Feb. 28, 1928. 1,660,890

C. SCHRAMM

GRINDING MACHINE

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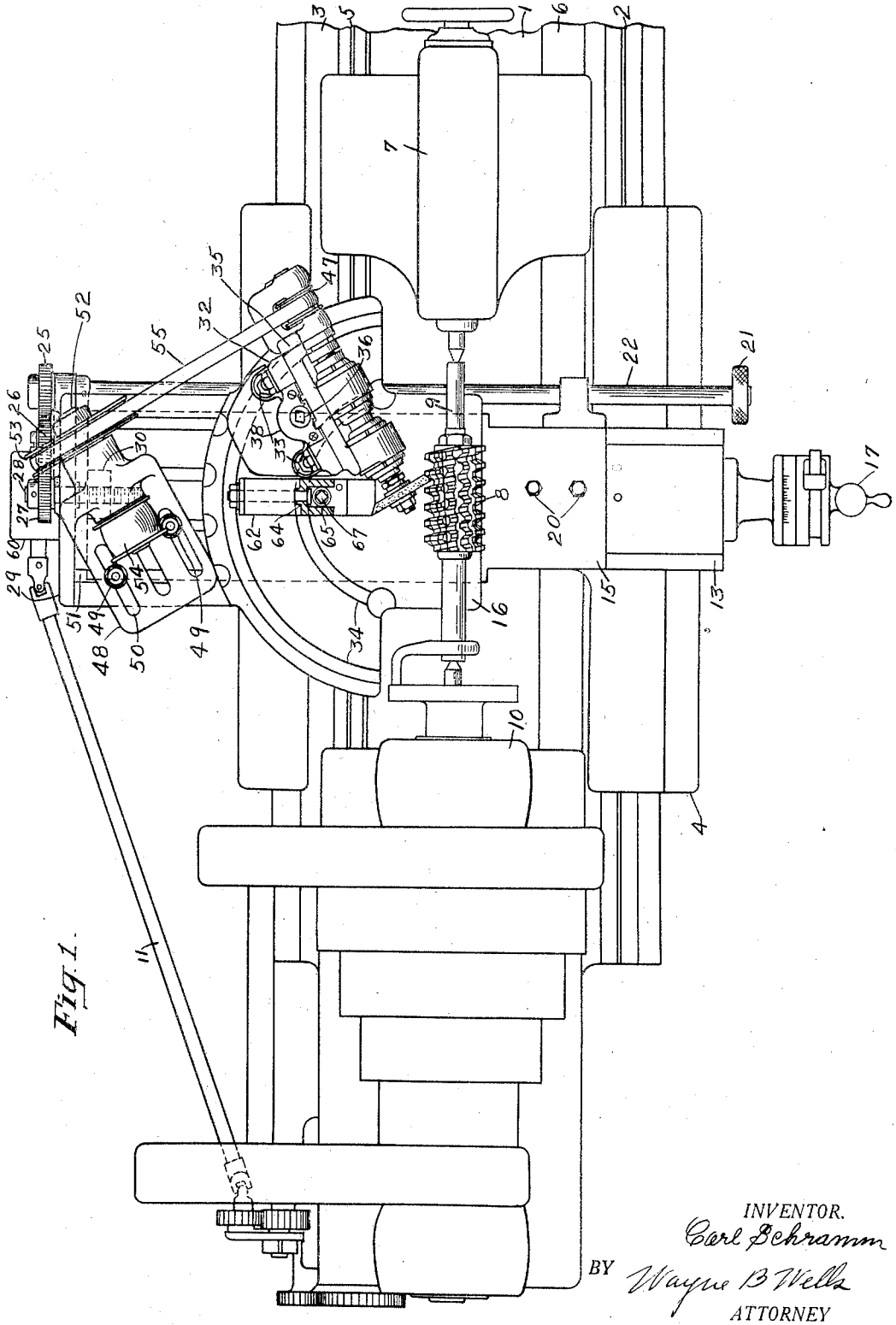


Fig. 1.

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Fig. 2.

