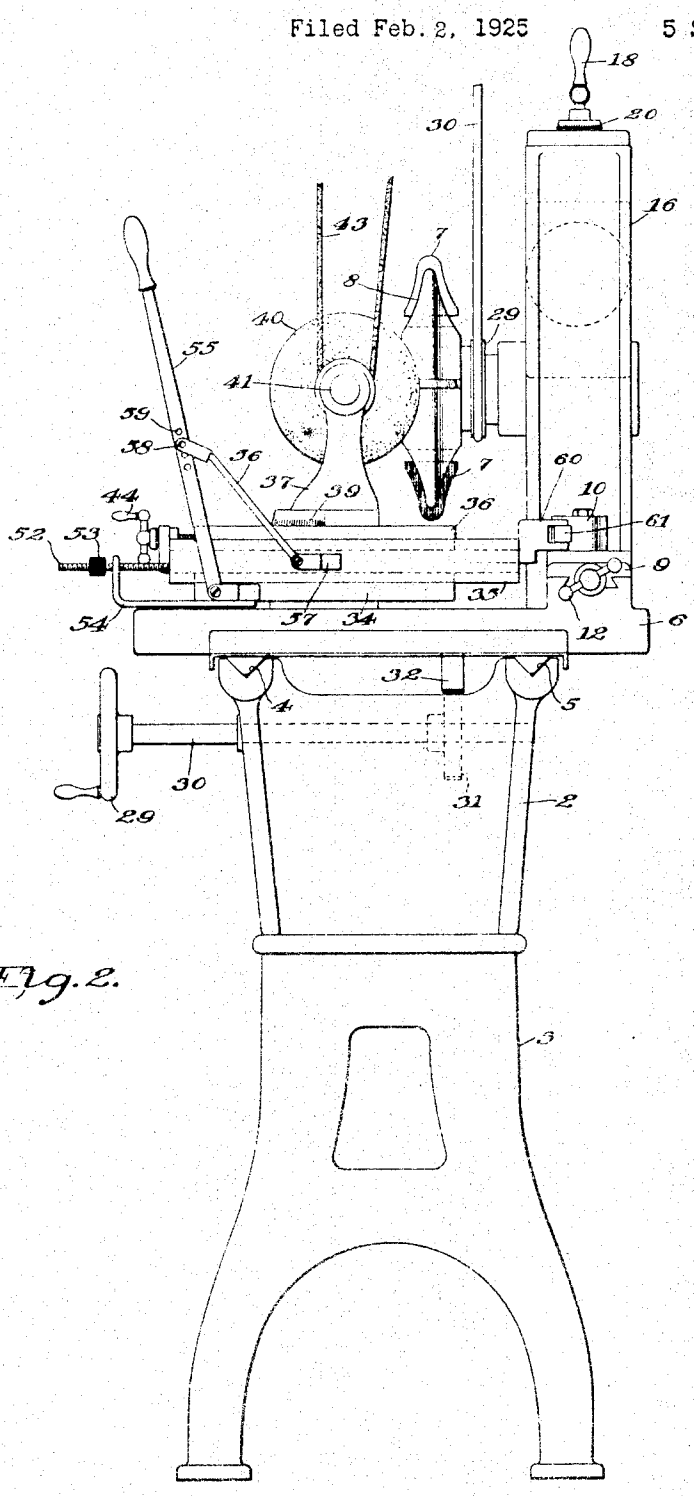

Fig. 2.

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MACHINE FOR GRINDING HOB AND DISK CUTTERS

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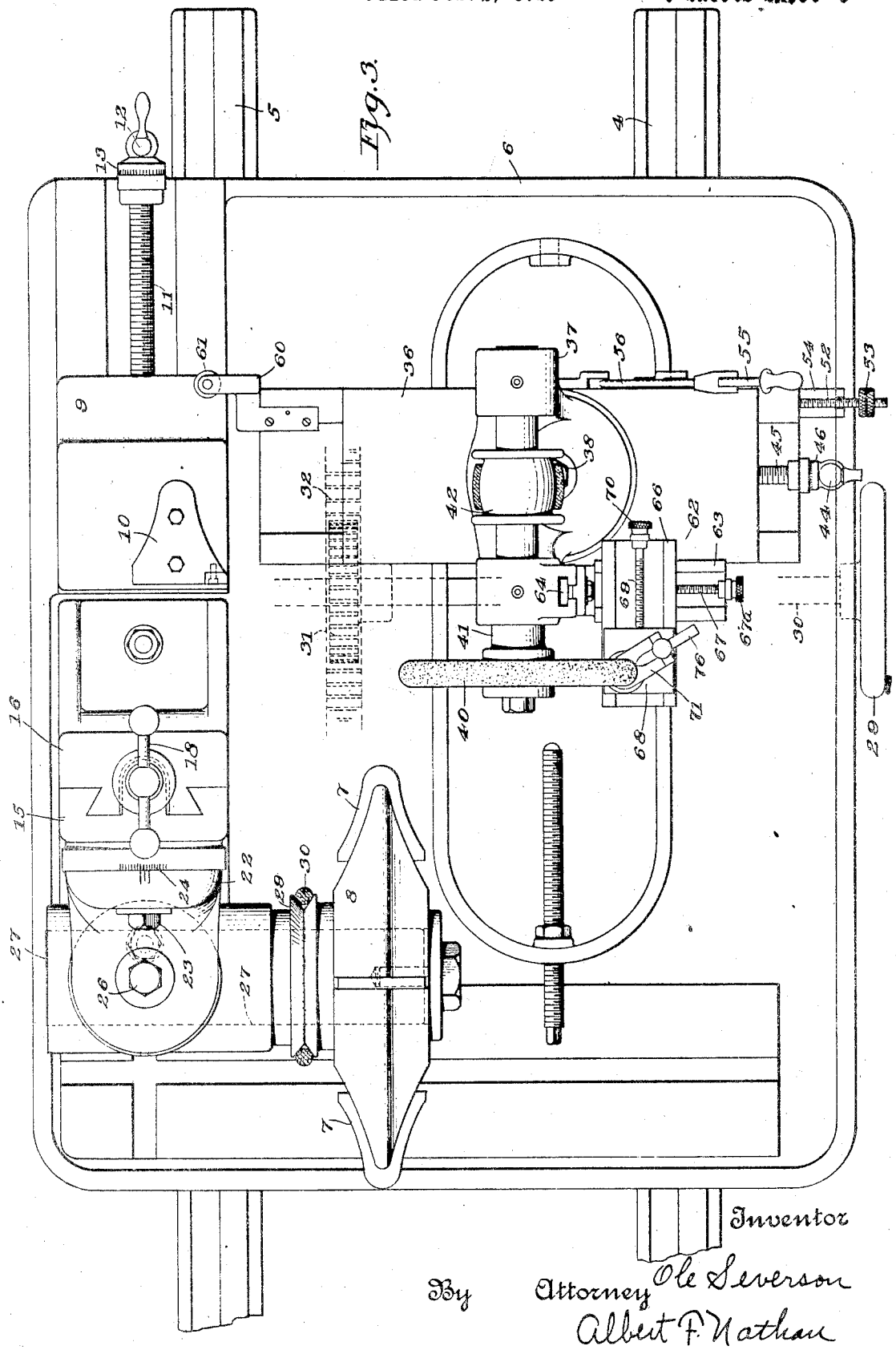
Fig. 3.



