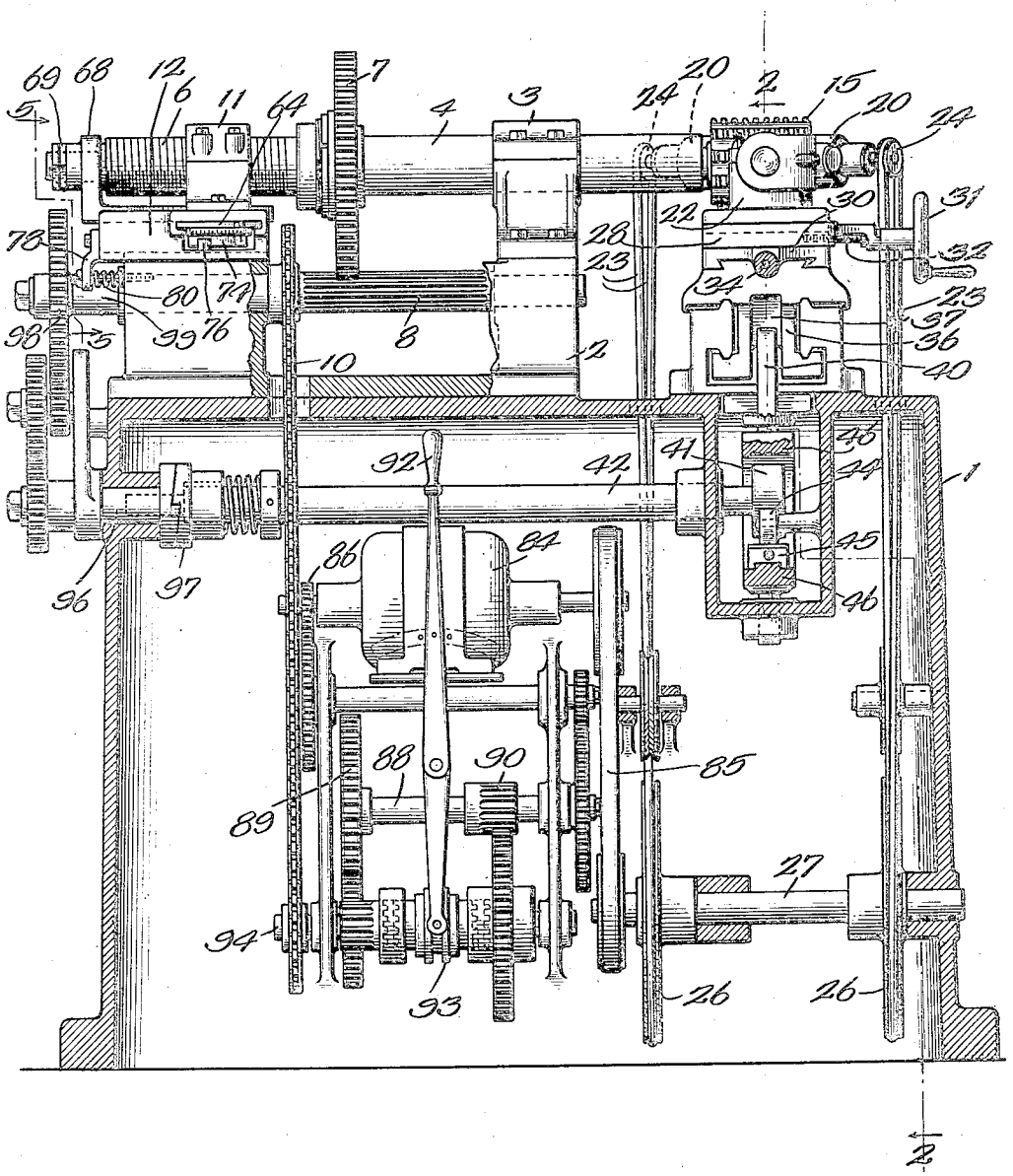
March 21, 1933. C. G. OLSON 1,901,926

HOB GRINDING MACHINE

Filed Feb. 16, 1928 6 Sheets-Sheet 1

Fig. 1.



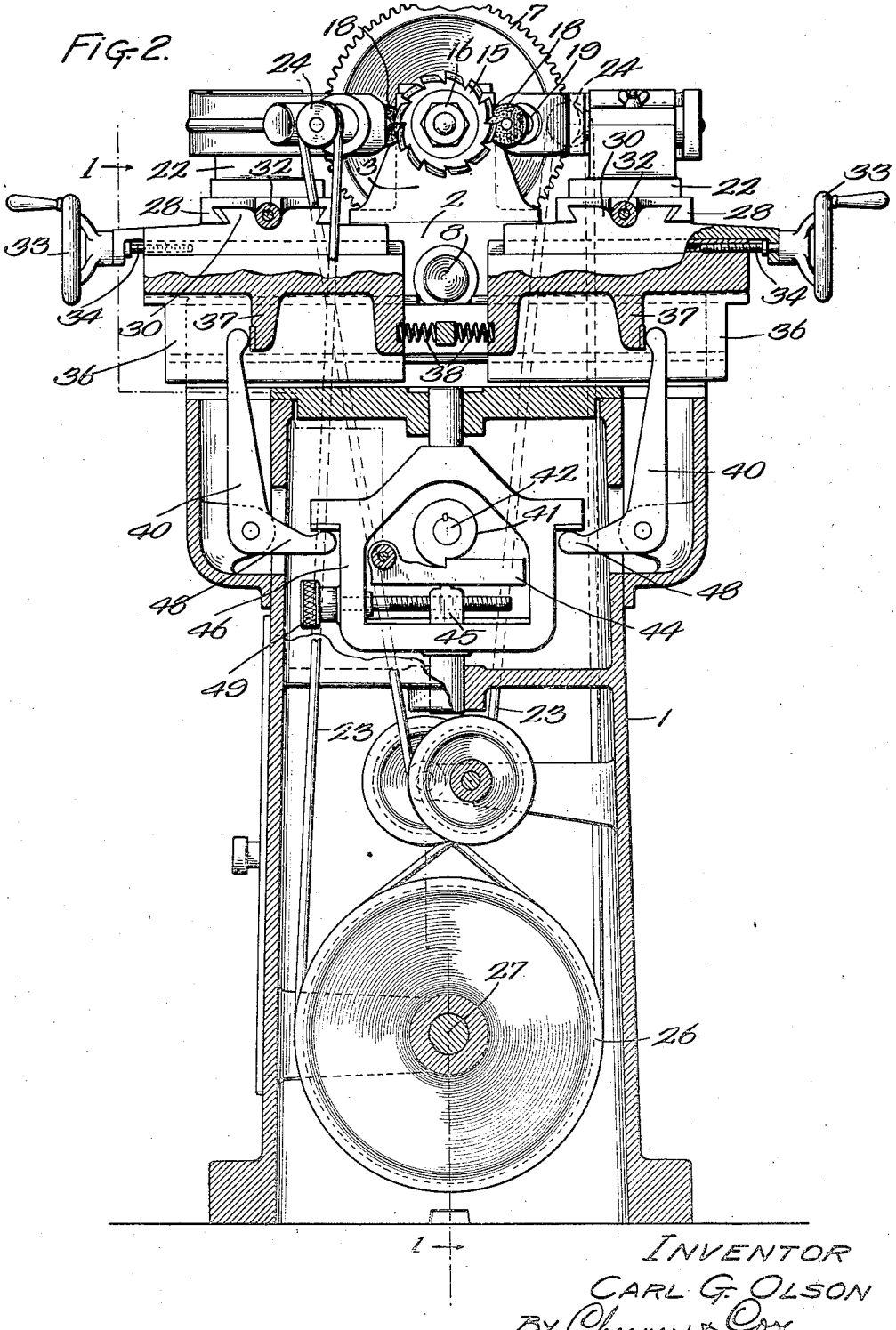
INVENTOR
CARL G. OLSON
By Cheever & Cox
ATTYS

