June 19, 1951 | C. B. ZIEGLER | 2,557,166

THREAD GRINDING MACHINE

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FIG. 1

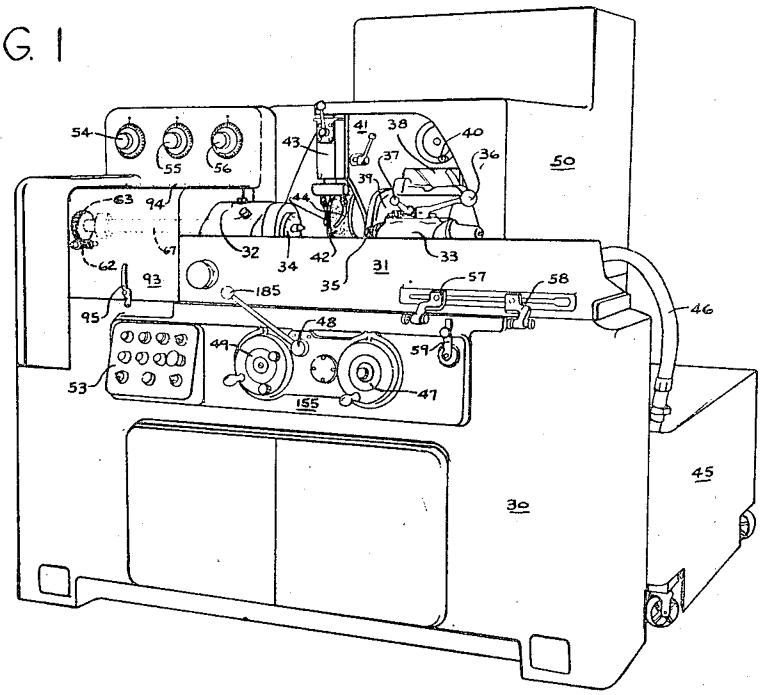


FIG. 3

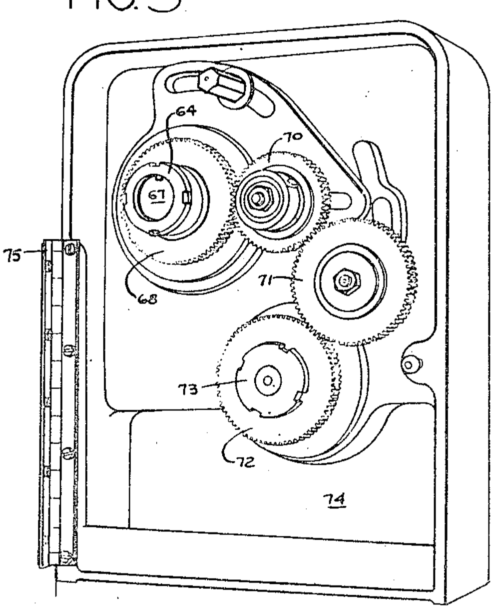
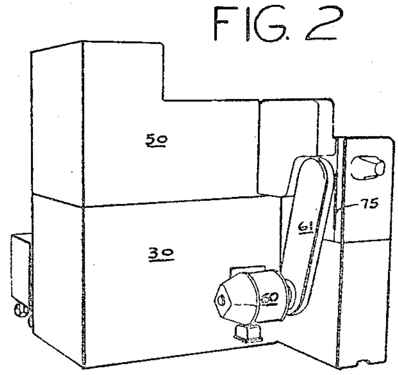


FIG. 2



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By Strauch & Hoffman

Attorney

FIG. 4

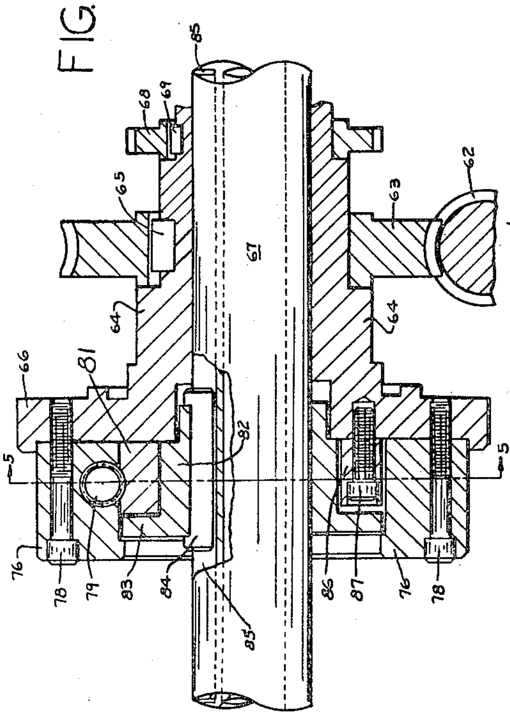


FIG. 6

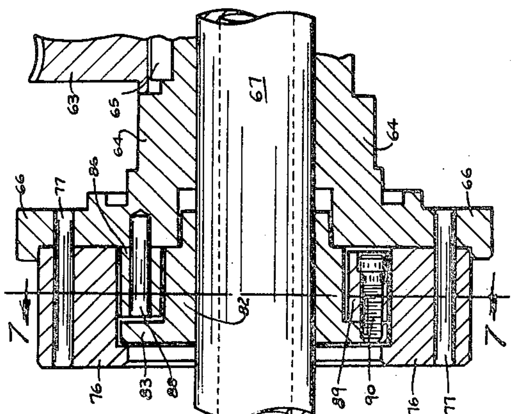


FIG. 5

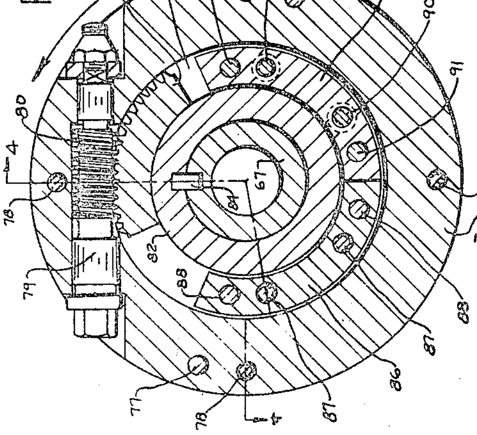
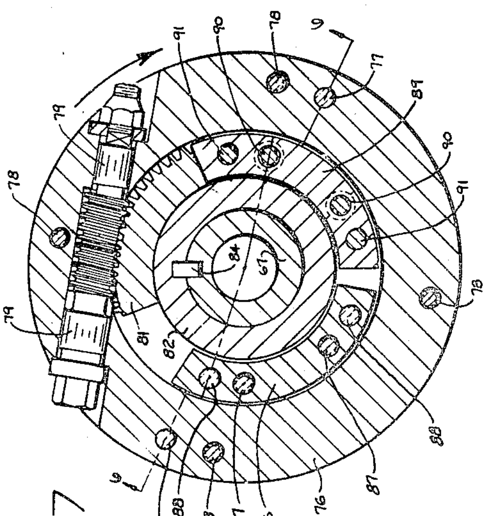