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MACHINE FOR GRINDING HOB AND DISK CUTTERS

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Fig. 9.

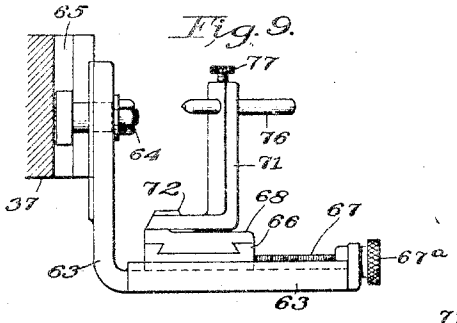
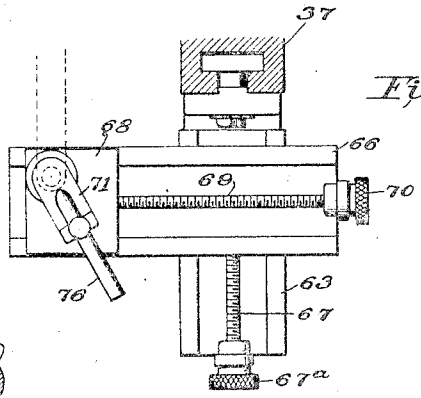


Fig. 7.



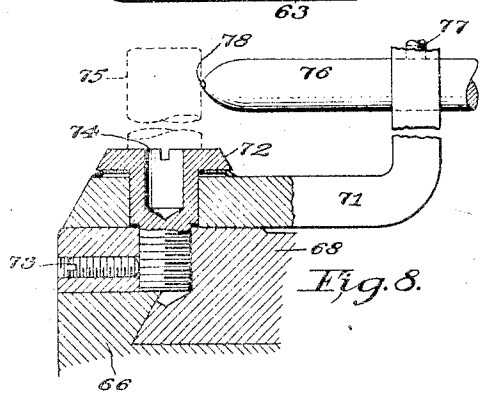


Fig. 8.

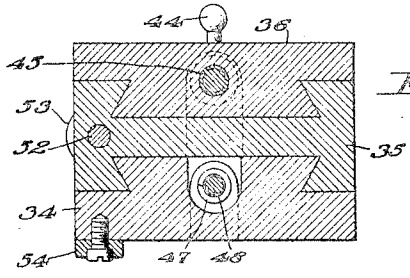


Fig. 6.

Fig. 5.

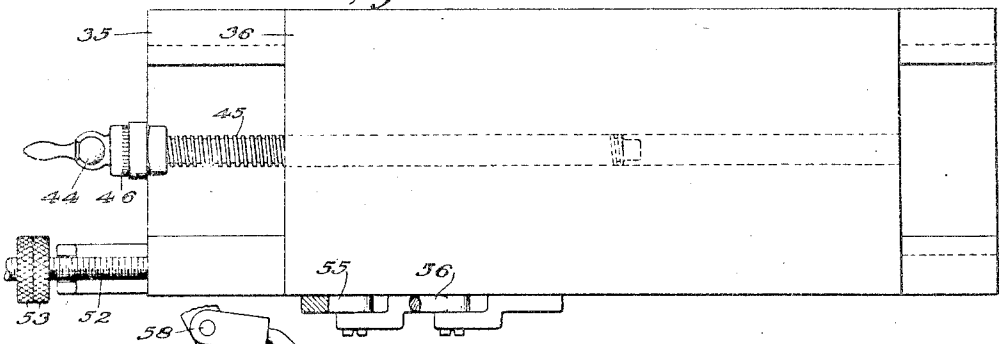
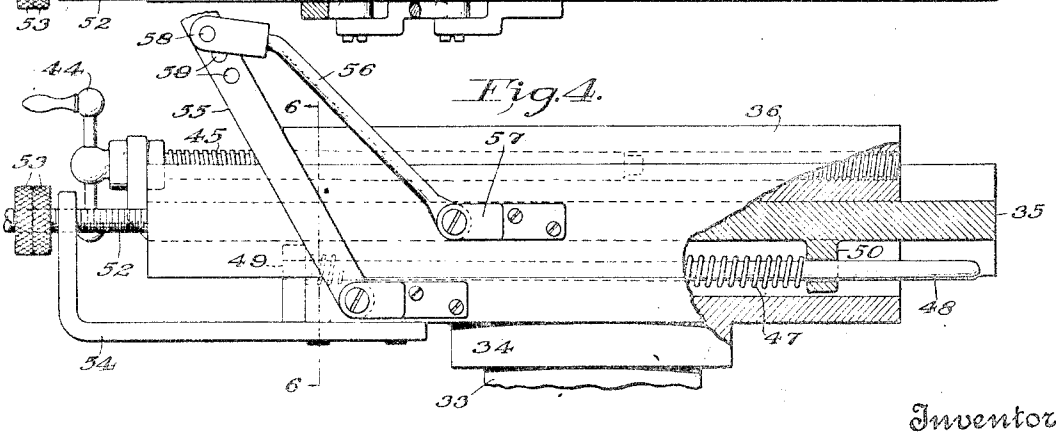