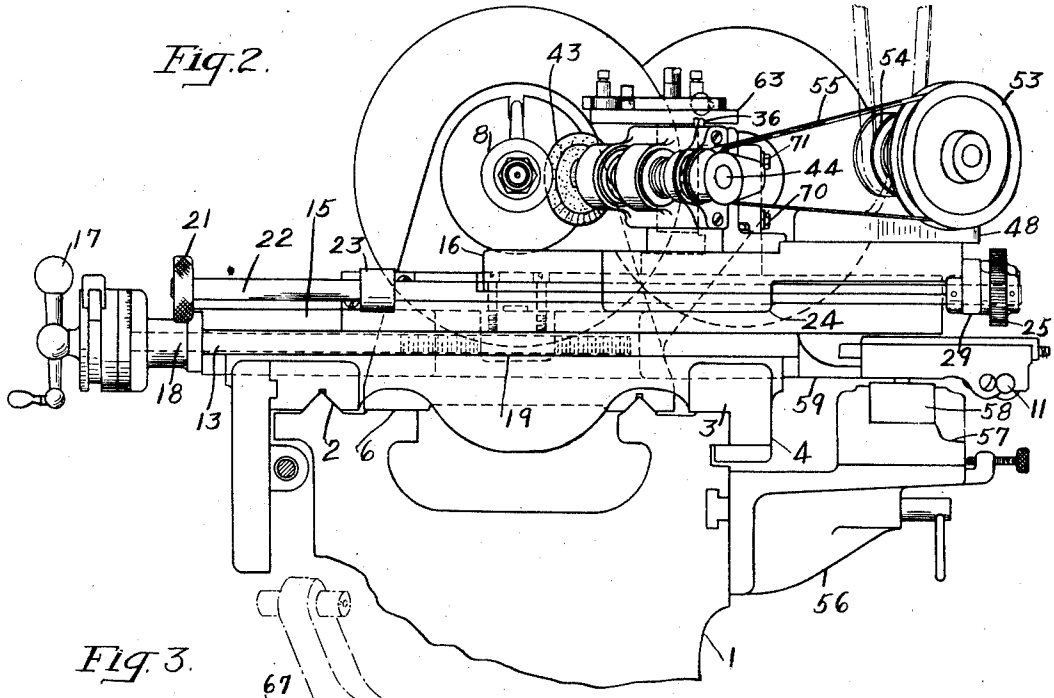



Fig. 3.

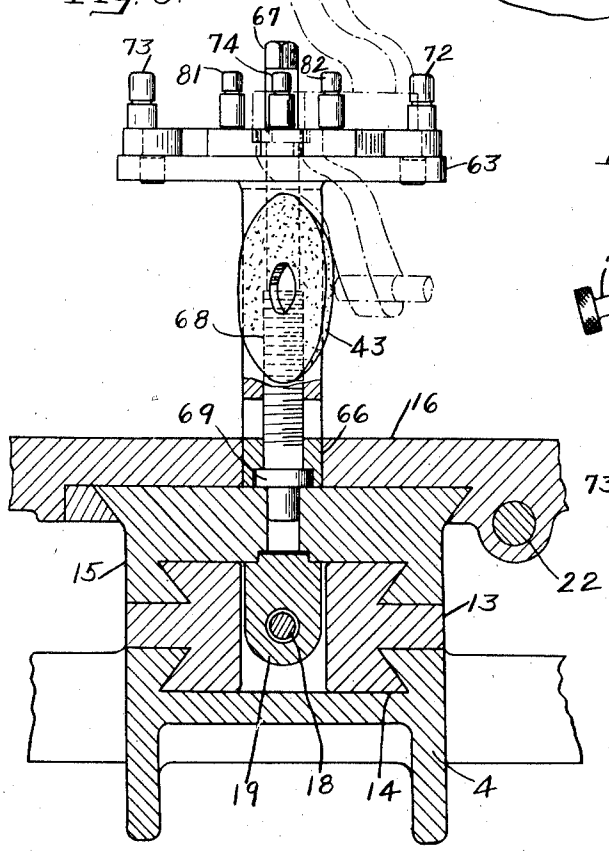
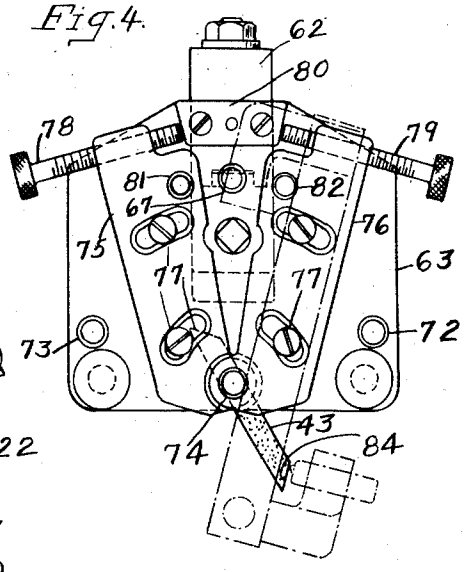