FIG. 7



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THREAD GRINDING MACHINE

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FIG. 8

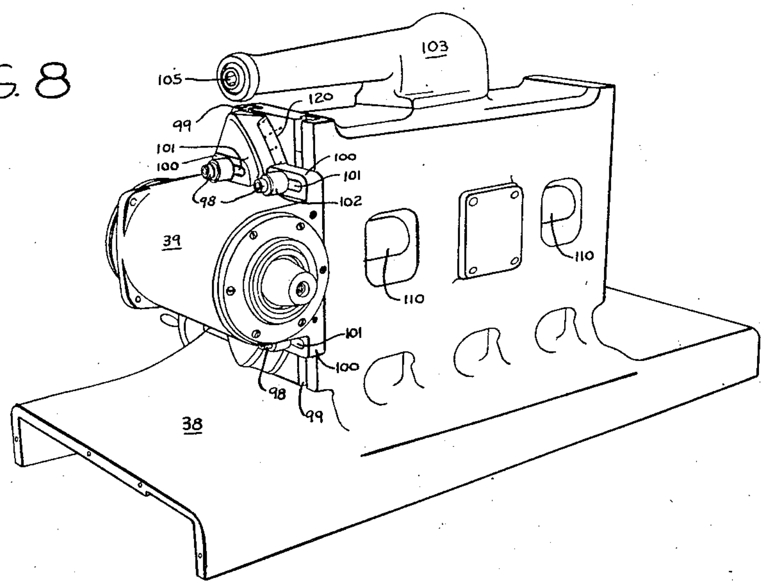
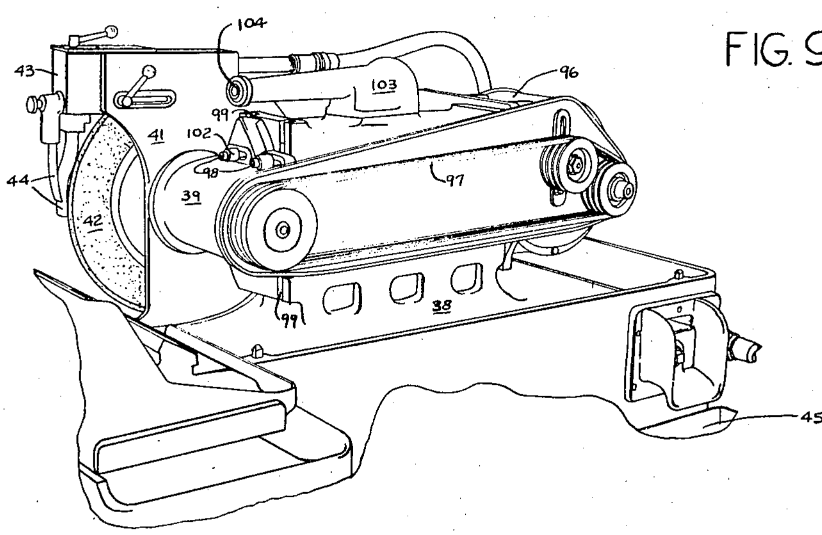


FIG. 9



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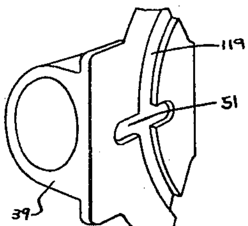

FIG. 10A

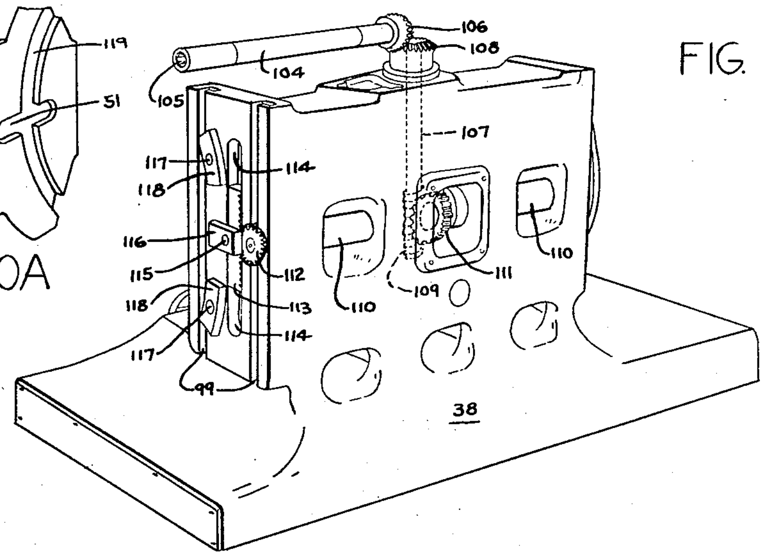

FIG. 10

FIG. 11A

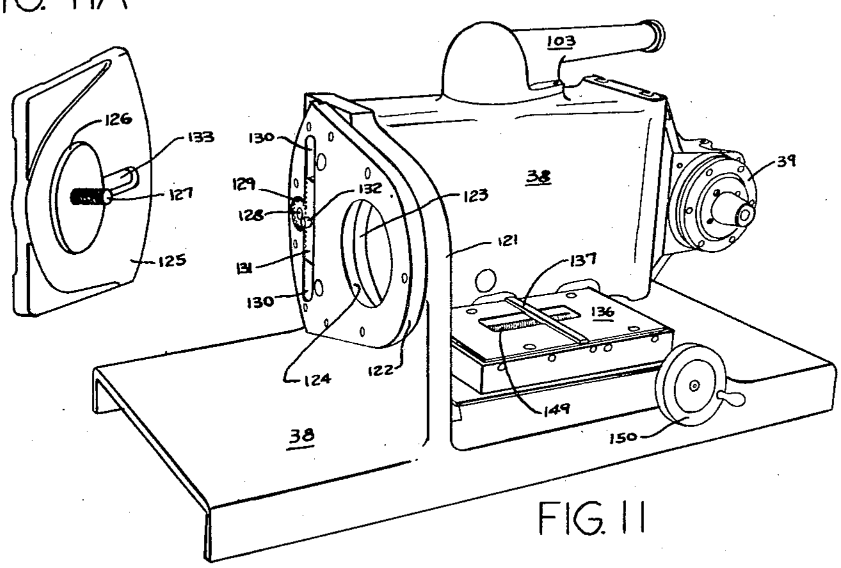

FIG. 11

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FIG. 12

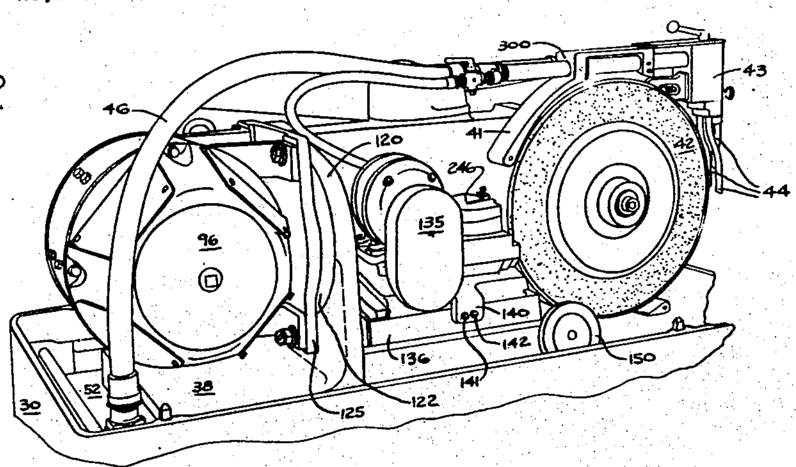
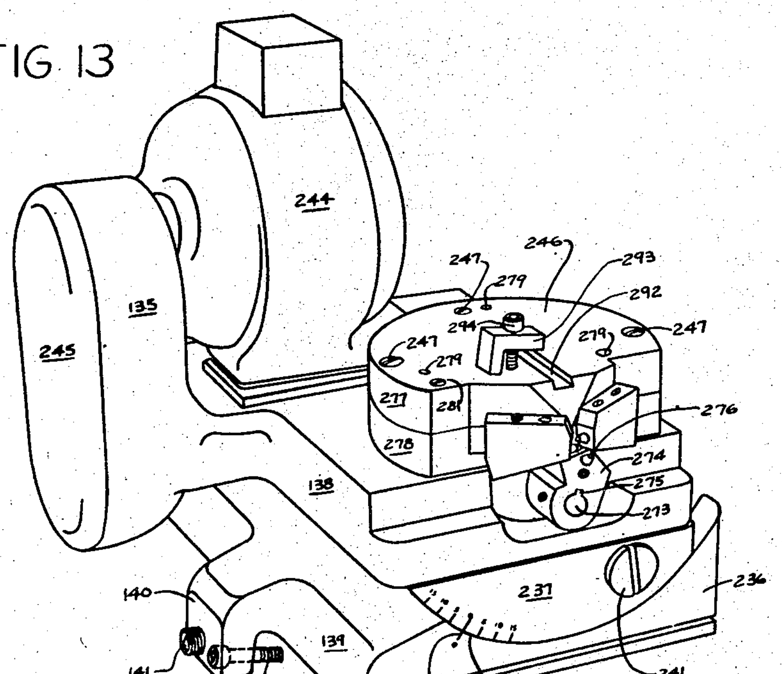