Fig. 4.



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MACHINE FOR GRINDING HOB AND DISK CUTTERS

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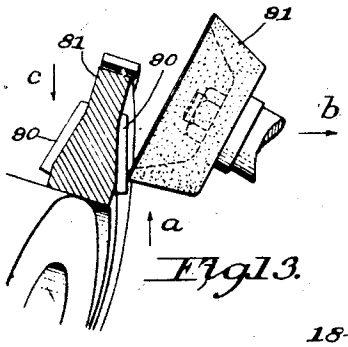
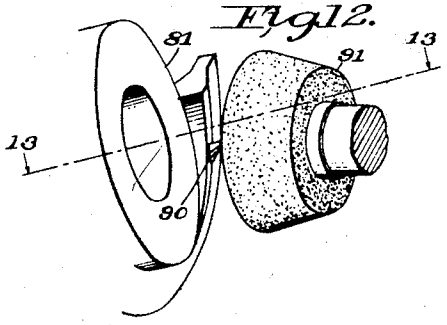


Fig 13.

Fig 12.



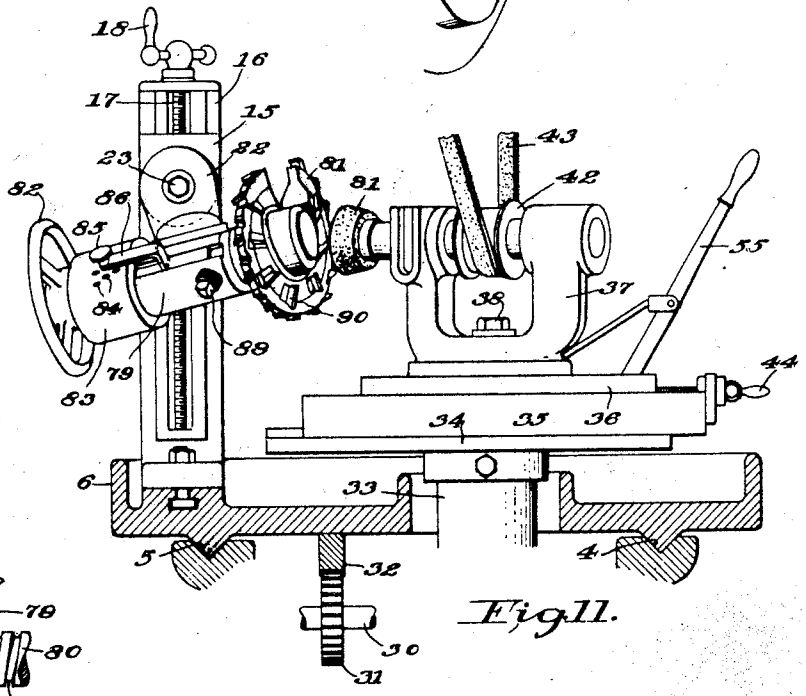


Fig 11.

Fig 14.

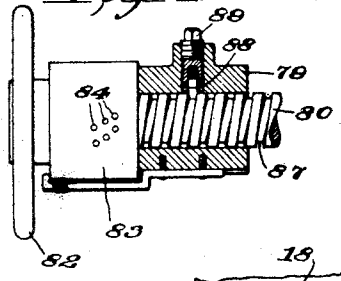
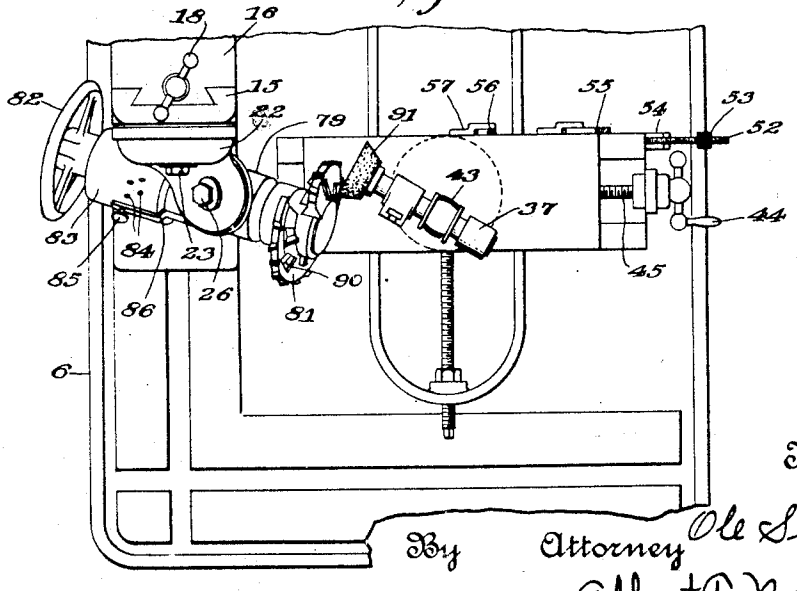


Fig 10.