Fig. 4.




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Fig. 5.

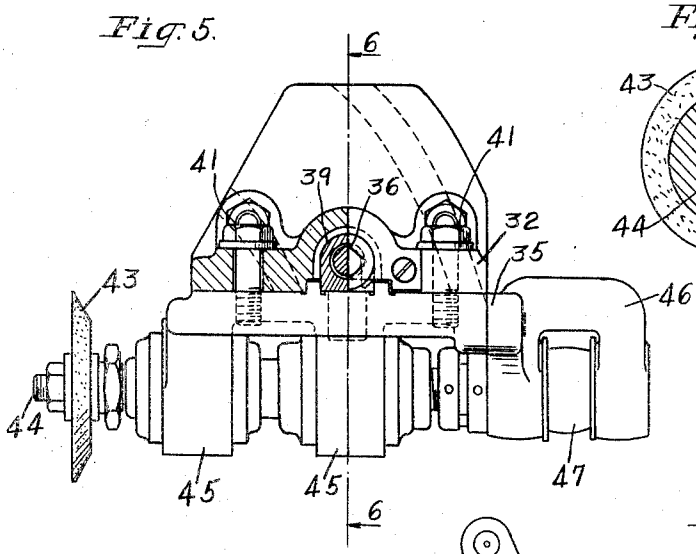



Fig. 6.

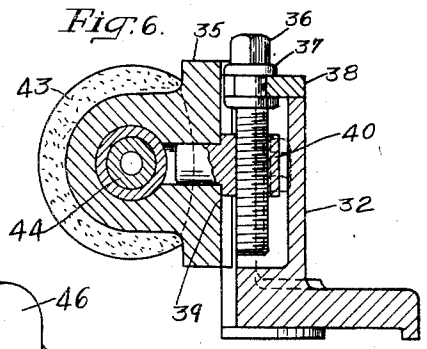



Fig. 7.

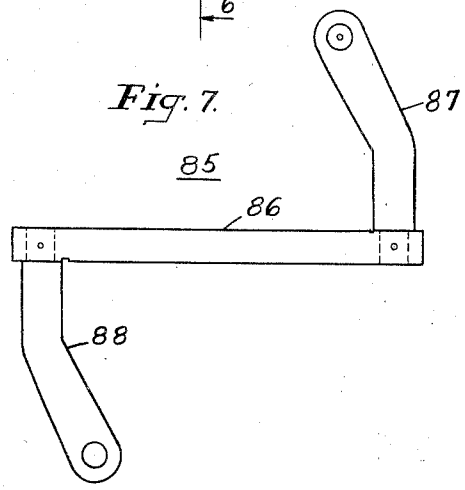



Fig. 8.

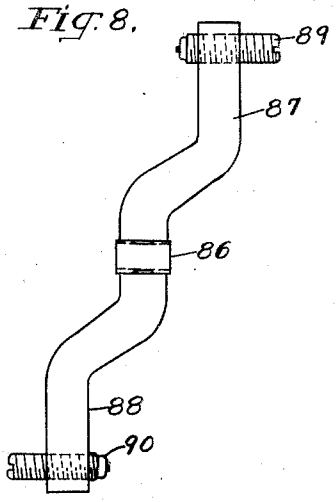



Fig. 9.