FIG. 13



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THREAD GRINDING MACHINE

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FIG. 14

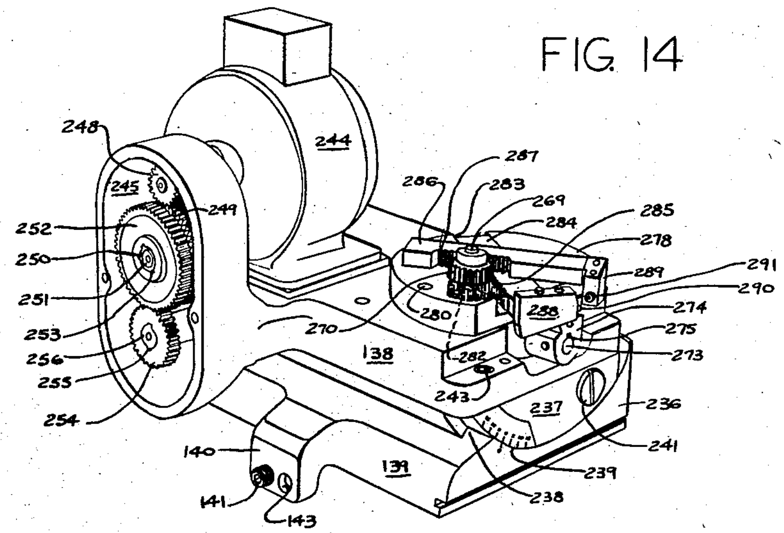
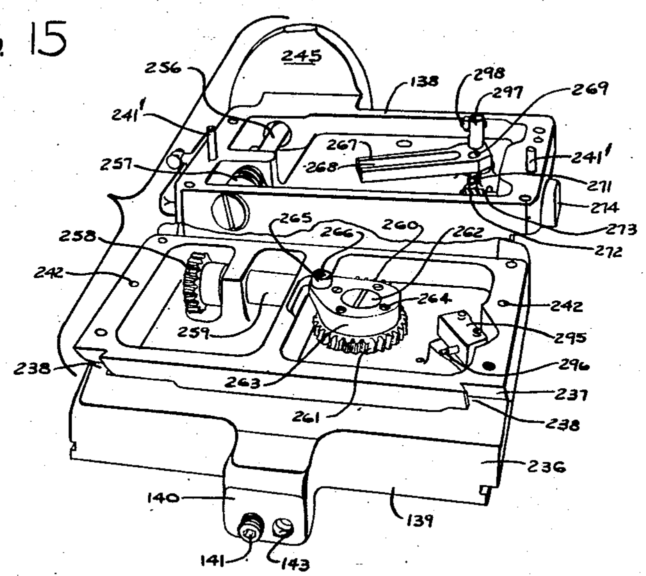


FIG. 15



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THREAD GRINDING MACHINE

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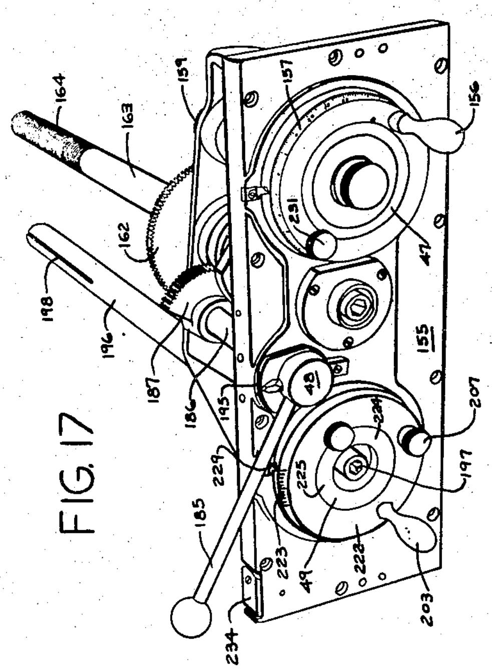

FIG. 17

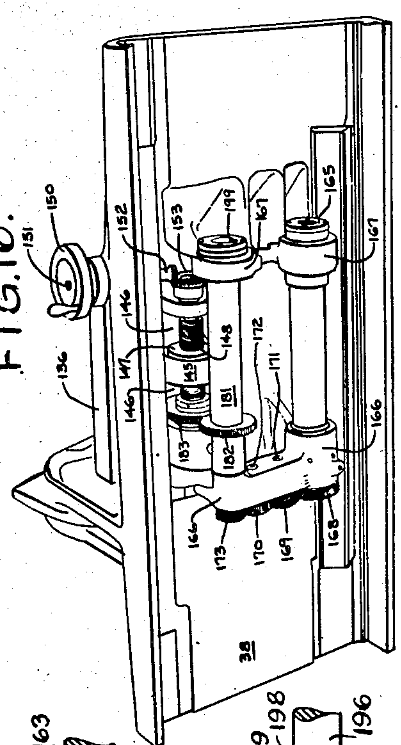

FIG. 16.