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Patented Mar. 13, 1928. 1,662,079

UNITED STATES PATENT OFFICE.

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MACHINE FOR GRINDING HOB AND DISK CUTTERS.

Application filed February 2, 1925. Serial No. 6,255.

My invention relates to grinding machines for shaping the teeth of rotatable milling cutters in accordance with a predetermined form and particularly to machines for grinding and shaping the teeth on hobs and disk milling cutters.

One object of my invention is to provide a machine that shall have improved mechanism for supporting a grinding wheel and a blank whereby the grinding wheel and a blank disk or a hob section may be conveniently moved relatively to each other for shaping the teeth on the blank or the hob section in accordance with a predetermined form.

Another object of my invention is to provide a grinding machine having mechanism for adjusting a blank carrying arbor in horizontal and vertical planes to grinding relation with respect to a grinding wheel and that shall be provided with mechanism for effecting relative movement between the grinding wheel and the blank for grinding and shaping the blank teeth in accordance with a predetermined form.

A further object of my invention is to provide a grinding machine with mechanism for rectilineally adjusting a blank carrying arbor in vertical and horizontal planes and for rotatably adjusting the arbor about two perpendicularly located axes and that shall also have mechanism for operating a slide carrying the grinding wheel, whereby a predetermined relative movement may be effected between the grinding wheel and the blank to cut the blank teeth to a predetermined form.

A machine constructed in accordance with my invention is adapted to grind or shape the teeth not only on a flat disk milling cutter but also to grind teeth on a hob and particularly a gear cutting hob. The machine is particularly adapted for grinding disk milling cutters and hobs which are provided with detachable cutting teeth. In the patent to George W. Conklin No. 1,495,067, dated May 20, 1924, is disclosed a hob having side teeth which are particularly adapted to be ground in my machine. When grinding a hob, mechanism is provided for indexing the hob with respect to the grinding wheel and for holding the hob stationary during a grinding operation. Such mechanism also provides means for axially moving the hob in accordance with the hob lead when an indexing operation is being effected. Such indexing mechanism is not essential when grinding a flat disk milling cutter.

When a flat disk milling cutter is being ground in the machine, guiding means comprising a templet is mounted on the carriage which supports the cutter blank. The templet is provided for controlling the movements of the grinding wheel with respect to the blank and preferably the slide for supporting the grinding wheel is resiliently held in engagement with the templet. The templet and the cutter blank are moved relatively to the grinding wheel and accordingly the wheel is moved in accordance with the shape of the templet by reason of said resilient force to shape the teeth on the blank. The teeth on a flat disk milling cutter are first shaped in accordance with the form of the templet and then the teeth are relieved by a separate relieving operation. During the shaping of the teeth the cutter is constantly rotated and the carriage is so operated as to move the grinding wheel in accordance with the shape of a templet having the form to which the cutter teeth are to be shaped. Upon shaping of the teeth in accordance with the form of the templet, a grinding wheel of reduced size is provided and the arbor for supporting the cutter is inclined at an angle corresponding to the angle of relief desired on the side of the teeth. The relieving of the teeth is effected in the same manner as the shaping of the teeth with the exception that the grinding wheel is held stationary during such operation. The teeth of the milling cutters are successively indexed and held stationary in an operative position to be engaged by the grinding wheel.

Other objects and advantages will be in part indicated in the following description and in part rendered apparent therefrom in connection with the annexed drawings.

To enable others skilled in the art so fully to apprehend the underlying features hereof that they may embody the same in the various ways contemplated by this invention, drawings depicting a preferred typical construction have been annexed as a part of this disclosure and, in such drawings, like characters of reference denote corresponding parts through all the views, of which:—

In the accompanying drawings, Figure 1 is a front elevational view of a machine con-

structed in accordance with my invention. Fig. 2 is a side elevational view of the machine shown in Fig. 1. Fig. 3 is a plan view of the machine shown in Fig. 1. Fig. 4 is a view partially in section of the slides for carrying the grinding wheel. Fig. 5 is a plan view of the slides shown in Fig. 4. Fig. 6 is a sectional view along the line 6—6 of Fig. 4. Fig. 7 is a plan view of the attachment for dressing the grinding wheel. Fig. 8 is an elevational view partially in section of the dressing attachment. Fig. 9 is an end view of the dressing attachment. Fig. 10 is a plan view of the attachment for supporting a hob. Fig. 11 is an elevational view of the attachment shown in Fig. 10. Fig. 12 is a view illustrating the position of the grinding wheel with respect to the hob during a grinding operation. Fig. 13 is a sectional view along the line 13—13 of Fig. 12 and Fig. 14 is a view, partially in section, showing the worm on the arbor for supporting the hob.

Referring to the drawings, a grinding machine 1 is illustrated comprising a base or frame 2 which is mounted on suitable supports 3. The base 2 is provided with guideways 4 and 5 for supporting a carriage 6. The carriage 6 serves not only to carry the hob or disk, which is to be ground, but also to carry the guiding member for controlling the movements of the grinding wheel when the teeth of a flat disk milling cutter are to be ground to a predetermined shape.