March 21, 1933. C. G. OLSON 1,901,926

HOB GRINDING MACHINE

Filed Feb. 16, 1928 6 Sheets-Sheet 2

FIG. 2.



INVENTOR
CARL G. OLSON
BY Cheever & Cox ATTYS

March 21, 1933. C. G. OLSON 1,901,926

HOB GRINDING MACHINE

Filed Feb. 16, 1928 6 Sheets-Sheet 3

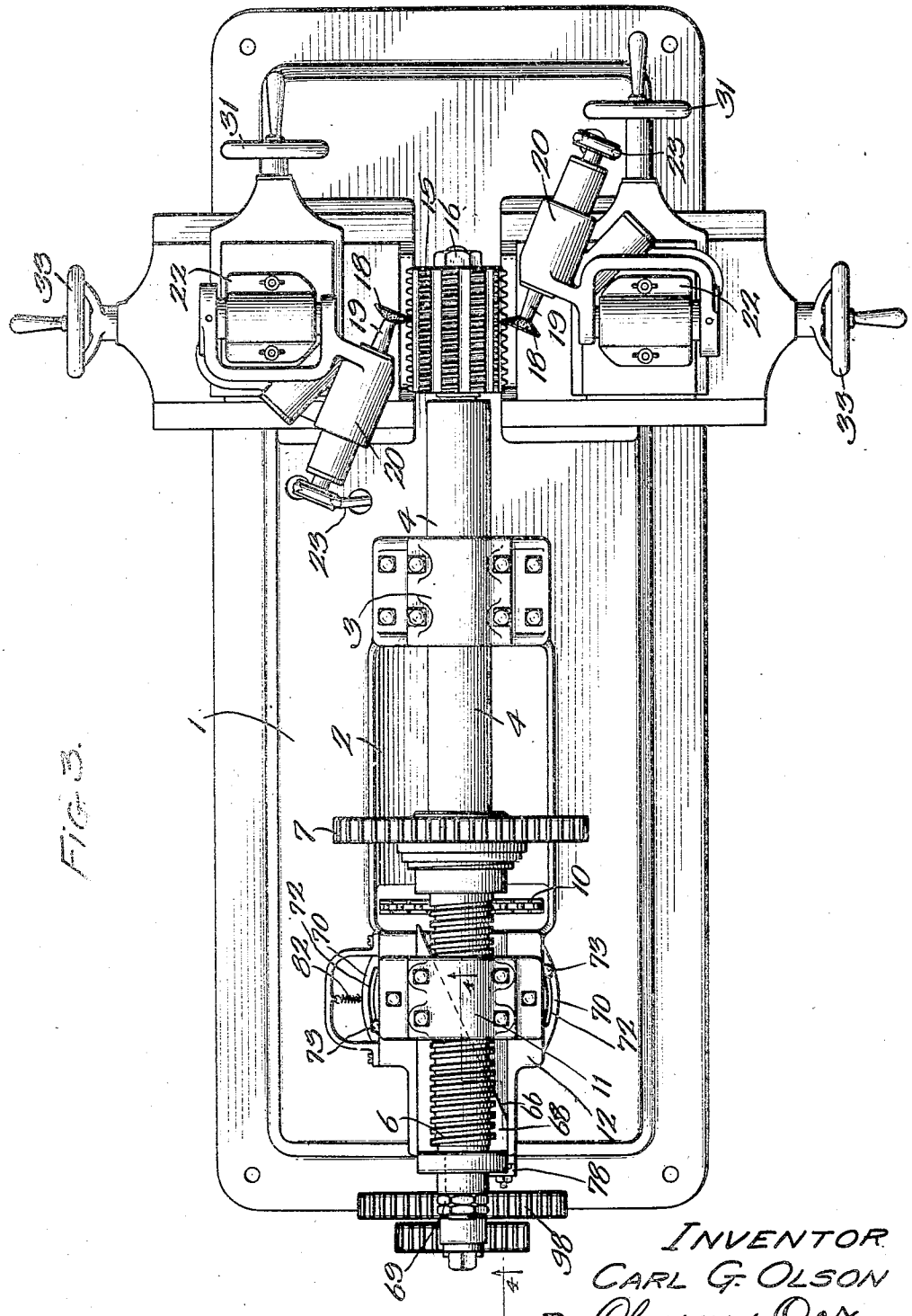


Fig. 3.

INVENTOR
CARL G. OLSON
BY Oliver & Cox
ATTY'S

March 21, 1933. C. G. OLSON 1,901,926

HOB GRINDING MACHINE

Filed Feb. 16, 1928 6 Sheets-Sheet 4

FIG. 4.