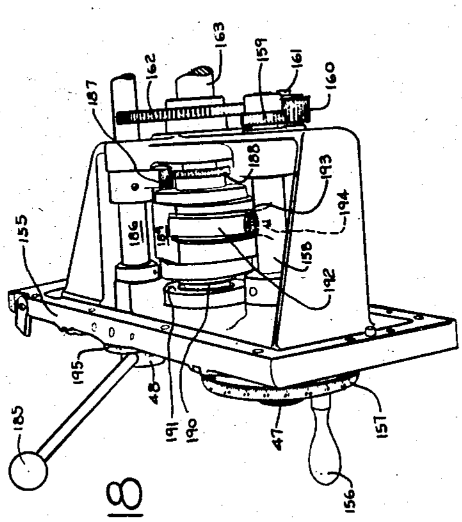

FIG. 18

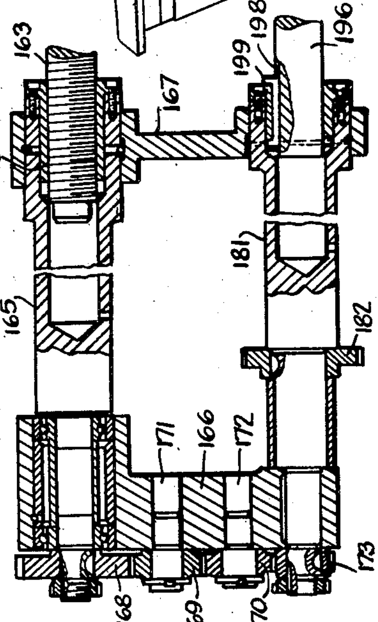

FIG. 23

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THREAD GRINDING MACHINE

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FIG. 19

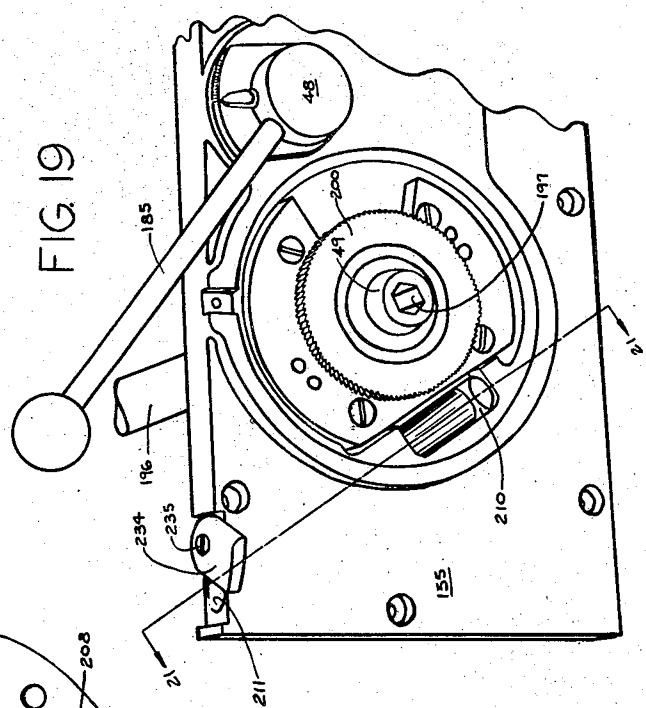


FIG. 20

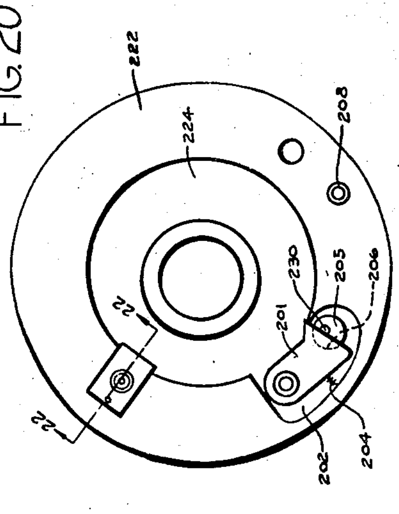


FIG. 21

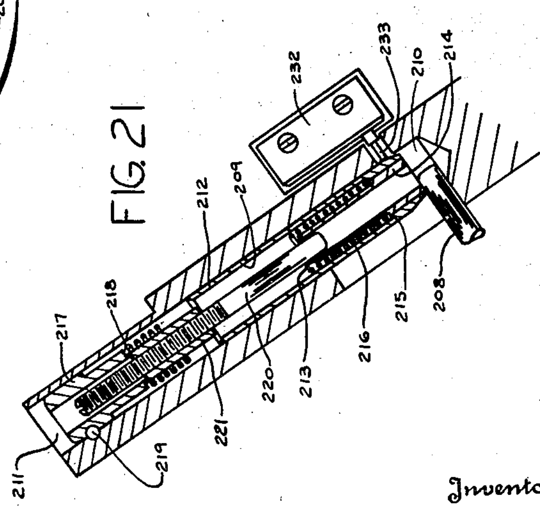
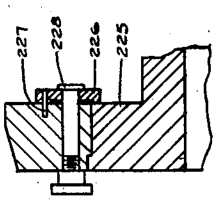


FIG. 22



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Patented June 19, 1951

2,557,166

UNITED STATES PATENT OFFICE

2,557,166

THREAD GRINDING MACHINE

Clarence B. Ziegler, Detroit, Mich., assignor to Landis Machine Company, Waynesboro, Pa., a corporation of Pennsylvania

Application January 21, 1944, Serial No. 519,210

18 Claims. (Cl. 51—95)

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This invention relates to machines of that general class which are designed for operation upon work pieces of metal or other material to produce a predetermined surface configuration thereon and has particular reference to a cutting or grinding machine.

The novel features of my present invention are more particularly applicable to a grinding machine of the type wherein the work piece is rotated and also traversed relative to a grinding wheel mounted to rotate in a plane substantially normal to the axis of rotation of the work piece, with special reference to the formation of helices on a surface of the rotatably mounted work piece.

The invention to be hereinafter described is primarily identified with thread grinding machines which may be divided into three well recognized classes, viz: manually-operated; semi-automatic; and fully-automatic. In machines of the first class the direction of movement of the work piece carriage is manually reversed by the operator, the infeeding of the grinding wheel to and its retraction from the work is manually controlled, and the operator must also adjust and control the operation of the truing or dressing means for the grinding wheel. Further manual adjustments must be made to compensate for the reduction of grinding wheel diameter resulting from the dressing operation.

In machines of the second class the traverse of the work piece carriage is automatically controlled, while an independent source of motive power is provided for the dressing mechanism with means for automatically compensating for reduction in wheel diameter incident to dressing.

In thread grinders of the third class, in addition to the above mentioned automatic controls, the dressing operation is automatically corelated with the work traverse, while the infeeding of the grinding wheel is automatically controlled to predetermine an entire operating cycle producing the desired thread on the work. Thus, after the work has been properly centered and the grinding wheel adjusted to the starting point of the thread to be formed thereon, no further attention is required by the operator during the thread grinding operation.

My present invention is more particularly concerned with grinding machines of the second class or semi-automatic type, though it will become evident as this description proceeds that many of its novel features may be advantageously incorporated in the fully automatic type of thread grinder to further increase the utility of this class of machines.

Generically considered, I aim, by means of my present improvements, to simplify the construction of the several machine units and operational controls therefor to such an extent that the machine may be employed for efficiently executing certain kinds of work which have heretofore required the more complex and expensive fully automatic type of thread grinders and, unlike the latter, to enable comparatively unskilled operators to properly control operation of the machine to produce threads of extreme accuracy as to size, form, and required helix angle and concentricity.

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With this general purpose in view my invention is characterized by many novel features, prominent among which are; selective grinding during one or both directions of traverse of the work past the grinding wheel; single or multiple pass grinding to the full depth of thread; a wide range of standard and special threads, wheel truing to predetermined degree; and wheel truing for a wide variety of thread forms.

For the realization of these desirable ends, the invention has for one of its important objects to provide a novel back-lash compensator construction automatically absorbing and compensating for lost motion in the lead screw gearing, upon reversal of its rotation to thereby insure the synchronized operation of the lead screw and work rotating spindle when grinding is to be done during the return or reverse travel of the work carriage.

Another object of my invention is to provide a novel mounting of the grinding wheel head on the wheel carriage or slide whereby the wheel may be variously positioned to rotate in a plane inclined to the rotative axis of the work to produce threads having the required predetermined helix.

A further object of the invention is to provide a simple adjustable mounting for the grinding wheel motor with a single adjusting means for simultaneously adjusting said motor and the grinding wheel head to accurately position the driving axis of the motor in parallelism with the grinding wheel axis in all positions thereof relative to the work.

An additional object of my invention is to provide a novel mounting for the dresser assembly and means for bodily adjusting said assembly axially of the grinding wheel to produce thread forms having laterally displaced root centers.

Still another object of the invention resides in the provision of a novel in-feeding and retracting mechanism for the grinding wheel, whereby the wheel can be disengaged from the work, and in a series of progressively executed in-feeding steps, grind the thread to an accurately predetermined depth.

My invention further incorporates a novel mechanism for dressing or truing the grinding wheel to a desired condition by truing increments of predetermined value.

It is also an important object of the invention to provide a novel dressing compensation mechanism which automatically positions the grinding wheel relative to the work to precisely compensate for the reduction in grinding wheel diameter incident to the dressing operation.

My invention further contemplates the provision of a novel grinding wheel dressing mechanism in which the effective wheel dressing movement of the diamonds is comparatively slow with a relatively quick return or idle movement thereof.

It is an additional aim of my invention to provide a novel construction and mounting of the dresser head so that various dresser heads for different forms of threads may be interchangeably used with the mechanism for actuating the diamonds, whereby the greater expense which would be incurred in the substitution of another complete dresser assembly is obviated.

Of the numerous subordinate objects of my invention, attention is directed to the machine organization in its entirety, in which the several functionally co-related units are so arranged, together with the adjusting and operating means therefor, as to provide an exceedingly compact assembly upon a supporting structure of minimum length, height and depth, with convenient access thereto for the purpose of inspection and repair; a simple and space-conserving mounting for the distributor head for the grinding wheel cooling medium which permits easy adjustment thereof; and a grinding machine of this type in which the structural parts of the several cooperating mechanisms are of rugged mechanical form, capable of fabrication at low cost and constitute a material factor in reducing repair and maintenance costs to a minimum.

Other practically important features of my present disclosure will become evident from the following detail description of one concrete example of the invention, illustrated in the accompanying drawings, in which similar reference characters designate corresponding parts throughout the several views, and wherein:

Figure 1 is a front perspective view of a grinding machine, illustrative of one embodiment of my invention;

Figure 2 is a rear perspective view thereof on a reduced scale;

Figure 3 is a perspective view of the work spindle and lead screw drive gearing with the housing therefor, the housing cover being removed;

Figure 4 is a fragmentary longitudinal sectional view, taken substantially on the line **4—4** of Figure 5, showing the gearing backlash or lost motion compensating mechanism;

Figure 5 is a transverse sectional view taken substantially on the line **5—5** of Figure 4;

Figure 6 is a sectional view similar to Figure 4 taken substantially on the line **6—6** of Figure 7;

Figure 7 is a transverse section taken substantially on the line **7—7** of Figure 6;

Figure 8 is a perspective view of the grinding wheel slide and wheel head, the wheel and wheel guard and operating motor being removed;

Figure 9 is a perspective view of the grinding wheel slide, wheel operating means and parts of the machine bed;

Figure 10 is a perspective view of the mechanism for adjusting the grinding wheel head;

Figure 10A is a fragmentary rear perspective view of the grinding wheel head;

Figure 11 is a similar view showing the means for adjusting the wheel operating motor in correspondence with the adjustment of the wheel head;

Figure 11A is a rear perspective view of the mounting plate for the grinding wheel motor;

Figure 12 is a perspective view illustrating the mounting of the wheel dressing mechanism with respect to the grinding wheel and its operating motor;