Referring particularly to Figs. 1, 2 and 3, the grinding machine is shown arranged to grind the teeth 7 on a flat disk milling cutter 8 to a predetermined form. A templet slide 9, which carries a templet 10, is slidably mounted on the carriage 6. The slide 9 is moved along the carriage 6 by means of a screw shaft 11 under the control of a hand lever 12. Preferably a suitable scale 13, as shown in Fig. 3 of the drawings, is provided for indicating the position of the templet slide. The templet 10 is secured to the slide 9 in any suitable manner and is shaped in accordance with the shape desired to be formed on the teeth 7 of the milling cutter 8.

A blank carrying slide 15 is mounted on an arm 16 which projects from the carriage 6. A screw shaft 17, which is operated by a suitable hand lever 18, is provided for adjusting the position of the blank carrying slide 15 on the supporting arm 16. Preferably, a suitable scale 19 is provided on the arm 16 for indicating the position of the slide. Moreover, a scale 20 may be provided on a collar carried by the screw shaft 17. as indicated in Fig. 1 of the drawings. The slide 15 carries a supporting bracket 22. The bracket 22 is adjustable about a bolt 23. A suitable scale 24, shown in Fig. 1, is provided for indicating the rotative position of the bracket. An arbor bracket 25 is rotatably supported on the bracket 22 by means of a bolt 26. The arbor bracket 25 carries an arbor 27 which supports the cutter blank 8. The arbor 27 is provided with a bearing in the bracket 25 and carries a pulley 29. The pulley 29 is operated by a belt 30 forming a suitable source of power. The cutter blank 8 is preferably secured to the end of the arbor 27, as indicated in Fig. 3 of the drawing.

In the construction above set forth it will be noted that the axis for the blank 8 may be adjusted in a horizontal plane by moving the carriage 6 and may be adjusted in a vertical plane by operating the slide 15. Moreover attention is called to the function performed by the bolts 23 and 26 which serve as axes for adjusting the position of the blank arbor. In this respect it may be noted that the axis of the bolt 26 is located perpendicularly to the axis of the bolt 23.

A hand wheel 29, which is mounted on a shaft 30, is provided at the front of the machine for controlling the movement of the carriage 6. The shaft 30 carries a gear wheel 31 which meshes with a rack 32 on the lower surface of the carriage.

A projection 33 from the base 2 of the machine serves as a swiveling support for a base 34. The base 34, which is rotatable on the projection 33, carries a primary slide 35. The primary slide 35 carries a wheel slide 36 and a wheel supporting bracket 37 is rotatably mounted on the slide 36. The bracket 37 is rotatable about a bolt 38 and preferably a suitable scale 39 is provided for indicating the rotative position of the bracket.

A grinding wheel 40 is mounted on an arbor 41 which is supported on the bracket 37. The arbor 41 carries a pulley 42 which is disposed between the bearings for the arbor on the bracket. The pulley 42 is connected by a belt 43 to a suitable source of power. The wheel slide 36, which supports the bracket 37, is operated on the primary slide 35 by means of a suitable hand-lever 44. The lever 44 is mounted on a screw shaft 45, as shown in Figs. 1, 4 and 5 of the drawings. The screw shaft 45 is mounted on the primary slide 35 and is connected to the wheel slide 36 by means of a nut. The shaft 45, as shown in Figs. 4 and 5 of the drawings, carries a scale 46 for indicating the rotative position of the shaft.

A spring member 47 is provided for exerting a force tending to move the primary slide and the parts carried by it in a direction towards the templet 10 which is carried by the templet slide 9. The spring member, which is best shown in Fig. 4 of the drawings, is mounted on a rod 48. The rod 48 is supported on a block 49, which is secured in any suitable manner to the base member 34,

and projects through a lug 50 which extends from the primary slide 34. The spring member 47 is disposed between such lug 50 and the block 49. By so positioning the spring member 47 it is apparent a force is exerted on the lug 50 and accordingly on the primary slide 35 for tending to move the slide 35 towards the right when viewed in Fig. 4 of the drawings.

The movement of the slides 35 and 36 towards the templet 10 on the templet slide is limited by means of a bolt 52 which is secured to the slide 35, and two nuts 53 which are threadably mounted on the bolt. The bolt 53 projects through a bracket 54 which is secured to the base 34 as shown in Fig. 4 of the drawings. It will be noted that the nuts 53 may be adjusted on the bolt 54 for limiting the movement of the slides in one direction and the slides themselves may engage the bracket for limiting their movement in an opposite direction.

A hand-operated lever 55 is provided for exerting a force to oppose the spring 47 and to move the slides 35 and 36 away from the templet 10 on the templet slide. The hand-lever 55 is pivotally mounted on the base 34 and is connected to the slide 35 by means of a link 56. The link 56 is pivotally secured to a block 57 on the slide 35 and is adjustably secured to the lever 55 by means of a pin 58. The pin 58 is adapted to fit the various holes 59 in the hand-lever 55.

The wheel slide 36 carries a bracket 60 having a roller 61 mounted thereon. The roller 61 is adapted to engage the templet 10 for controlling the movements of the wheel slide. It will be noted the spring member 47 holds the roller 61 in engagement with the templet and, when the templet is moved by operating the carriage 6, the wheel slide will be moved in accordance with the shape of the templet.

A dressing attachment 62, which is mounted on the bracket 37, is provided for truing the grinding wheel 40 in accordance with the diameter of the roller 61. The dressing attachment 62 comprises an L-shaped base 63 which is secured to one arm of the bracket 37, as shown in Figs. 3, 7, 8 and 9 of the drawings. A T-headed bolt 64, which is secured to one arm of the L-shaped base 63, is fitted to a slot 65 in the bracket 37. The vertical position of the dressing attachment with respect to the axis of the grinding wheel is controlled by varying the position of the bolt 64 in the T-slot 65.