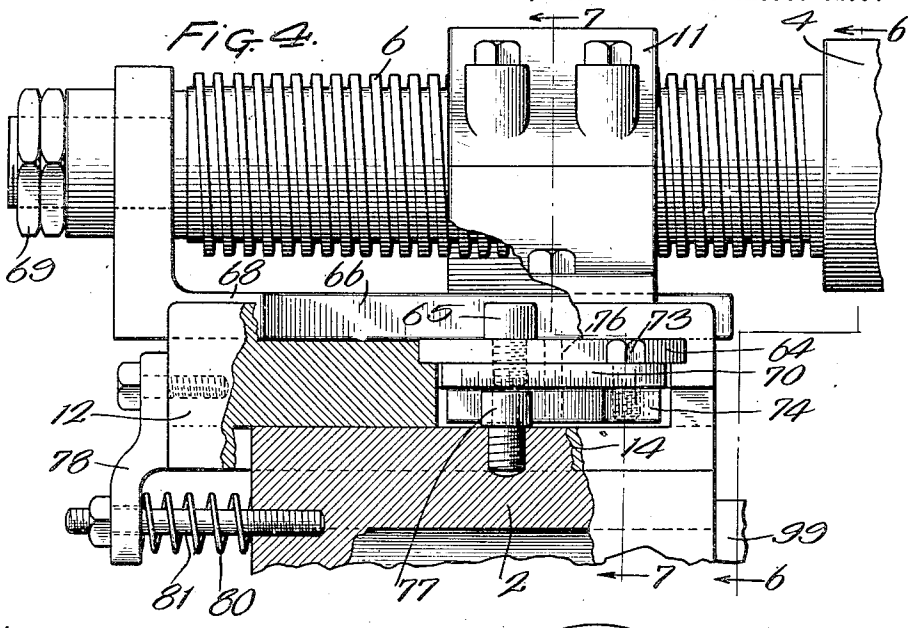


FIG. 5.

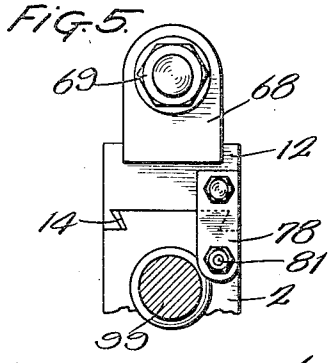


FIG. 6.

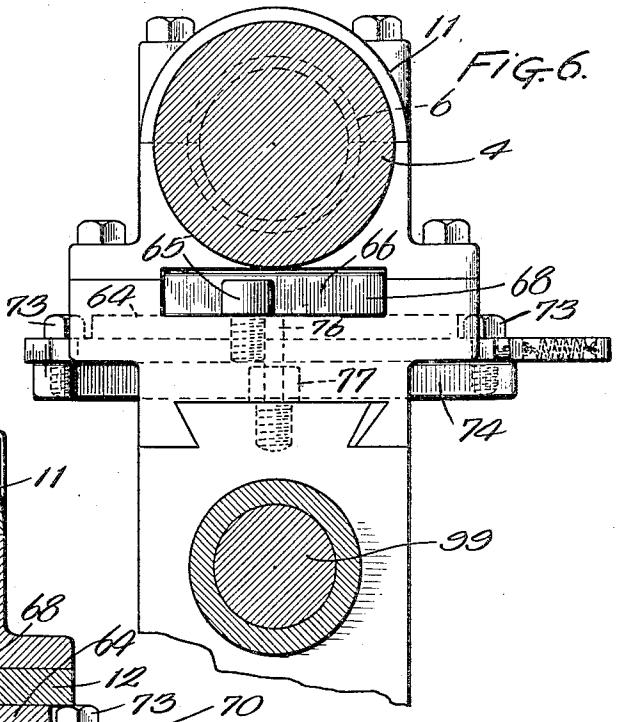
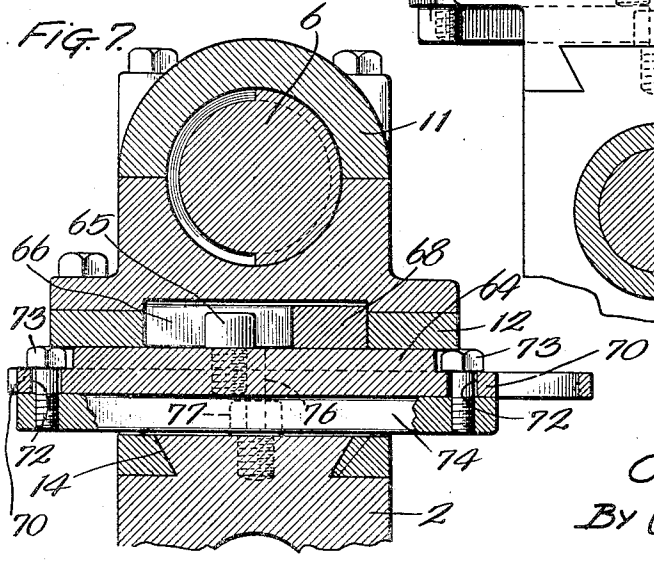


FIG. 7.



INVENTOR
CARL G. OLSON
BY Cleaver & Cox
ATTYS.

March 21, 1933. C. G. OLSON 1,901,926

HOB GRINDING MACHINE

Filed Feb. 16, 1928 6 Sheets-Sheet 5

Fig. 8.