Figure 13 is a similar view of the dresser mechanism removed from the machine;

Figure 14 is a perspective view of the dresser head mechanism and parts of the operating means therefor;

Figure 15 is a perspective view showing the two sections of the dresser unit in separated relation and illustrating the internal operating mechanism;

Figure 16 is a similar view illustrating the mechanism on the underside of the grinding wheel carriage;

Figure 17 is a perspective view of parts of the in-feeding and retracting mechanisms for the grinding wheel and the wheel dressing compensation mechanism;

Figure 18 is a similar view illustrating further details of said mechanisms, the retracting mechanism having been operated to fully retract the grinding wheel;

Figure 19 is a perspective view showing the mechanism for actuating the dresser and for predetermining the movement thereof relative to the grinding wheel;

Figure 20 is a rear face view of the manually operable means which determines the extent of dresser movement;

Figure 21 is a detail sectional view substantially on the line **21—21** of Figure 19, illustrating the means for controlling the incremental movement of the dresser;

Figure 22 is a detail fragmentary sectional view taken substantially on the line **22—22** of Figure 20, and

Figure 23 is a horizontal sectional view of the units shown in Figures 16 and 17 in assembled relation, taken on a plane containing the axes of the telescoped shaft members.

THE MACHINE ORGANIZATION

To facilitate a ready understanding of my invention I shall first generally describe the arrangement of the several units and their respective functions in the machine organization and then fully describe the novel features of said units and their several advantages in functional operation as distinguished from previously known machines of this type.

Referring then first to Figure 1 of the drawings, upon a supporting structure or base **30**, of suitable structural form and dimensions, the work carriage **31** is slidably mounted for horizontal traveling movement in manner customarily employed in various kinds of metal working machines. Upon this carriage the usual head stock **32** and tail stock **33**, of conventional construction, are mounted in spaced apart relation. The head stock has the usual driving spindle **34** and the tail stock a work supporting center **35**, the latter being spring pressed and retracted in the mounting or removal of the work piece by a lever **36**. The tail stock assembly is adjustable on the carriage **31** for different lengths of work shaft 67, and, through the gear train shown in Figure 3, actuates lead screw 73 to move the work carriage 31. Axial movement of shaft 67 with the carriage and relative to the back-lash compensator is provided for by making keyway 85 substantially co-extensive in length with the maximum extent of rectilinear travel of the work carriage.

In Figure 5 it will be noted that screw 79 has been actuated to adjust the block 81 so as to space one end of said block from the opposing end of block 89 on the collar flange 83, as indicated at 92. This circumferential gap or space is substantially proportional to the amount of backlash or lost motion between shaft 67 and lead screw 73. Therefore, when the direction of rotation of worm wheel 63 is reversed, the rotation of sleeve 64, disk 66 and blocks 81 and 86 is also reversed. Since gear 68 is fixed to sleeve 64, the rotation of the lead screw transmission gearing is likewise reversed. However reverse rotation is not transmitted to shaft 67 until the clearance space 92 has been absorbed or taken up, as shown in Figure 7. Thus, any lost motion or backlash in the lead screw gearing is absorbed before collar 82 and shaft 67 are rotated in the new direction as indicated by the arrow in Figure 7, whereby the reversed rotation of work spindle 34 and the reversed travel of the work carriage 31 are exactly synchronized.

The mechanism above described is enclosed by a suitable hood 93 hinged to a part of the structure 30, as at 94 and secured in closed position by the latch device 95. By raising said hood access may be readily had to the screw 79 for the purpose of adjusting the gap 92 as may be required from time to time to compensate for gear wear and other factors. It will be apparent that by the provision of my novel compensating mechanism the work may be operated upon by grinding wheel 42 in both the forward and reverse movement of carriage 31, with the assurance of a high degree of accuracy in the generation of the required thread. Spoilage of the work is reduced to a minimum and production materially increased.

Helix angle adjustment of grinding wheel

To grind a true helix upon the work, I have provided novel means for adjusting the grinding wheel and its operating motor to position said wheel in a predetermined inclined plane of rotation and at an angle to the axis of rotation of the work which approximates the helix angle of the thread being generated.

Referring now to Figures 1, 8, 9 and 10 of the drawings, the rotative axis of grinding wheel 42 is mounted in the wheel head 39 in any approved or well known manner and is driven from the motor 96 by a drive belt 97 of suitable conventional type as seen in Figure 9. The wheel head 39 is mounted on wheel slide 38 in the manner best shown in Figure 9 and is attached thereto by T bolts 98, the heads of which are slidably engaged in vertical slots 99 in one end face of the slide 38. The threaded ends of these bolts extend outwardly through horizontal slots 101 in the top and bottom flanges 100 on the wheel head 39 and have clamping nuts 102 engaged thereon, as shown in Figure 8.

As shown in Figures 9 and 10, slide 38, at the top thereof, is provided with a horizontally disposed hollow arm 103 in which a shaft 104 is suitably journalled. To one end of this shaft the hand wheel 40, shown in Figure 1 may be fixed or said end of the shaft may be formed with a suitable wrench receiving socket, as indicated at 105 in Figure 10. The other end of this shaft carries gear 106 in constant mesh with gear 108 on the upper end of a vertical shaft 107. The lower end of this shaft is provided with a worm 109 in mesh with worm gear 111 fixed to shaft 110 intermediate of its ends. This shaft is suitably journalled in the slide 38 and at its forward end has a pinion 112 fixed thereto. This pinion rotates in a recess in the end face of the slide and is engaged with the teeth of a rack 113 mounted for vertical movement in a slot 114 in said slide face. Between its ends this rack carries a pin 115 upon which block 116 is rotatably supported. At one side of slot 114, the face of the slide 38 has vertically spaced pins 117 embedded therein upon which arcuate blocks 118 of equal radii are swivelled for rocking motion.

The rear face of the wheel head 39, as seen in Figure 10A, is provided with the vertical arcuate slot 119 to receive the blocks 118 and, intermediate the ends of said slot, with an adjoining horizontal slot 51 to receive the block 116 carried by rack 113. It will thus be evident that, when clamping nuts 102 are loosened and shaft 104 is rotated, rotation is transmitted through shafts 107 and 110 to the pinion 112. As rack 113 is vertically moved block 116 thereon turns on pin 115 and imparts rotary movement to the wheel head 39 about an imaginary center which is coincident with the center of arcuate curvature of the blocks 118. The degree of rotation of the wheel head in each direction from the position shown in Figure 8 is limited by the length of the slots 101 in which the head attaching bolts 98 are engaged, the heads of which move vertically in slots 99 in the rotative adjustment of said head. After the adjustment is made the nuts 102 are again tightened to securely fix the wheel head in the new position. A suitable scale, indicative of the helix angle of grinding wheel 42, may be provided at 120 (see Figure 8).

Simultaneous wheel and motor adjustment

Since motor 96 is connected with the grinding wheel shaft by belt 97, it is necessary to provide a means for adjusting said motor and drive belt simultaneously with the helix adjustment of the wheel 42 in order to avoid skewing or twisting of said belt.

With this end in view I have devised the simple and novel motor mounting and adjusting means shown in Figures 11, 11A and 12. Referring to Figure 11, intermediate of its ends the slide 38 is formed with a transversely disposed upwardly projecting supporting web 121 to one side of which the motor bearing plate 122 is rigidly secured. The mounting plate 125 for the motor 96 is pivotally mounted on the bearing plate 122 by having the boss 126 of the mounting plate rotatably fit in the openings 123 and 124 in the plate 122 and web 121 respectively. The motor may be properly retained in mounted position by means of a stud 127 axially projecting from boss 126 and cooperating with a retaining means of conventional type coacting with the front face of the web 121.

The rear end of shaft 110 has a reduced axial extension 128 to which pinion 129 is fixed for rotation in a suitable recess in the face of plate 122 which communicates with one side of a vertical slot 130 in said plate. A rack 131, geared to pinion 129 is movable in this slot and between its ends carries a laterally projecting stud or pin pieces and clamped or secured in adjusted position by lever 37.