The base 63 carries a slide 66 which is movable in a direction towards or away from the grinding wheel. The slide 66 is operated on the base 63 by means of a screw shaft 67 which has an operating knob 68 secured to the end thereof. The slide 66 carries a dressing slide 68, which is movable in a direction perpendicular to the direction of movement of the slide 66. The slide 68 is operated by a screw shaft 69 which has a knob 70 secured to the end thereof. An angular bracket 71 is swivelled on a post 72, as best shown in Fig. 8 of the drawings. The post 72 is preferably threadably connected to the slide 68 and is held in position by means of a set screw 73. The post 72 is provided with a hole 74 in the center thereof for holding a guide pin 75. The pin 75 serves as a guide for setting the dressing attachment to true the grinding wheel to the required form. The angular bracket 71, which is swivelled on the post 72, carries a diamond holder 76. The holder 76 is adjustable in the angular bracket and is secured in any set position by means of a set screw 77. A diamond 78 is mounted in the end of the holder 76 for engaging and dressing the surface of the grinding wheel.

In dressing the wheel 40, the L-shaped bracket 63 is adjusted on the bracket 37 to position the diamond holder 76 in the same horizontal plane with the axis of the grinding wheel 40. The slides 66 and 68 are operated to move the diamond holder into operative relation to the grinding wheel 40. However, prior to the movement of the diamond holder 76 into operative relation to the grinding wheel, the pin 75 is positioned in the hole 74 for setting the holder 76. The pin 75 has a diameter the same as the diameter of the roller 61. When the pin 75 is in position, as above set forth, the diamond holder is moved in the bracket 71 so as to engage the surface of the pin 75. When the diamond holder 76 is so set it is apparent the movement of the angular bracket 71 about the post 72 as a center of rotation serves to move the diamond in a circular path similar to the circumference of the roller 61. Consequently, when the diamond holder is moved into operative position with respect to the grinding wheel 40 and is moved about the post 72 as a center, the grinding wheel will be dressed exactly in accordance with the shape of the roller 61.

The teeth 7 on the milling cutter 8 are first shaped in accordance with the form of the templet 10 and then are relieved by a separate operation. During the shaping of the teeth 7, the milling cutter 8 is constantly rotated and the carriage 6 is operated to move the templet 10 along the roller 61. The movement of the templet 10 along the roller 61 serves to operate the grinding wheel 40 in accordance with the shape of such templet.

After shaping the teeth 7 in the above indicated manner, the grinding wheel 40 is replaced by a grinding wheel of much smaller diameter. The smaller grinding wheel is dressed in the same manner as the large grinding wheel to the shape of the roller 61. The axis of the milling cutter 8 is adjusted

about the bolt 23 in accordance with the angle of relief desired on the sides of the milling cutter teeth. During the relieving operation, the milling cutter is held stationary with the face of one tooth substantially in the same plane as the axis of the grinding wheel. The grinding wheel and the milling cutter are moved relative to each other by means of the carriage 6 in the same manner as above set forth in describing the shaping of the cutter teeth. The outer periphery of each of the teeth is relieved to the same angle as the sides thereof by a hand grinding operation in any suitable manner. If the teeth on the milling cutter are disposed non-radially, it is necessary to correct the shape of the templet 10 in accordance with the hook on the teeth and to adjust the centers of the milling cutter and the grinding wheel in accordance with the degree of hook on the teeth.

Referring to Figs. 10, 11, 12, 13 and 14 of the drawings, an attachment is shown which is particularly adapted to grind the side teeth on hobs. The description heretofore given as to Figs. 1 to 9 inclusive, refers particularly to the grinding of flat disk milling cutters. When the side teeth on a hob are to be ground the arbor bracket 25, shown in Fig. 1 of the drawings, is replaced by a hob bracket 79. The hob bracket 79 is angularly adjusted on the supporting bracket 22 in the same manner as the arbor bracket 25 is adjusted on the supporting bracket 22. The hob bracket 79 carries a hob arbor 80. A hob or hob section 81, which carries the teeth to be ground, is mounted on one end of the arbor 80 and a hand wheel 82 is mounted on the opposite end thereof. Between the hand wheel 82 and the bearing for the arbor on the hob bracket is mounted an indexing drum 83. The indexing drum is splined to the arbor 80 and has a number of holes 84 formed in the periphery thereof. Such holes 84 are arranged according to the indexing operations desired and cooperate with a pin 85 for indexing the arbor 80 and the hob section 81. The pin 85 is mounted on a bracket 86 which is secured to the hob bracket 79, as shown in Fig. 11 of the drawings. A thread 87 is formed on the arbor 80 with the same lead as the lead of the hob to be ground. The thread 87 is engaged by a shoe 88 under the control of a set screw 89. The set screw 89 and the shoe 88 are mounted in the hob bracket 79. Thus, it is apparent upon rotation of the arbor 80 a longitudinal movement thereof will be effected. The shoe 88 and the set screw 89 serve not only to effect longitudinal movement of the arbor and the hob section in accordance with the rotative movement thereof but also serve to clamp the arbor and the hob section in any indexed position. The above mechanism for indexing a hob section is disclosed and claimed in my co-pending application for "method of and machine for grinding fine tooth hobs" filed January 12, 1925, Serial Number 1,876.