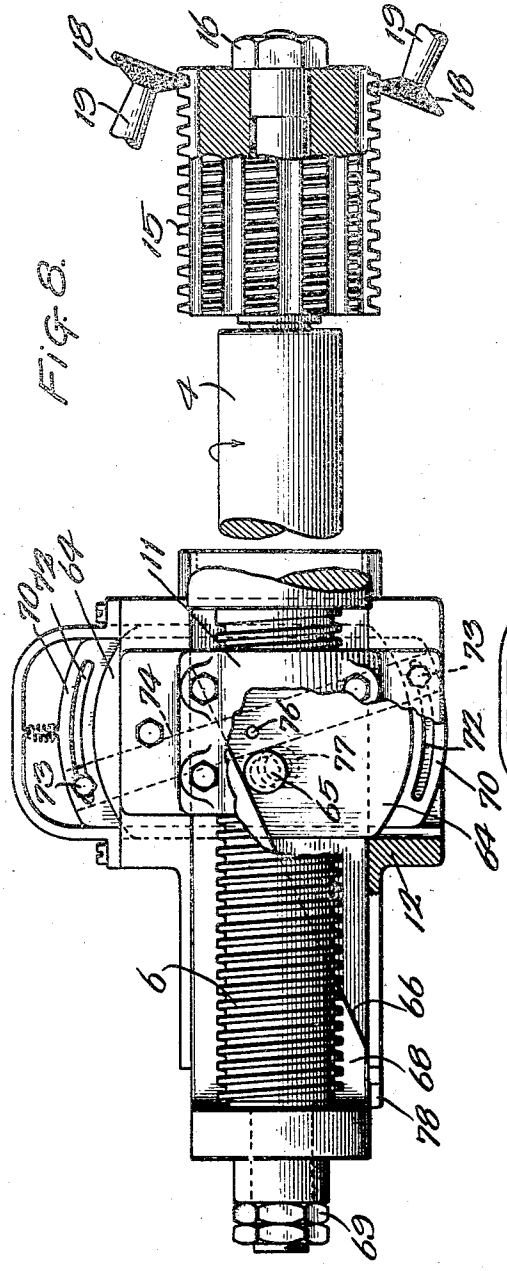
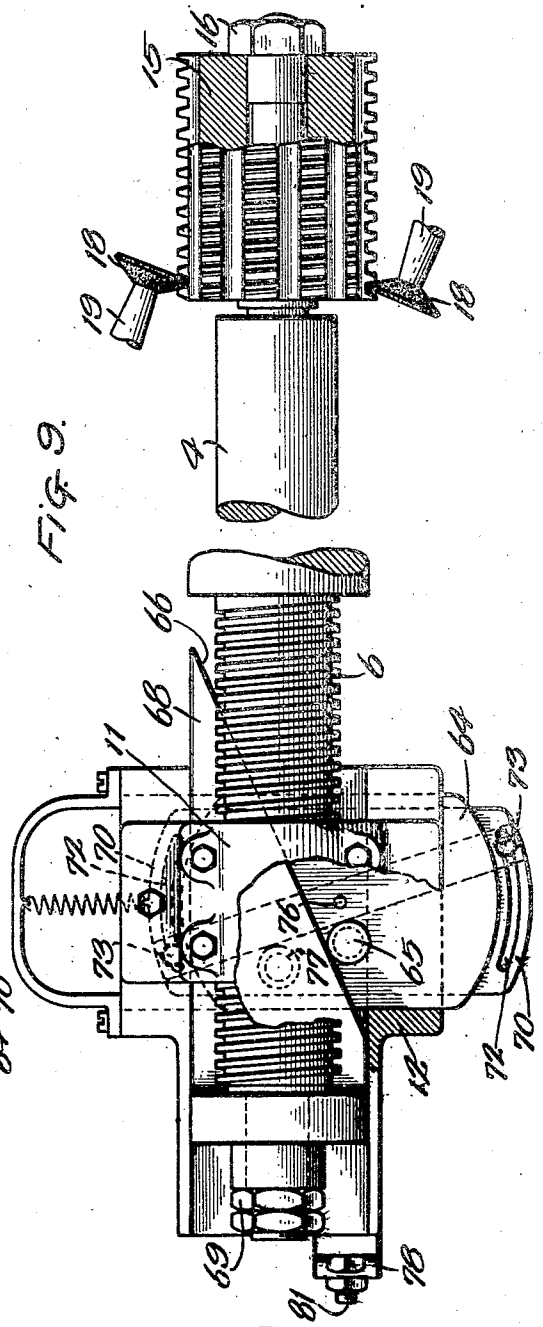


Fig. 9.



INVENTOR
CARL G. OLSON
By Cheever & Cox ATTYS.

March 21, 1933. C. G. OLSON 1,901,926

HOB GRINDING MACHINE

Filed Feb. 16, 1928 6 Sheets-Sheet 6

FIG. 10

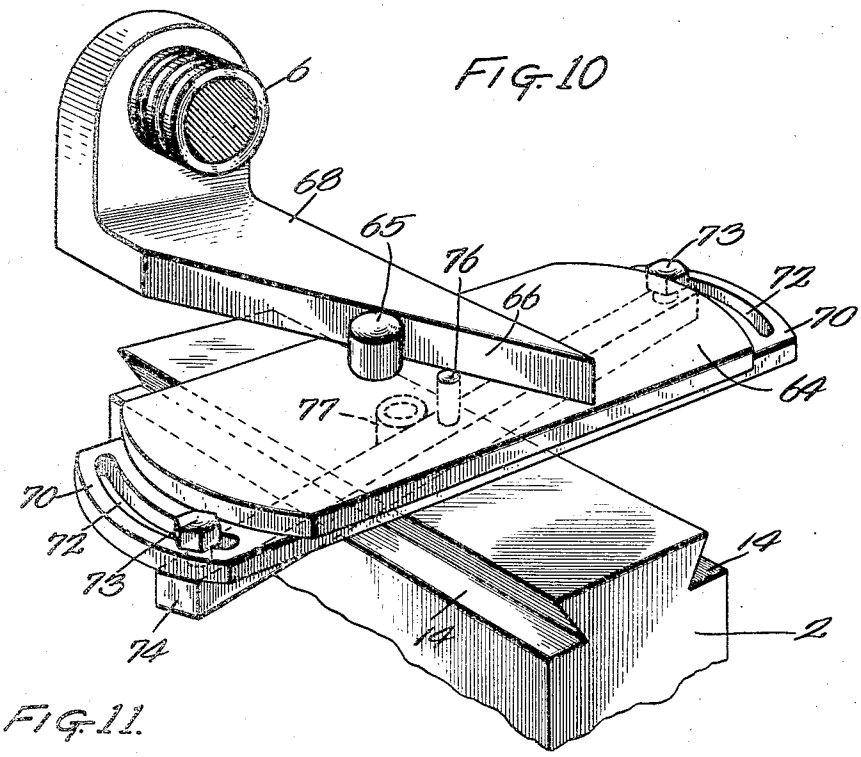
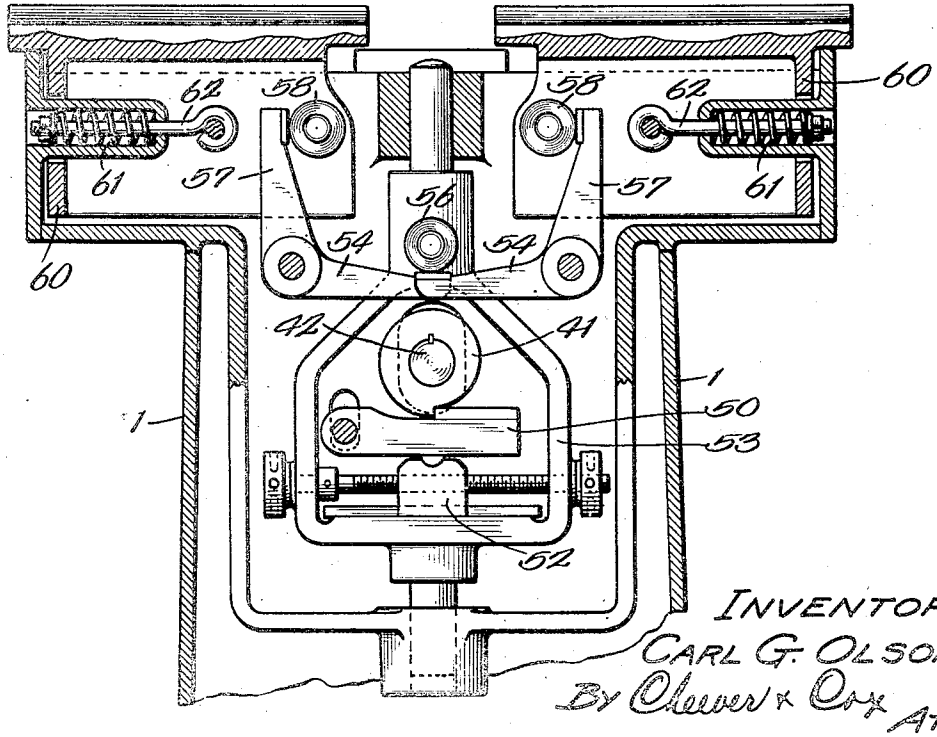