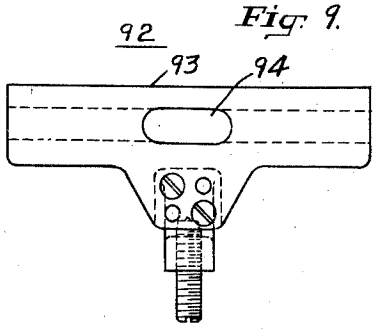
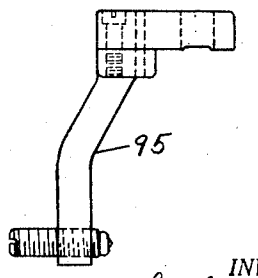



Fig. 10.




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Patented Feb. 28, 1928. 1,660,890

# UNITED STATES PATENT OFFICE.

CARL SCHRAMM, OF WEST HARTFORD, CONNECTICUT, ASSIGNOR TO PRATT & WHITNEY COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

## GRINDING MACHINE.

Application filed February 8, 1924. Serial No. 691,398.

My invention relates to machines for grinding helicoidal surfaces and particularly to machines for grinding hobs.

One object of my invention is to provide a grinding machine that shall grind either radially arranged or undercut teeth on a hob in an efficient and improved manner.

Another object of my invention is to provide a grinding machine of the above indicated character that shall grind the sides of the hob teeth to involute helicoids in conformity to any desired relief so that the cutting faces of the teeth may be ground without changing the contour cut by the teeth.

A further object of my invention is to provide a grinding machine of the above indicated character that shall be provided with a cone shaped grinding wheel for grinding the sides of the hob teeth to involute helicoids and that shall be provided with means for elevating the grinding wheel axis relative to the hob axis according to the involute helicoids being ground on the hob teeth.

As is well known, it is difficult to accurately grind a continuous screw thread with any degree of accuracy unless the thread is very small. However, it is a relatively simple matter to grind a surface which is in the form of an involute helicoid. The properties of involute helicoids are discussed at considerable length in the patent to Earle Buckingham No. 1,540,757 granted June 9, 1925. Accordingly an extended description of the involute helicoid will not be given in this application.

An involute helicoid may be considered as being formed by continuously advancing a line along a helix while maintaining the line tangent to the helix. Inasmuch as the involute helicoid is formed by lines tangent to a helix, it is apparent a grinding plane may be provided which includes any line which is tangent to the helix. Therefore, it is apparent that it is a relatively simple matter to grind an involute helicoid. However, as above set forth, it is impossible to accurately grind a continuous screw thread with any degree of accuracy unless the lead of the thread is very small. The reason for the difficulty of grinding the screw thread is the inability of the grinding wheel to cut along the same cutting line by which the thread was initially formed.

Although a machine constructed in accordance with my invention is particularly adapted to grind a hob for forming involute gear teeth, it is to be understood that such machine is also applicable for grinding thread hobs, taps, worm threads and other similar articles. Although my invention is illustrated with a commercial relieving lathe, it is to be understood that my invention is equally applicable to a relieving machine such as disclosed in the patent to Friederich Müller, No. 1,429,611 dated September 19, 1922. The machine is adapted to grind hobs having straight or helical flutes and having teeth provided with radially or non-radially arranged cutting faces. The machine is preferably operated in accordance with the methods disclosed in the application of Ernest Wildhaber Serial No. 543,385 filed March 13, 1922.

In the accompanying drawings:

Figure 1 is a plan view of a machine embodying my invention.

Fig. 2 is an end elevational view of the machine shown in Fig. 1,

Fig. 3 is a fragmentary front elevational view, partially in section, of the machine shown in Fig. 1.

Fig. 4 is a plan view of the dressing plate.

Fig. 5 is a plan view of the grinding wheel and the wheel bracket.

Fig. 6 is a section along the line 6—6 of Fig. 5.

Figs. 7 and 8 are views of one dressing bar for the wheel.

Figs. 9 and 10 are views of a second dressing bar for truing the outside diameter of the wheel.