In grinding a side tooth 90 on the hob section 81, the supporting bracket 22 is adjusted about the bolt 23 as a center in accordance with the relief desired to be formed on tooth 90. The hob bracket 79 is adjusted about the bolt 26 as a center in accordance with the side angle of the tooth 90. The slide 15 is adjusted and the hob section 81 is indexed so as to have a tooth 90 in the same horizontal plane with the axis of a grinding wheel 91. In referring to Figs. 10, 11, 12 and 13 of the drawings, it will be noted a cup shaped wheel 91 is substituted for the grinding wheel 40 shown in Figs. 1 and 2 of the drawings. The base support 34 for the slides 35 and 36, which carry the grinding wheel, is swivelled on the support 33 to bring the wheel 91 into the position shown in Fig. 13 of the drawings. When the grinding wheel 91 and the hob section 81 are positioned as shown in Fig. 13 of the drawings, the carriage 6 is operated by the hand-wheel 29 for effecting movement of a tooth 90 along the grinding wheel 91. It will be noted that the grinding wheel 91 is in rotation whereas the hob section 81 is held stationary. The relation of the hob section with respect to the grinding wheel is in a direction indicated by the arrow *a* in Fig. 13 of the drawing. When the grinding wheel is at the end of the hob tooth, one or the other of the slides 35 and 36 are operated for moving the grinding wheel 91 in the direction indicated by the arrow *b* in Fig. 13 of the drawings. At such point in the operation, the hob section 81 is indexed to bring a second tooth 90 into operative relation with respect to the grinding wheel. During or after the indexing operation the carriage 6 is operated in the direction of the arrow *c* to bring the grinding wheel and the hob section 81 into position for grinding the second tooth. The above operation is repeated until all of the teeth on one side of the hob section have been ground. A new setting, similar to the above described setting, is made to grind the teeth on the opposite side of the hob section.

Without further analysis, the foregoing will so fully reveal the gist of this invention that others can, by applying current knowledge, readily adapt it for various utilizations by retaining one or more of the features that, from the standpoint of the prior art, fairly constitute essential characteristics of either the generic or specific aspects of this invention and, therefore, such adaptations should be and are intended to be, comprehended within the meaning and range of equivalency of the following claims.

Having thus revealed this invention, I

claim as new and desire to secure the following combinations and elements, or equivalents thereof, by Letters Patent of the United States:

1. In a grinding machine, the combination comprising a carriage slidably mounted on the frame of the machine; a blank slide mounted on said carriage and movable in a direction perpendicular to the direction of the carriage movement; a blank carrying arbor mounted on said blank slide; a wheel slide mounted on the frame of the machine and movable therealong in a direction perpendicular to the direction of carriage movement and in a plane parallel to said carriage plane; means for exerting a force tending to move the wheel slide towards the blank slide; and a grinding wheel mounted on said wheel slide.

2. In a grinding machine, the combination comprising a carriage slidably mounted on the frame of the machine; a blank carrying arbor mounted on said carriage and rotatably adjustable about two perpendicularly located axes; a wheel slide rotatably mounted on the frame of the machine and slidable with respect to said carriage; a grinding wheel mounted on said slide; and means for effecting a predetermined movement of the wheel slide upon movement of said carriage.

3. In a grinding machine, the combination comprising a carriage slidably mounted on the frame of the machine; a blank slide mounted on said carriage; a blank carrying arbor mounted on said blank slide and rotatably adjustable about two perpendicularly located axes; a wheel slide mounted on the frame of the machine and movable with respect to the carriage; a bracket mounted on said wheel slide and adjustable about an axis perpendicular to the plane of movement of the wheel slide; and a rotating grinding wheel mounted on said bracket.

4. In a grinding machine, the combination comprising a carriage slidably mounted on the frame of the machine; a blank carrying arbor mounted on said carriage and rotatably adjustable about two perpendicularly located axes; a slide rotatably mounted on the machine frame and movable with respect to the carriage; means normally exerting a force tending to move said slide; and a wheel supporting bracket mounted on said slide and rotatable about an axis perpendicularly located with respect to the plane of movement of the slide.

5. In a grinding machine, the combination comprising a carriage slidably mounted on the frame of the machine; a slide mounted on said carriage and movable in a direction perpendicular to the direction of movement of the carriage; a supporting bracket mounted on said slide and rotatably adjustable about an axis located perpendicularly to the direction of movement of the slide; an arbor bracket mounted on said supporting bracket and rotatable about an axis located perpendicularly to the axis of adjustment for the supporting bracket; a blank carrying arbor mounted on said arbor bracket; a wheel slide rotatably mounted on the frame of the machine and movable with respect to the direction of carriage movement; and a rotatable grinding wheel mounted rotatably on said wheel slide for engaging a blank carried by said arbor.

6. In a grinding machine, the combination comprising a carriage slidably mounted on the frame of the machine; a supporting bracket mounted on said carriage and rotatably adjustable about an axis parallel to the direction of carriage movement; an arbor bracket mounted on said supporting bracket and rotatable about an axis perpendicularly located with respect to the axis of adjustment for the supporting bracket; a wheel slide mounted on the frame of the machine; a rotatable grinding wheel mounted on said wheel slide for engaging a blank carried by said arbor bracket; and means for effecting a predetermined movement of the wheel slide upon movement of said carriage.

7. In a grinding machine, the combination comprising a carriage slidably mounted directly on the frame of the machine; a supporting bracket mounted on said carriage and rotatably adjustable about an axis parallel to the direction of carriage movement; a blank carrying bracket mounted on said supporting bracket and rotatable about an axis perpendicular to the axis of adjustment for the supporting slide; a blank carrying arbor mounted on the blank bracket; a wheel slide directly mounted on the machine frame; and means for effecting a predetermined movement of the wheel slide upon movement of the carriage.