FIG. 11.



INVENTOR
CARL G. OLSON
By Clever & Cox ATTYS.

Patented Mar. 21, 1933 1,901,926

UNITED STATES PATENT OFFICE

CARL G. OLSON, OF CHICAGO, ILLINOIS, ASSIGNOR TO ILLINOIS TOOL WORKS, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS

HOB GRINDING MACHINE

Application filed February 16, 1928. Serial No. 254,776.

This invention relates to material working machines, and particularly to machines such as hob grinders and the like, wherein the work is reciprocated through the agency of a lead screw.

In the manufacture of hobs it is common practice to employ the same machine for grinding hobs of varied diameters, and in order to employ such a machine in this manner the pitch of the lead screw thereof which actuates the work carrier must conform to the axial pitch of the hob to be ground. This will be readily apparent when it is understood that the helix angles of hobs vary in accordance with their diameters and consequently the difference between the normal pitch and the axial pitch correspondingly varies. While the requirement for the normal pitch may be the same for hobs of different diameters it is necessary to change the axial pitch in accordance with a change in the hob diameter, and this axial pitch of the hob is equal to the pitch of the lead screw which actuates the work carrier in grinding machines heretofore used. Hence, in order to adapt such machines to cover a wide range of leads, it is necessary to provide a large number of interchangeable lead screws, and obviously this represents a large investment, and the interchanging of these screws requires the expenditure of considerable time in setting up the machine for each job.

An object of my invention is to preclude the necessity of frequently interchanging lead screws by providing a compensating device which will serve to alter the axial movement of the work from that of the movement ordinarily imparted to the work during each revolution of the lead screw, and thereby enable the use of one lead screw of a predetermined pitch to produce an infinite number of leads within a certain range.

Another object of my invention is to provide a compensating device of economical and rigid construction which may be readily superimposed upon the lead screw of a grinding machine, or any other machine of like nature, and which may be easily adjusted to accurately effect a differential movement between the head screw and its companion nut within very close limits.

In addition to the above mentioned characteristics, it is a further object of my invention to provide a machine in which a pair of oppositely disposed grinding wheels are employed to simultaneously grind opposite surfaces of the hob teeth, and this represents an improvement over the grinding machine disclosed in my copending application, Serial No. 86,206, filed February 5, 1926 wherein a single grinding wheel is employed which may be reversed in order to grind both surfaces of the hob teeth.

A further object is to arrange the grinding wheels so that the wheels start simultaneously and likewise simultaneously complete the grinding operation, thereby requiring minimum time to complete the effective stroke or movement of the wheels, and this feature represents an improvement over the machine disclosed in my Patent No. 1,259,770 dated March 19, 1918 wherein a number of grinding wheels are positioned on the same side of the hob.

With the foregoing and other objects in view, which will appear in the following description, the invention resides in the novel combination and arrangement of parts and in the details of construction hereinafter described and claimed.

In the accompanying drawings:

Figure 1 is an elevational view of a grinding machine which represents one embodiment of my invention, a portion of the machine bed and frame being broken away to disclose structure otherwise hidden.

Figure 2 is a transverse vertical sectional view taken on the line 2—2 of Figure 1.

Figure 3 is a plan view of the machine disclosed in Figure 1.

Figure 4 is an enlarged fragmentary view of the lead screw and associated compensating device as viewed in Figure 1, a portion of the cooperating parts thereof being broken away to more clearly disclose the internal structure.

Figure 5 is a detailed vertical sectional view taken on the line of 5—5 of Figure 1.

Figure 6 is a vertical section taken on the line 6—6 of Figure 4.

Figure 7 is a vertical section taken on the line 7—7 of Figure 4.

Figure 8 is an enlarged plan view of the lead screw and associated mechanism disclosing the relative position of the various elements at the beginning of the effective stroke of the work spindle.

Figure 9 is a plan view, similar to Figure 8, disclosing the relative position of the machine elements as the work spindle approaches the completion of its operative stroke.