Referring to the drawings, the machine shown in Figs. 1, 2 and 3 of the drawings comprises a main frame 1 having ways 2 and 3 formed thereon for supporting a carriage 4 and ways 5 and 6 for supporting a suitable tailstock 7. A hob blank 8, which is mounted on an arbor 9, is shown in position between the tailstock 7 and headstock 10. The headstock 10 may be of any suitable type and also serves to operate the relieving rod 11 in timed relation to the blank rotation. The relieving rod 11 serves to effect relieving movements by the grinding wheel.

A relieving slide 13 is mounted in a transverse guideway 14 formed on the carriage 4. An adjusting slide 15 is mounted on the relieving slide 13, as shown in Fig. 3 of the drawings, and an adjusting plate 16 is mounted on the adjusting slide 15. The slide

15 is adjusted relative to the relieving slide 13 by means of a handle 17 which operates a screw 18. The screw 18 is mounted in the relieving slide 13 and is connected to the adjusting slide 15 by a suitable nut 19. The adjusting slide 15 is preferably secured to the relieving slide 13 by suitable bolts 20, as indicated in Fig. 1 of the drawings. The slide 15 merely serves to obtain rough adjustment of the grinding wheel with respect to the blank.

The base plate 16 is adjusted with respect to the slide 15 by means of a knob 21, which is mounted on a shaft 22. The shaft 22 is provided with a bearing 23 on the adjusting slide 15 and with a bearing 24 on the base plate 16. A gear wheel 25, which is mounted on the rod 22 near the end thereof, meshes with a gear wheel 26. The gear wheel 26 meshes with a gear wheel 27, which is mounted on a screw shaft 28. The screw shaft 28 and the gear wheels are supported on a bracket 29 which is attached to the base plate 16. The screw 28 is connected to the adjusting slide 15 by means of a suitable nut 30. Thus, by operating the rod 22, adjustment of the base plate 16 with respect to the adjusting slide 15 is effected. Such adjustment is used during the dressing of the wheel.

A grinding wheel bracket 32 is mounted on the base plate 16 and is connected thereto by means of bolts 33. The bolts 33 extend into circular guideways or T-slots 34 which are formed in the base plate. The bracket 32 carries a slide 35 which is moved vertically by means of a suitable screw 36. The screw 36 is provided with two collars 37 which are disposed above and below a plate 38. The plate 38 is attached to the top of the bracket 32. The screw 36 is attached to the slide 35 by means of a nut 39 which projects into the slide 35, as shown in Figs. 5 and 6 of the drawings. Thus, by operating the screw 36, the vertical position of the wheel slide 35 is varied. Two bolts 41, which project through slots formed in the bracket 32, serve to hold the wheel slide securely in any adjusted position. A grinding wheel 43 is mounted on a suitable shaft 44. The shaft 44 is supported on the wheel slide 35 by means of bearings 45 and a pulley bracket 46. The pulley bracket 46 is U-shaped and carries a pulley 47 for operating the wheel shaft 44, as shown in Fig. 5 of the drawings.

A power bracket 48, which is mounted on the base plate 16, is secured thereto by means of bolts 49. The bolts 49 extend through slots 50 formed in the power bracket into T-slots 51 which are formed in the base plate. By means of the slots formed in the bracket and in the base plate, it is possible to effect any desired adjustment of the power bracket with respect to the base plate. The bracket 48 carries a shaft 52 on which are mounted two pulleys 53 and 54. The pulley 53 is connected by a suitable belt 55 to the pulley 47 on the shaft 44 and the pulley 54 is connected by a suitable flexible connection to a source of power.

A bracket 56, which is supported on the frame 1 of the machine, carries a guideway 57 for a taper slide 58. The relieving slide 13 is connected to the taper slide 58 by means of an arm 59. The bracket 56 also supports a suitable relieving attachment 60 which is operated by the shaft 11. Inasmuch as the relieving attachment and the taper arm are well known in the art, a detail description thereof is deemed unnecessary.