8. In a grinding machine, the combination comprising a carriage slidably mounted directly on the frame of the machine; a slide mounted on said carriage and movable in a direction perpendicular to the direction of movement of the carriage; a supporting bracket mounted on said slide and rotatably adjustable about an axis perpendicular to the direction of movement of the slide; a blank carrying bracket mounted on said supporting bracket and rotatable about an axis located perpendicularly to the axis of adjustment for the supporting bracket; a blank carrying arbor mounted on the blank carrying bracket; a wheel slide directly mounted on the machine frame; and means for effecting a predetermined movement of the wheel slide upon movement of the carriage.

9. In a grinding machine, the combination comprising a base rotatably mounted on the frame of the machine; a primary slide mounted on said base; means for exerting a force tending to move the primary slide in

a predetermined direction; a wheel slide mounted on said primary slide and adjustable with respect thereto; a bracket mounted on said wheel slide and adjustable about an axis perpendicular to the planes of movement of the two slides; and a rotating grinding wheel mounted on said bracket.

10. In a grinding machine, the combination comprising a primary slide mounted on the frame of the machine; means normally exerting a force on said primary slide tending to move it in a predetermined direction; a wheel slide mounted on the primary slide and adjustable with respect thereto, a bracket mounted on said wheel slide and adjustable about an axis perpendicular to the plane of movement of the primary slide; and a rotating grinding wheel mounted on said bracket.

11. In a grinding machine, the combination comprising a primary slide mounted on the frame of the machine; means normally exerting a force on said primary slide to move it in a predetermined direction; a wheel slide mounted on the primary slide and adjustable with respect thereto; a grinding wheel mounted on said wheel slide; and means for angularly adjusting said slides with respect to the frame of the machine.

12. In a grinding machine, the combination comprising a rotating cutter blank; a carriage for supporting said blank; a templet mounted on said carriage; a slide for supporting a rotating grinding wheel; and means for resiliently holding the wheel slide in engagement with said templet whereby the carriage may be operated for so moving the grinding wheel as to grind the cutter teeth in accordance with the shape of the templet.

13. In a grinding machine, the combination comprising a rotating cutter blank; a carriage for supporting said cutter blank; a templet mounted on said carriage and having the shape desired to be cut by the finished cutter; a slide for supporting a rotating grinding wheel and movable in a direction perpendicular to the direction of movement of the carriage; and means for holding the wheel slide resiliently in engagement with templet whereby the carriage may be operated for so moving the grinding wheel as to grind the cutter teeth in accordance with the shape of the templet.

14. In a grinding machine, the combination comprising a rotating cutter blank; a rotating grinding wheel for engaging the teeth on the cutter blank; means for supporting said wheel and the cutter to effect movements at right angles to each other; and means comprising a templet for controlling the movements of said supporting means to grinding the teeth on the cutter in accordance with the form of said templet.

15. In a grinding machine, the combination comprising a rotating arbor for supporting a cutter blank; a carriage for supporting said arbor and movable upon ways formed on the frame of the machine; a templet mounted on said carriage and having the shape desired to be cut by the teeth of the cutter; a rotating grinding wheel; a slide for supporting said wheel independent of said carriage; means for resiliently holding said wheel slide in engagement with said templet whereby the carriage may be operated for so moving the grinding wheel as to grind the cutter teeth in accordance with the shape of the templet.

16. In a grinding machine, the combination comprising a rotating arbor for supporting a cutter blank, a carriage for supporting said arbor and movable on the frame of the machine; a grinding wheel for shaping the teeth on the cutter; and slides for supporting said wheel; a templet adjustably mounted on said carriage; and means mounted on the wheel slides for engaging said templet whereby the carriage and the wheel slides may be moved for so operating the wheel and the cutter blank as to grind the cutter teeth in accordance with the shape of the templet.

17. In a grinding machine, the combination comprising a rotating arbor for supporting a cutter blank, a slide movable in a vertical plane and serving to support said arbor; a carriage for supporting said vertical slide and having movement in a horizontal plane; a templet adjustable upon said carriage and having the shape desired to be formed on the teeth of the cutter blank; a rotating grinding wheel; two slides for supporting said grinding wheel and having movement parallel to said arbor; means for resiliently holding one of said slides in engagement with said templet, whereby the carriage may be moved for so operating the wheel and the cutter blank as to grind the cutter teeth in accordance with the shape of the templet.

18. In a grinding machine, the combination comprising a carriage slidably mounted on the frame of the machine; a blank carrying arbor; a bracket mounted on said carriage and supporting said arbor, said bracket being angularly adjustable to vary the position of the arbor about an axis parallel to the direction of the carriage movement; a wheel slide mounted on the frame of the machine and movable in a direction perpendicular to the direction of carriage movement; means for exerting a force tending to move the wheel slide in a predetermined direction; and a grinding wheel mounted on the wheel slide.

19. A grinding machine combining, a frame; a carriage mounted for horizontal movement thereon; a slide mounted for ver-

tical movement on said carriage; a blank carrying arbor mounted on said slide; a wheel slide horizontally movable on said frame; means normally urging said wheel slide in a predetermined direction; and coacting templet means between said carriage and wheel slide for determining the relative movement thereof.

20. A grinding machine combining a carriage slidably mounted on the frame; a blank carrying bracket mounted on said carriage; an auxiliary slide mounted on said carriage; a templet carried by said auxiliary slide; a grinding wheel slide mounted on the frame; and means normally urging said wheel slide into engagement with said templet as the carriage is translated.

In witness whereof, I have hereunto subscribed my name.

OLE SEVERSON.