Figure 10 is a perspective view of the elements comprising the compensating device in association with the cam member carried by the lead screw, and,

Figure 11 is a detailed view of the mechanism for imparting a reciprocatory movement to the grinding wheels and this mechanism represents an alternative form of the mechanism disclosed in Figure 2, which is employed for the same purpose.

Referring now to the drawings wherein like numerals have been employed to designate similar parts throughout the various figures, it will be observed that a machine bed 1 supports a frame 2 and rising from and secure to one end of the frame 2, Figure 1, is a split bearing 3 which provides a mounting for a work spindle 4. The work spindle 4 is formed integral with a lead screw 6 and supports a gear 7 which engages an elongated pinion 8. Rotation is imparted to the pinion 8 through the agency of a chain 10, and it will be observed that the lead screw 6 is rotatable within a suitable split nut 11. The split nut 11 is secured to the upper surface of a block 12, which is mounted within guide-ways 14, Figure 10, formed in the upper portion of one end of the frame 2. From the foregoing it will be clear that upon the rotation of the lead screw 6 within the split nut 11 said screw and the work spindle 4 will be moved axially and a hob 15 supported at the reduced outer extremity of the work spindle 4 will likewise experience the same axial movement. This hob 15 is secured to the spindle by means of a suitable tightening nut 16 and is adapted to be advanced between a number of grinding wheels 18.

These grinding wheels 18 are supported by spindles 19 rotatable within holders 20, which are mounted upon companion pedestals 22. The spindles 19 are rotated by means of suitable belts 23, which extend between sheaves 24 and driving pulleys or sheaves 26 carried by a shaft 27, Figures 1 and 2, mounted within the lower portion of bed 1. Each of the pedestals 22 which support the spindle holders 20 is mounted upon a platform 28 which is mounted upon a slide 30 and thus the holder 20 is adjustable in a direction parallel with the axis of the work spindle 4 by means of a hand wheel 31, Figures 1 and 2 which rotates a screw 32. The slide 30 is adjustable horizontally toward and away from the work by a hand wheel 33 which actuates a screw 34. Each of the slides 30 is supported by a table 36, Figure 2, which is provided with a depending lug 37 and coil springs 38 operate to urge the tables 36 outwardly, thereby maintaining engagement of the depending lugs 37 with a bell crank arm 40. A cam 41, Figures 1 and 2, is supported at the extremity of a drive shaft 42 and engages a pivoted finger 44. It is to be understood that upon each rotation of the cam 41 the finger 44 will experience a downward movement against a block 45, which rests within a yoke member 46. Laterally extending portions of the yoke member 46 engage bell crank arms 48 and thus during each rotation of the cam 41 the arms 40 and 48 will be actuated in response to the movement of the yoke 46 and the tables 36 will be moved inwardly. The cam 41 is timed to cause the inward movement of the tables 36 in accordance with the position of the relieved surfaces on the table of the hob 15, the reciprocation of the grinding wheels 18 being similar to the movement experienced by a tool in a conventional backing-off machine. The position of the block 45, which rests upon the yoke 46, may be adjusted by manipulating a knurled screw 49 and by varying the position of the block 45 with respect to the pivoted finger 44 the degree of reciprocating movement experienced by the grinding wheels 18 may be accurately adjusted.

Referring to Figure 11, it will be observed that a modified or alternative mechanism is disclosed which functions to reciprocate the grinding wheels 18. This mechanism employs the cam 41, a pivoted finger 50, an adjustable block 52, and a yoke 53, all of these elements cooperating in the manner just described in connection with similar parts disclosed in Figure 2. The operation of the mechanism disclosed in Figure 11 differs from the mechanism already described in that bell crank arms 54, which correspond to the bell crank arms 48 in Figure 2, engage a roller 56 carried medially of the upper portion of the yoke 53. By having these arms 54 actuated from a medial point on the yoke, a similar degree of movement of each of the arms is insured. Companion arms 57 engage rollers 58 secured to tables 60 which correspond to the tables 36 disclosed in Figure 2. Coiled springs 61 surrounding an eye bolt 62 constantly urge the table outwardly and thereby maintain engagement between the rollers 58 and the arms 57.

From the foregoing, it will be understood that the rotation of the lead screw 6 within

the split nut 11 will cause the supported hob 15 to be moved axially between the grinding wheels 18. It will also be clear that the cam 41 and the described elements actuated thereby operate in timed relation to effect a predetermined movement of the grinding wheels toward and away from the work. In the event that the axial pitch of the hob 15 is the same as the pitch of the lead screw 6, it will be apparent that for each revolution of the screw the hob will be moved axially through a distance equal to said pitch. However, if the axial pitch of the hob to be ground differs from the pitch of the screw 6, means must be provided to compensate for the variation in the axial pitch of the hob and the pitch of the screw. This compensating or differential effect is accomplished by means to be described.

A compensating device or sine bar mechanism shown in detail in Figures 4 and 8 to 10 inclusive comprises a cross slide 64 which is movable transversely of the block 12. This cross slide 64 carries a pin 65 which projects upwardly therefrom and which is adapted to be engaged by the angular surface 66 of a cam member 68 supported at one extremity of the lead screw 6. The cam member 68 is secured in position by means of lock nuts 69, and during the axial movement of the lead screw 6 to the right, Figures 1, 3 and 4, the angular surface 66, which engages the pin 65, will cause said pin and its associated cross slide 64 to be moved to the left, Figure 10. The cross slide 64 is carried by a mounting plate 70 provided at its extremities with arcuate slots 72 which cooperate with adjusting screws 73 to position an actuating bar 74, which is pivoted at 76, Figure 10. When the actuating bar 74 assumes an angular position with respect to the cross slide 64 as shown in Figures 8 to 10 inclusive, said bar, during the movement of the cross slide 64, will be carried into engagement with a roller 77 mounted upon the frame 2 medially of the guide-ways 14, and this will cause the block 12 and the split nut 11 mounted thereon to move in a direction parallel with the axis of the lead screw to the right, Figures 8 and 9. The degree of angularity of the actuating bar 64 will control the degree of movement thus imparted to the split nut 11 and the lead screw 6 associated therewith, and obviously when the bar 74 occupies a central or zero position no compensating movement will be transmitted to the lead screw. Graduations are provided at the extremity of the plate 70, Figures 1 and 4, to facilitate the quick adjustment of the bar 74. Secured to one end of the slidable block 12 is a depending bracket arm 78, and interposed between the bracket arm 78 and a surface of the frame 2 is a coiled spring 80, Figures 1 and 4, which encircles a bolt 81 upon which the bracket arm 78 is slidable. This spring 80 operates to insure contact between the roller 77 and the actuating bar 74. Another coiled spring 82, Figures 3 and 9, serves to oppose the outward movement of the cross slide 64. From the foregoing description of the compensating device it will be understood that a differential or compensating movement is produced to obtain variations in the axial travel of the supported hob with reference to a given number of revolutions of the lead screw, and that the motion which is superimposed upon the lead screw by the compensating device may be varied by a simple adjustment of the actuating bar. By employing this arrangement, one lead screw is able to produce an infinite number of leads within a range of leads which is required in grinding hobs of different sizes.