A wheel dressing bracket 62, which is secured to the adjusting slide 15, supports a wheel dressing plate 63. The wheel dressing bracket is provided with a groove 64 in which a projecting portion 65 from the plate 63 is fitted. The bracket 62 projects through an elongated slot 66 formed in the base plate 16 in order that the dressing bracket and the dressing plate may have movement relative to the base plate 16 and the wheel 43. A screw 67, which has a threaded portion 68 connected to the projection 65 from the dressing plate 63, is provided with a collar 69. The collar 69 is located below the dressing bracket 62, as indicated in Fig. 3 of the drawings. It is apparent the rotation of the screw 67 serves to effect relative vertical movement between the dressing bracket 62 and the dressing plate 63. Two bolts 70 and 71 are provided for holding the dressing plate 63 securely in any adjusted position.

The dressing plate 63 carries three dressing pins 72, 73 and 74. The dressing pin 74 serves as a pivotal support for two adjusting plates 75 and 76. The adjusting plates 75 and 76 are held in adjusted position by means of screws 77 which pass through arcuate slots formed in the adjusting plates. Two screws 78 and 79 are respectively mounted on the adjusting plates 75 and 76 and engage a stop 80 on the dressing plate 63. Such screws 78 and 79 serve to adjust the angular position of the plates 75 and 76. Two dressing pins 81 and 82 are respectively mounted on the adjusting plates 75 and 76. The pins 81 and 82 serve with the pin 74 as reference points for truing the grinding face 84 of the wheel to any desired angle relative to a plane perpendicular to the blank axis.

Referring to Figs. 7 and 8, a wheel dressing bar 85 is illustrated which is adapted to dress the peripheral grinding face of the wheel 43 to any desired angle. The dressing bar 85 comprises a straight section 86, which engages the pins 82 and 74 or the pins 81 and 74, and two arms 87 and 88. The two arms 87 and 88 respectively carry two screws 89 and 90 having diamonds suit-

ably mounted therein. The machine disclosed in this application is preferably provided with a right hand and a left hand bracket for supporting the grinding wheel. In the drawings, only a right hand bracket 32 is illustrated. The left hand bracket is similar in construction to the right hand bracket and serves to support the grinding wheel on the opposite end of the guideways 34, in order that the opposite sides of the hob teeth may be ground and relieved. An illustration and a further description of such slide is considered unnecessary.

In dressing the grinding wheel 43 in the position shown in the drawings, the plate 76 is adjusted in accordance with the angle desired to be formed on the peripheral grinding face of the wheel. The straight section 86 of the dressing bar 85 is then moved in engagement with the pins 82 and 74 and the diamond carried by the arm 88 engages the wheel 43, as indicated in Fig. 4 of the drawings. In case the grinding wheel is in the opposite position for grinding the opposite sides of the hob teeth, then the plate 75 is adjusted in accordance with the angle desired to be formed on the grinding wheel. The bar 86 is moved in engagement with the pins 74 and 81 so that the arm 87 moves the diamond carried thereby in contact with the grinding wheel.

In case it is desired to adjust the outside diameter of the grinding wheel and form a flat thereon as is necessary when grinding certain types of thread hobs, a dressing bar 92 is provided. The bar 92 cooperates with the two pins 73 and 72 when dressing the outside diameter of the grinding wheel. The bar 92 comprises a straight portion 93 having a slot 94 formed therein and a projecting arm 95. When the bar is in position and in engagement with the pins 73 and 72, the pin 74 projects through the slot 94. The arm 95 carries a diamond which is mounted in a suitable pin. In order to operate the bar 92 to true the outside diameter of the grinding wheel, it is apparent that the axis of the grinding wheel must be set parallel to the axis of the blank.

In grinding a blank in accordance with my invention, the screw 18 is operated by the handle 17 for adjusting the grinding wheel in position for grinding the sides of the hob teeth. The screw 36, which controls the elevating of the grinding wheel, is adjusted in accordance with the involute which is to be formed on the blank. The dressing plate 63, which carries the pins 72 and 74 and also the adjusting plates 75 and 76 is kept a fixed distance from the top of the wheel slide 35. Thus, if the wheel slide is elevated any distance, the dressing plate must be elevated the same distance in order that the grinding wheel may be correctly dressed. The plate 63, as heretofore set forth, is adjusted by means of a screw 67. Upon grinding one side of the hob teeth, the wheel is mounted on the oppositely positioned bracket for grinding the opposite sides of the hob teeth.