Upon the wheel slide 38 mounted on the structure 30 the wheel head 39 is adjustably supported, the helix angle of the grinding wheel being variously fixed by operation of a hand wheel 40, as will be later fully explained. The wheel guard 41 is attached to the head 39 and protects the operator against possible injury in the event of breakage of the grinding wheel 42. A suitable cooling medium is supplied to the wheel 42 from a distributor head 43 through the tubes 44, said head being replenished from the tank or reservoir 45 through the flexible conduit 46. Movement of the wheel slide 38 is controlled by the infeed mechanism generally indicated at 47 and the retracting mechanism indicated at 48. The wheel dressing and compensating control mechanism is indicated at 49.

The wheel slide 38 and its associated mechanism are enclosed by a hood 50 to confine the mist or vapor emanating from the wheel cooling medium during the grinding operation, a conventional suction fan and filter (not shown) being connected with said hood, the condensate and any suspended foreign matter flowing by gravity to the guideway 52 of the structure 30 in which wheel slide or carriage 38 is mounted. This latter feature, the purpose of which will be later described in greater detail, is one of the novel details of the present disclosure.

The machine is also equipped with the usual control panel 53 whereby the operation of the several units may be manually controlled. Conventional variable control circuits for the operating motors to be later referred to are provided and by properly adjusting the dial 54 the work carriage may be moved forwardly at low speed for an initial roughing cut and at relatively high speed in the reverse direction for a finishing cut, by adjustment of dial 55. Dial 56 controls the speed of rotation of the grinding wheel. These operational controls, being familiar features of machines of this type, will not be further described in detail. The adjustable dogs 57 and 58 which determine the length of the thread by actuating circuit breaking switch 59 for the work carriage operating motor are also well known in the art and do not constitute an essential part of the invention.

Also the mechanism shown in Figures 1, 2 and 3 of the drawings for synchronously rotating the head stock spindle 34 and the work carriage lead screw is generally known to those familiar with this art. The following brief description will, therefore, suffice for a clear understanding of the application of our present improvements to this mechanism.

At the rear side of the structure 30 operating motor 60 is mounted in any preferred manner and, through a standard type of drive belt or other transmission means enclosed within the housing 61, operates drive means for the worm 62 engaged with worm wheel 63 keyed or otherwise fixed, as at 65, to the sleeve 64 having a disk 66 integrally formed with one end thereof. This disk constitutes one of the elements of a back-lash compensator, to be presently described and which is loosely mounted on the outer end of the driving shaft 67, the inner end of shaft 67 being rigidly connected with the head stock spindle 34 by any approved means.

To the other end of sleeve 64 the gear 68 is keyed or otherwise fixed as at 69 (see Figures 3 and 4). Through suitable gears 70 and 71 rotation is transmitted from the gear 68 to a gear 72 fixed to one end of the conventional lead screw 73 which is operatively connected with the work carriage 31 in well known manner. This gearing is, preferably, enclosed within a suitable gear box 74, having a hinged closure 75 for one side thereof to afford convenient access to the box when it is desired to change the gear ratos. As is well known in the art, it will thus be understood that rotation of the lead screw moves the work, in synchronism with the rotation thereof, past the grinding wheel 42 so that the latter generates a thread helix as the work passes in contact with the peripheral thread form of the wheel.

Back-lash compensating mechanism

As above stated, in connection with the operation of the control dials 54 and 55, in one method of operation it may be desirable to grind the work piece in both directions of traverse of the work past the grinding wheel. Of course, the gear elements of Figure 3, even if machined or fabricated to accurately perfect dimensions, will, due to frictional wear develop more or less lost motion or back-lash between the teeth of the intermeshing gear elements. It is therefore inevitable that, unless some compensating means is provided, when the direction of rotation of sleeve 64 is reversed, the slack or lost motion between gears 68 and 72, will result in a few degrees of rotation of shaft 67 before lead screw 73 would be rotated to reverse the traverse of work carriage 31. As a consequence thereof the functionally synchronized horizontal travel and axial rotation of the work would be disturbed, resulting in an inaccurate thread when two-way, or forward and reverse grinding is employed.

I have devised a simple and efficiently operating compensating mechanism which, notwithstanding structural deficiencies or incidental wear of the operating gearing, will insure accurate synchronization of the axial rotation of the work piece with the reversible, rectilinear, bodily movement thereof past the grinding wheel.

With more particular reference to Figures 4 to 7 of the drawings, as above noted, the compensating mechanism includes the disk 66. To one side face of this disk the ring or annulus 76 is connected by drive pins 77 and securely fastened thereto by screws 78. Within this ring an adjusting screw 79 is mounted in substantially tangential relation to the internal circumference thereof. The threads 80 of this screw coact with the external threads of an arcuate block 81 rotatably mounted upon a collar 82 between an end flange 83 thereof and the side face of disk 66. This collar is connected by key 84, engaged in keyway 85 of the shaft 67, for rotation as a unit with said shaft. A drive block 86 of arcuate form is concentrically located between the collar 82 and ring 76 and secured to disk 66 by the screws 87. Drive pins 88 fixed in the disk 66 are fitted in openings in said block 86.

A second drive block 89 of like radius to the block 86 is also positioned between the disk 66 and collar flange 83 and secured to the latter by screws 90 while drive pins 91 fixed in said flange are fitted in openings in said block.

It will be seen from the above that worm wheel 63 drives the sleeve 64 and disk 66, ring 76 rotating as a unit therewith in the direction of the arrow in Figure 5. Block 86 is driven by pins 88 to contact the opposed end of block 89 which, through pins 91 drives the collar 82 to rotate

132. This pin rides in a horizontal slot or groove 133 in the rear face of motor mounting plate 125 and, by coacting with the edges of said slot imparts rotative or rocking movement to plate 125 and motor 96 about the axis of bearing boss 126.

It is apparent from the above that I have provided a single positively operating connecting means between the grinding wheel head and the wheel operating motor, controlled from the manually operable shaft 104, for simultaneously adjusting the motor when the helix angle of the grinding wheel is adjusted and maintaining exact parallelism between the wheel shaft and motor shaft, thus obtaining a smooth transmission of power with minimum wear on the driving belt. Also the means which I provide for adjustably mounting the wheel head enables me to make a material reduction in the width of the end face of slide 38 with proportionately lower manufacturing cost. This feature also affords easy access to the wheel dressing mechanism mounted on the slide directly behind the grinding wheel, as will now be described.

Dresser assembly mounting

In Figures 11 to 16 of the drawings the wheel dressing mechanism generally indicated at 135 is mounted on the top surface of a carriage 136. This surface is provided with a key 137 (Figure 11) to engage a keyway of the dresser unit which permits lateral bodily movement of said unit parallel to the grinding wheel shaft but prevents transverse movement of said unit relative to the carriage toward and from the wheel shaft.

The dresser unit comprises separable upper and lower sections 138 and 139, respectively, which will later be described in detail. The lower section 139 carries a lug 140 depending over the front side wall of carriage 136, said lug having an adjusting screw 141 threaded therein which bears against said side wall to laterally displace the dresser unit on carriage 136. A clamping screw 142 is disposed through opening 143 in the lug 140 and is adapted for threaded engagement in a recess in the carriage 136 to clamp or lock the dresser unit in its laterally adjusted position on said carriage. The carriage 136 has a lug 145 extending downwardly through an opening 146 in slide 38, said lug carrying a fixed nut 147 with which feed screw 148 is engaged (Figure 16). A spring 149 has one of its ends attached to carriage 136 and its other end to the slide 38 (Figure 11) so that the nut 147 will be resiliently pressed into intimate engagement with the threads of the feed screw 148.

A hand wheel 150 is fixed to one end of a transverse shaft 151 mounted on the slide 38, the other end of said shaft having a gear 152 thereon in mesh with the gear 153 fixed to one end of the lead screw 148. By rotating wheel 150 the dresser carriage 136 may thus be adjusted transversely of the grinding wheel axis to move the wheel dressing elements into and out of engagement with the peripheral thread forming faces of the grinding wheel, while the lateral adjustment of the dresser unit on carriage 136, as above explained, positions the dressing elements in proper relation to the wheel 42 axially thereof to redress a wheel having an offset thread form with unequal flank lengths.