In the operation of the described apparatus power is supplied from an electric motor 84, Figure 1, or any other suitable means, to a belt 85, which actuates the shaft 27 which supports the sheaves 26. The motor 84 also carries a gear 86 which causes the rotation of a shaft 88 through a suitable train of gears, and this shaft 88 carries a gear 89 and a pinion 90. By manipulating a hand lever 92 a clutch mechanism 93 connected with the lower end of the lever 92 may be actuated to transmit rotation to a drive shaft 94. Thus when the clutch 93 is moved to the left, Figure 1, the shaft 94 will be driven in one direction, and when the clutch is moved to the right the shaft will be rotated in the reverse direction. After securing the hob 15 upon the work spindle 4 and adjusting the positions of the grinding wheels 18 with respect to the hob teeth by means of the hand wheels 31 and 33, the actuating bar 74 of the compensating mechanism is positioned in accordance with the motion, which must necessarily be superimposed upon the lead screw to effect the proper axial travel of the hob. The handle 92 is then manipulated to actuate the clutch 93 and rotation is imparted to the work spindle 40 as hereinbefore described. As the cam member 68 moves to the right, Figures 8 to 10 inclusive, the angular surface 66 thereof will engage the pin 65 carried by the cross slide 64 and the lead screw 61 will experience a decreased or increased compensating movement in accordance with the setting of the actuating bar 74. By having the grinding wheels arranged in the described manner each of the wheels will begin and finish a grinding stroke simultaneously with respect to its companion wheel, and in this manner minimum time is expended in simultaneously grinding both surfaces of the hob teeth. The spindles 19 of the grinding units are arranged obliquely with respect to the axis of the hob and in

this manner the conical grinding wheels 18 may be very effectively employed. Through the action of the cam 41 carried by the shaft 42, Figures 2 and 11, the grinding wheels 18 are moved toward and away from the work at predetermined intervals corresponding to the relieved surfaces on the hob teeth. The shaft 42 which carries the cam 41 is operatively connected with a drive shaft 93, Figure 1, by means of a suitable spring clutch 97 and rotation is imparted to the shaft 93 through the agency of a suitable train of gears which connect the shaft 96 with a gear 98 secured to a shaft 99 which forms an extension of the elongated pinion 8. The spring clutch 97 is formed with a single tooth and when the clutch 93 is moved so as to effect the rotation of the work spindle 4 in a reverse direction, and thereby move the hob 15 to the left, Figure 1, the clutch 97 will click or slip and the shaft 42 will not be rotated.

From the foregoing it is to be understood that my invention contemplates the production of a grinding machine which is adapted to be used for grinding hobs having different helix angles without dismantling or interchanging any of the machine parts. It will also be clear that the described compensating device or sine bar mechanism serves to very accurately control the proper movement of the grinding wheels within the thread of a hob and by having the grinding wheels oppositely disposed with respect to a supported hob, the expeditious operation of the grinding wheels during their effective stroke is insured. Although my invention has herein been described in connection with a particular type of grinding machine, it is to be understood that the invention is capable of many other applications, and should therefore be limited only by the scope of the appended claims.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In material working apparatus of the class described having a lead screw for actuating a work support and means for rotating the screw, threaded means for receiving the lead screw, and means for superimposing a compensating movement upon the lead screw during the rotation thereof within the threaded means.

2. In material working apparatus of the class described having a lead screw for actuating a work support and means for rotating the screw, threaded means for receiving the screw to cause the axial movement of the screw during the rotation thereof, and means for imparting an axial movement to the threaded means during the rotation of the lead screw.

3. In apparatus of the class described provided with a lead screw for actuating a work support and means for rotating the screw, threaded means for receiving the lead screw to cause the axial movement of the screw during the rotation thereof, a support for the threaded means, and means for causing a relative movement between the threaded means and the support therefor during the rotation of the lead screw.

4. In apparatus of the class described provided with a lead screw for actuating a work support and means for rotating the lead screw, threaded means for receiving the screw to cause the axial movement thereof, and means for superimposing a compensating axial movement upon the lead screw, said compensating means being operable in response to the axial movement of the lead screw.

5. In material working apparatus of the class described provided with a lead screw for actuating a work support and means for rotating the lead screw, threaded means for receiving the screw to cause the axial movement thereof, a support for the threaded means, and means movable transversely of the lead screw axis for causing a relative movement between the threaded means and the support therefor in a direction parallel with the screw axis.

6. In material working apparatus having a lead screw for actuating a work support and means for rotating the screw, threaded means for receiving the screw to cause the axial movement thereof, a support for the threaded means, means movable transversely of the lead screw axis for causing a relative movement between the threaded means and the support therefor, and means carried by the lead screw for causing the actuation of the transversely movable means.

7. In material working apparatus of the class described having a lead screw and means for rotating the screw, threaded means for receiving the screw, means for superimposing a compensating axial movement to the lead screw during the rotation thereof within the threaded means, and means for adjusting the compensating means in accordance with the compensating effect desired.

8. In material working apparatus of the class described having a lead screw directly connected to a work holder and means for rotating the lead screw, a nut on said lead screw, and a compensating device actuated by the lead screw to cause the nut to travel independently of the lead screw in a direction parallel to the axis of the lead screw.

9. In material working apparatus of the class described having a lead screw, a frame, a nut on the lead screw, a slide associated with the nut, an actuating member secured to the slide, a roller on the frame adapted to be engaged by the actuating member, and means for actuating the slide in response to

the axial movement of the lead screw to cause a movement of the nut with respect to the frame.