In case it is desired to dress the grinding wheel, the wheel is moved away from the blank by means of the handle 17. Thereupon, the knob 21 is operated to advance the grinding wheel very slightly. One of the dressing bars is operated on the plate 63 to dress the wheel in accordance with the movement thereof which has been effected by the knob 21. In this regard, it will be noted the handle 17 serves to adjust the wheel with respect to the blank and the knob 21 serves merely for adjusting the position of the diamond with respect to the wheel for truing purposes.

Modifications in my machine, and in the arrangement and location of parts may be made within the spirit and scope of my invention and such modifications are intended to be covered by the appended claims.

What I claim is:

1. In a machine for grinding hobs, the combination with a rotating blank, a relieving slide, means for effecting feeding and relieving movements by said slide in timed relation to the blank rotation, and a grinding wheel having a peripheral grinding surface, of means for mounting said wheel on the slide so that the grinding face may make any predetermined angle with a plane perpendicular to the blank axis, and means for varying the position of the wheel axis so that the blank axis is not included in the plane of relieving movements effected by the axis of the grinding wheel.

2. In a machine for grinding hobs, the combination with a rotating blank, a relieving slide, means for effecting feeding and relieving movements by said slide in timed relation to the blank rotation, and a grinding wheel having a peripheral grinding surface, of means for varying the position of the grinding wheel with respect to the axis of the blank so that the axis of the wheel is positioned a predetermined distance from the blank axis in a direction perpendicular to the plane of the relieving movements to cut involute helicoids on the sides of the hob teeth.

3. In a machine for grinding hobs, the combination with a rotating blank, a relieving slide, means for effecting horizontal relieving movements by said slide in timed relation to the blank rotation, and means for effecting feeding movements by the slide in timed relation to the blank rotation, of a grinding wheel having a peripheral grinding face, and means for raising the grinding wheel a predetermined distance above the blank axis so that involute helicoids may be cut on the sides of the blank teeth.

4. In a machine for grinding hobs, the combination with a rotating blank, a grinding wheel having a peripheral grinding face, a horizontal relieving slide operated in timed relation to the blank rotation, and means for effecting feeding movements by said slide in timed relation to the blank rotation, of means for supporting the grinding wheel on the relieving slide so that the grinding surface makes a predetermined angle with a plane perpendicular to the blank axis, and means for elevating the wheel axis a predetermined distance above the blank axis in accordance with the involute helicoid which is to be cut on the sides of the teeth.

5. In a grinding machine, the combination with a rotating blank having teeth in the form of a thread, a rotating conical grinding wheel, and means for effecting feeding and relieving movements by the wheel in timed relation to the blank rotation, of means for effecting rectilinear adjustment of the grinding wheel in a vertical plane to vary the position of the wheel axis with respect to the blank axis in accordance with involute helicoids to be cut on the blank teeth.

6. In a grinding machine, the combination with a rotating blank having teeth in the form of a thread, a rotating conical grinding wheel, means for effecting relieving movements by said wheel in timed relation to the blank rotation, and means for feeding the wheel according to the blank rotation, of means for angularly adjusting the grinding wheel in a horizontal plane, and means for effecting rectilinear adjustment of the wheel in a vertical plane.

7. In a grinding machine, the combination with a rotating blank having teeth in the form of a thread, a carriage movable longitudinally on the machine, a transversely movable relieving slide mounted on said carriage, and means for operating the slide and the carriage in timed relation to the blank rotation, of a circular guideway extending across said relieving slide, a rotating conical grinding wheel, a support for said grinding wheel movable along the circular guideway, said grinding wheel being adjusted along the circular guideway in order to vary the angle the peripheral grinding face makes with a plane perpendicular to the blank axis, and means for varying the vertical position of the grinding wheel to grind different involute helicoids on the sides of the teeth.

In testimony whereof, I hereto affix my signature.

CARL SCHRAMM.