Grinding wheel infeed mechanism

Referring more particularly to Figures 16, 17 and 18, the panel 155 is suitably mounted on the bed structure 30 and carries the grinding wheel

infeed mechanism 47 and the retract mechanism 48. The infeeding movement of the slide 38 and grinding wheel 42 is effected by operation of the hand wheel assembly 156 having the graduated dial 157 to indicate the amount of transverse movement of the wheel 42 relative to the rotating work. This assembly is mounted on a shaft 158 journalled in panel 155, the rear end of said shaft carrying a gear 159. This gear is engaged with an idler gear 160 on stud shaft 161, fixed to panel 155 and which rotates gear 162 secured to feed screw 163. The threaded section 164 of this feed screw coacts with internal threads on one end of a tubular shaft 165 which is rotatably mounted against axial movement relative to the wheel slide 38 in spaced depending bearing lugs 166 and 167 formed on said slide. The other end of shaft 165 carries a fixed gear 168 in mesh with an idler gear 169 which in turn meshes with a second idler gear 170, said idler gears being rotatably mounted on the spaced studs 171 and 172 respectively. Gear 170 is engaged with gear 173 fixed to one end of a tubular shaft 181 journalled at its opposite ends in the bearing lugs 166 and 167. On this shaft a gear 182 is fixed, said gear meshing with gear 183 fixed to the dresser feed screw 148. The operation of this mechanism is as follows:

Upon rotation of the hand wheel assembly 156 rotation is imparted to lead screw 163 through the gearing 159, 160 and 162, as above described. The frictional resistance to turning movement of shaft 165 being far greater than the torque exerted by the threads of screw 163 on the internal shaft threads, it follows that said shaft and, of course, the slide 38 will be drawn axially along said lead screw to move the slide toward or away from the work piece and thereby position the grinding wheel 42 relative to the axis of rotation of said work piece.

Grinding wheel retract mechanism

The operating lever 185 for the wheel retracting mechanism 48 is fixed to one end of a shaft 186, to the other end of which a gear segment 187 is keyed to rotate therewith. This segment actuates gear 188 fixed to one side of a cam 189, rotatably mounted on lead screw 163 and axially movable as a unit therewith for a distance equivalent to that between the end face 190 of said cam and surface 191 of panel 155, against which the cam face 190 is adapted to accurately contact.

The cam track or groove 192 coacts with a roller 193 which is rotatably mounted against axial movement on a fixed shaft 194 carried by panel 155. Movement of the lever 185 in a clockwise direction from the position of Figure 17 to that shown in Figure 18 results in a counterclockwise rotation of cam 189, separating its end face 190 from the abutment surface 191 as shown in the latter figure, owing to the camming action between the side walls of groove 192 and roller 193. Since the cam 189 cannot move axially independently of the lead screw 163, the latter is thus moved rearwardly to operate as a pusher rod, cooperating with the internally threaded shaft 165, to retract the slide 38 and wheel 42 away from the work at rapid speed. Of course, counterclockwise movement of lever 185 from the position of Figure 18 draws the lead screw 163 forwardly and again positions the wheel 42 in operative relation to the work, as finally established by abutting contact between the surfaces 190 and 191. This is an important feature as lever 185 may be moved in the counterclockwise direction for, say 50 thousandths of an inch, as indicated by graduations 195, and the wheel 42 made to contact the work by operating the infeed mechanism 47 through rotation of hand wheel 156, as above described. Then lever 185 may be returned to zero position in any number of progressive steps, representing rough grinding and a final finish grinding step, with complete assurance that the thread will be ground to a depth of 50 thousandths of an inch, as pre-set.

Dresser feed compensating mechanism

Referring again to Figures 1, 16 and 17 of the drawings shaft 196 is rotatably mounted in panel 155 and has its forward end provided with wrench receiving socket 197 and its rear end with a key-way 198 receiving the key 199 of tubular shaft 181 in which shaft 196 slidably telescopes as the tube shaft 181 moves with slide 38 toward or away from panel 155. Rotation of shaft 196 causes rotation of tubular shaft 181 to rotate gear 182 and coacting gear 183 whereby dresser feed screw 148 is rotated. This screw cooperating with nut 147 moves the dresser carriage 136 toward or away from the grinding wheel 42.

In order to compensate for the reduction of diameter of the grinding wheel 42 incident to the truing or dressing operation, rotation is transmitted from tubular shaft 181 through gears 173, 170, 169 and 168 to the internally threaded shaft 165 which now coacts with the threads 164 of lead screw 163 to move the wheel slide 38. Thus, any reduction in grinding wheel radius resulting from truing will be fully compensated for to maintain the same thread depth after truing as was pre-set by the grinding wheel infeed mechanism 47 or the retracting mechanism 48. Also, since rotation of hand wheel 150 transmits rotation through gear 183 to shaft 165, movement of the dresser carriage 136 relative to said wheel slide is automatically compensated.

Precision dresser feed mechanism

Referring to Figures 17 and 19 to 22 inclusive, the shaft 196 has a ratchet disk 200 (Figure 19) fixed thereto with which the toothed end of a pivoted pawl 201 is engaged. This pawl is mounted in a recess 202 in the rear face of the dial member 222 of a hand wheel assembly 203 and is yieldingly held in cooperative engagement with the teeth of the ratchet disk 200 by a suitable spring 204. An eccentric 205 is also mounted in one end of the recess 202 and operated by member 230 to coact with an arcuate shoulder 206 formed one one side of the free end of the pawl 201. This eccentric may be conveniently operated by a knob or button 207 mounted on the member 230 and, as will be evident, when rotated in one direction cooperates with shoulder 206 to withdraw the toothed end of pawl 201 from operative engagement with the teeth of ratchet disk 200, against the action of spring 204. This will permit a rapid movement of dresser carriage 136 away from the grinding wheel 42 by actuation of shaft 196 by means of a wrench applied to end socket 197 thereof, as would be desirable in replacing a worn out grinding wheel with a new one.

The hand wheel assembly dial 222 carries a pin 208 which extends into the lower end of a slot 210 communicating with a cylindrical bore 209, extending diagonally upward through the panel 155 and opening at its upper end in the recess 211 formed in the upper edge of said panel. Within the lower portion of bore 209 a sleeve 212 is slidably fitted. A second sleeve 213 of relatively small diameter is concentrically fixed within the sleeve 212 by the tightly fitted comparatively thick lower end wall sections of said sleeve, as indicated at 214, which provide a bearing seat 215 for the lower end of a coil spring 216 extending upwardly therefrom between the sleeve walls.

The upper end of spring 216 is seated against a shoulder 218 formed on a tubular rod 217 which is fixed within the bore 209 by a locking pin 219. The lower end of this rod is interiorly threaded to receive a threaded section 221 of an adjustable stop rod 220, the lower end of which is loosely engaged in the upper end of sleeve 213. Provision is made on the upper end of said rod for the application of a suitable adjusting wrench.

It will be readily understood from the above that the position of the lower end of rod 220 determines the extent of upward movement of the pin 208 in slot 210 which, in turn, determines how many degrees of rotation hand wheel assembly 203 can make in one oscillation thereof and the maximum movement which can be transmitted therefrom to ratchet disk 200 by the pawl 201. Stop rod 220 is usually set to provide a movement of about one thousandth of an inch of dressing unit feed for each oscillation of the hand wheel 222. However, this can be varied as desired.

The hand wheel assembly 203 includes the dial 222 having a peripheral graduated scale 223, and a collar 224. This collar is fixed to shaft 196 and has a flange 225, the dial 222 being recessed to receive said flange so that the outer surfaces of the dial and collar flange lie in a common plane, as seen in Figure 17. To the rear side of dial 222 a block 226 is loosely attached at one of its ends by the pin 227, the other end of said block overlying the rear face of the collar flange 225. A locking member 228 is threaded in the dial and connected at its rear end to the block 226 so that, after setting the dial graduations with respect to the index member 229 on the panel 155, said dial may be locked to the flanged collar to rotate therewith by adjusting the member 228 to cause the block 226 to frictionally clamp against the rear face of the collar flange 225 (see Figures 21, 22). Thus, when it is desired to feed the dresser carriage 136 a distance of say six ten thousandths of an inch, dial 222 is set to register its zero point with index 229; member 228 is adjusted to lock the dial and collar 224 against relative rotation; and dial 222 then turned to register the six ten thousandths of an inch graduation with the index 229, said collar and shaft 196 being simultaneously rotated to the same extent and thereby advancing the dresser carriage by that amount. If it is subsequently desired to reduce the grinding wheel diameter by a further two ten thousandths of an inch, the friction block 226 is loosened by turning member 228 to permit dial 222 to be reset to zero. The above described operation is then repeated.