10. In an apparatus of the class described having a lead screw, a frame, a slide mounted on the frame, a nut on the lead screw mounted on the slide, a cross slide mounted in said slide, an actuating bar attached to the cross slide, a roller mounted on the frame for engagement with said actuating bar to move the first mentioned slide by causing the cross slide to move transversely of the first slide, and means for causing the cross slide to move at a predetermined ratio with respect to the axial movement of the screw.

11. In grinding apparatus of the class described, having a lead screw for supporting threaded work, a nut on the lead screw, a grinding wheel for grinding work supported by the lead screw, means for rotating the lead screw to cause the axial movement thereof, and a compensating mechanism for varying the axial movement of the lead screw during the rotation thereof in accordance with the axial pitch of the threads in the work.

12. In grinding apparatus of the class described having a lead screw for supporting threaded work, a nut on the lead screw, a grinding wheel for grinding work supported by the lead screw, means for rotating the lead screw to cause the axial movement thereof, a frame, compensating mechanism including a cross slide movable in response to the axial movement of the lead screw to cause a movement of the nut with respect to the frame, and means for adjusting the movement of the cross slide in accordance with the axial pitch of the threads in the work to be ground.

13. In hob grinding machines having a lead screw for supporting a hob, a nut on the lead screw, a grinding wheel for grinding the teeth of a supported hob, means for reciprocating the grinding wheel in accordance with the relieved surfaces of the hob teeth, and means for superimposing a compensating effect upon the axial movement of the lead screw in accordance with the axial pitch of the hob to be ground.

14. In material working apparatus of the class described, a rotary work support, a tool for acting upon a work piece carried by said support, means for imparting relative movement between the work support and said tool, and a sine bar mechanism adapted to impart longitudinal movement to the work support.

15. In material working apparatus of the class described, a rotary support for a hob, a grinder positioned in operative relation with respect to the hob teeth, means for imparting relative movement to the hob and grinder in accordance with the relief on the hob teeth, and a sine bar mechanism adapted to impart longitudinal movement to the hob support.

16. In material working apparatus of the class described, a rotary support for receiving a hob to be ground, a grinder support, said grinder support and hob support being relatively movable in a direction transversely of the hob axis, and a sine bar mechanism for imparting movement to one of said supports in a direction parallel with the hob axis.

17. In a grinding machine of the class described, a rotary hob support, a grinder adapted to be positioned in operative relation with respect to the teeth of a hob on said support, means for imparting relative movement to the hob and grinder in accordance with the relief on the hob teeth, and a sine bar mechanism adapted to impart movement to one of said supports to effect relative longitudinal movement between the hob support and the tool support.

18. In material working apparatus of the class described, a rotary work support, a tool support, said tool support and work support being relatively movable, and a mechanism for imparting movement to one of said supports, said mechanism including a slide having an angularly disposed surface, a second slide shiftable at an angle with respect to the first mentioned slide, means interposed between said slides for imparting movement from one slide to the other, and a fixed abutment against which one of said slides operates during the movement thereof.

19. In material working apparatus of the class described, a rotary work support, a tool support, said tool and work supports being relatively movable to effect a cutting action along the peripheral surface of a supported work piece, and means for imparting relative movement to said parts in an axial direction with respect to the work piece including means having an inclined surface shiftable in predetermined synchronism with the rotation of the work support, and actuating means slidably engaging and driven by said inclined surface.

20. In a hob grinding machine, a rotary spindle for supporting a hob, a tool support, a grinder wheel mounted on said tool support, means for imparting relative movement between the grinder wheel and hob spindle in accordance with the relief in the teeth on a supported hob, and means for imparting relative movement between said supported hob and grinder axially of the rotary spindle including a member coupled with and shiftable in synchronism with the rotation of the spindle, said member having an inclined surface, and a second member having means slidably engageable with said inclined surface, whereby to effect relative

angular movement between said members in response to the shifting of the first member.

21. In a hob grinding machine, a rotary hob supporting spindle, a tool support, a grinder wheel carried by said support, means for imparting relative movement between a supported hob and said grinder in accordance with the relief in the teeth on said hob, and mechanism for imparting relative movement between the hob and said grinder in a direction axially of said hob, said mechanism including means shiftable in timed relation with the actuation of the spindle, an angularly adjustable slide member movable in response to the shifting of said means, and a member engageable with the surface of said angularly adjustable slide member.

22. In a hob grinding machine, a rotary spindle for supporting a hob, a grinder support, a grinder wheel on said grinder support for grinding the teeth on a supported hob, said supports being relatively movable axially of the supported hob to maintain the proper position of the grinder wheel within the thread helix of said hob, means for controlling the above mentioned relative axial movement between the supported hob and said grinder, said means including an actuating device shiftable in a direction transverse to the spindle axis and a second device slidably coupled therewith, said devices being relatively slidable and operatively connected with at least one of said supports, and means for effecting relative transverse movement between said supports in accordance with the relief in the hob teeth.

23. In a hob grinding machine, a rotary spindle for supporting a hob, a grinder support, a grinder wheel mounted on said grinder support, said supports being relatively shiftable in a direction axially of a supported hob to maintain the proper position of the grinder wheel within the thread helix of the hob, means for controlling the above mentioned relative movement including a slide device shiftable in a direction transverse to the spindle axis, an angularly adjustable slide member mounted on said device, and means slidably coupled with said slide member and adapted to be shifted in a direction longitudinally of the spindle in response to the movement experienced by said slide member, and means for imparting relative transverse movement between the grinder and the supported hob in accordance with the relief on said hob teeth.

24. In a hob grinding machine, a rotary spindle for supporting a hob, a grinder support, a grinder wheel on said grinder support for grinding the teeth on a supported hob, said supports being relatively movable axially of the supported hob to maintain the proper position of the grinder wheel within the thread helix of said hob, means for controlling the above mentioned relative axial movement between the supported hob and said grinder, said means including an actuating device shiftable in a direction transverse to the spindle axis and a second device slidably coupled therewith, said devices being relatively slidable and operatively connected with at least one of said supports, means continuously urging said shiftable actuating device in a given direction, and means for effecting relative transverse movement between said supports in accordance with the relief in the hob teeth.

In witness whereof, I have hereunto subscribed my name.

CARL G. OLSON.