In order to facilitate the making of accurate adjustments by unskilled operators, the hand wheel assembly 156 of the grinding wheel infeed mechanism 47 is, preferably, of similar construction to the hand wheel assembly 203 above described, having a locking screw or member 231 for the independently rotatable dial 157. By the provision of the dials 157 and 222 rotatable relative to the respective hand wheel assemblies, about the shafts 158 and 196, respectively, and means for connecting said dials for unitary rotation with said shafts, the operator is enabled to reset the dial graduations without in any way disturbing the mechanisms, the subsequent adjustments of which are indicated thereby. This is particularly advantageous in the operation of the machine upon a wide variety of work pieces of different diameters.

In Figure 21 of the drawings there is shown a control switch 232 for the operating motor for the dresser mechanism to be presently described. This switch has a spring pressed detent 233 which contacts the lower end of sleeve 212 and is released upon upward movement of pin 208 to close the motor energizing circuit.

Preferably, the upper end of bore 209 in panel 155 is normally closed by plate 234, pivoted at one of its ends in recess 211, as shown at 235.

Dresser mechanism

The dresser mechanism mounted on carriage 136, is fully illustrated in Figures 12 to 15 of the drawings. As previously noted, the dresser unit is preferably constructed in two separable sections 138 and 139 respectively. The section 139 includes a base 236 on which depending lug 140 is formed, said base being formed with a seat for the rockable cradle 237 which is held against axial movement thereon by the dovetail connections, indicated at 238. One end face of cradle 237 is graduated as at 239 for accurate adjustment of the cradle with respect to index 240 in correspondence with the helix adjustment of grinding wheel 42, heretofore described. Any suitable means, controlled by screw 241, may be provided for locking the cradle in adjusted position on the base 236.

The top section 138 carries a number of dowel pins 241′ to be received in registering bores 242 in the cradle 237 of bottom section 139 to retain said top section in superposed assembled position on said cradle. In addition one or more screws, such as that indicated at 243 in Figure 14, may be used to securely clamp section 138 against movement relative to the cradle 237.

Upon one end of the top section 138 of the dresser unit motor 244 is securely mounted to drive the gearing contained in gear box 245, which in turn actuates mechanism to be presently described for the dresser head 246 which is securely fixed upon the top section 138 of the dresser unit by suitable screws 247. Thus different dresser heads for different thread forms can be interchangeably used.

Referring more particularly to Figure 14, motor 244 drives gear 248 which rotates gear 249 fixed to one end of tubular shaft 250 rotatably supported on a fixed stud 251. A gear 252 is splined to the other end of shaft 250, as shown at 253, to rotate therewith, and meshes with gear 254 having a splined connection 255 with the driven shaft 256. The gears 252 and 254 may be readily removed and others of different diameters substituted therefor to change the driving ratio. Such changes in the speed of rotation of shaft 256 may be required by the use of grinding wheels 42 having structural characteristics which require a faster or a slower movement of the dressing diamonds past the peripheral faces of the grinding wheel.

In Figure 15 the motor driven shaft 256 is seen provided with the worm 257 which actuates a worm gear 258 fixed to one end of shaft 259 journaled in suitable bearings found on the cradle 237. The other end of this shaft carries worm 260 engaged with worm gear 261 mounted for rotation about the fixed vertical stud shaft 262 on cradle 237. To the upper side of gear 261 a crank 263 is fixed by screws 264 to rotate therewith. A roller 265 is freely rotatable on a vertical stud 266 fixed in the end of said crank. When sections 138 and 139 are assembled, as in Figures 13 and 14, roller 265 is received in the longitudinal channel 268 of a rocker arm 267, the lower face of which is in clearance relation to the upper face of crank 263. At one of its ends rocker arm 267 is securely fastened to vertical shaft 269 journaled in the section 138 and extending upwardly therefrom into the dresser head 246, and having pinion 270 fixed to its upper end (see Figure 14).

The shaft 269 is also provided with a helical gear 271 intermediate its ends coacting with gear 272 carried by the shaft 273 journaled in section 138. To the forward end of this shaft diamond carrying head 274 is splined, as at 275. Thus rotation of the shaft 269 is transmitted to the diamond head 274. The diamond 276 carried by said head will thus be oscillated by rocker arm 267 which is actuated by crank 263 to slowly move the diamond in one direction as it is fed across the flat peripheral crest of grinding wheel 42 which provides a flat root form of the thread generated by the grinding wheel, with a rapid return movement of said diamond. This is due to the fact that as crank 263 is rotated it transmits motion to arm 267 through a longer series of radii from shaft 269 during one phase of the oscillation of said arm than during the other phase thereof. Similarly pinion 270 is oscillated with a quick rotary motion in one direction and a relatively slow motion in the opposite direction since it is rotated by shaft 269 whose motion is determined by rocker arm 267.

Of course, many forms of threads do not have a flat root and when this is the case, the diamond 276 is merely removed from the head 274, or as heretofore observed, the entire dresser head 246 may be removed and replaced by another type appropriate to the particular geometric form of thread produced by grinding wheel 42.

In the illustrated embodiment of the dresser head which I have herein disclosed, it preferably comprises an upper plate 277 and a lower plate 278 which are accurately assembled in superimposed relation by suitable dowels 279 on plate 277 fitted in bores 280 in plate 278, said plates being then fixedly secured together by the screws 281. The lower plate 278 has an opening 282 therein to accommodate the pinion 270 and is also provided with an upwardly opening diagonal slot 283 tangential to said opening. The upper plate 277 has a similar downwardly opening diagonal slot (not shown) in tangential relation to a recess receiving the upper part of pinion 270 and which overlies the slot 283 in intersecting relation therewith. A bar 284 is longitudinally movable in slot 283 and has rack teeth 285 engaged with the lower portion of the teeth of pinion 270. A similar rack bar 286 is movable in the slot of the upper plate 277, the teeth 287 thereon engaging the upper portion of pinion 270. The forward ends of these rack bars carry the heads 288 and 289 respectively on which diamonds 290 and 291 are mounted.

It will be evident from the above that, corresponding with the rotary oscillations of pinion 270, the rack bars 284 and 286 will be slowly moved along divergent paths to cause a slow advancing movement of the diamonds 290 and 291 along the divergently angled flanks of the peripheral thread form on grinding wheel 42. Of course, the included angle between said flanks, after dressing, is determined by the angular setting of the rack bars 284 and 286 and for a different included angle another dresser head 246 having a relatively different angular setting of said rack bars would be substituted.

Among other refinements I may provide a slot 292 in the upper plate 277 of the dresser head into which a suitable type of gauge (not shown) can be fitted and securely clamped by the L-shaped member 293, one leg of which carries a clamping screw 294 threaded into the plate 277. Such a gauge is employed to determine the distance to which the diamonds 290 and 291 extend from their mountings in the diamond heads 288 and 289, respectively.

As heretofore explained, operating current is supplied to motor 244 by switch 232 when detent 233 is released in the operation of hand wheel assembly 203. I may also provide a second switch 295 in the motor circuit, carried by cradle 237, having a circuit breaking detent 296. This detent is engaged and actuated by the contact lug 298 on a stud 297 fixed to the rocker arm 267 to stop the operation of motor 244 after each complete oscillation or the forward and return movements of diamonds 290 and 291 across the thread grinding flanks of the wheel 42.

As shown in Figure 12 of the drawings, I also provide a convenient slidable mounting of the distributing head 43 for the liquid cooling medium upon the grinding wheel guard 300 so that said head may be easily adjusted with respect to the wheel to position the outlet ends of the tubes 44 relative to the periphery thereof.

From the foregoing description the relative arrangement of the several machine units, as well as the construction and operation of the individual units and their cooperative functional relationship in the machine organization will be clearly understood. One of the prominent novel features of my invention resides in the very compact mounting and arrangement of the grinding wheel head and the wheel dressing unit together with the operating motors therefor upon a slide 38 of minimum length. The simple and efficiently operating mechanism which I provide for feeding the grinding wheel to the work and for retracting the same and for adjustably positioning the dresser unit relative to said wheel is also a novel feature in thread grinding machines of the semi-automatic type.

The provision of a single manually operable means for simultaneously and synchronously adjusting the wheel head and its operating motor, mounted on opposite ends of the slide is of major practical importance and obviates damage or injury to the drive belt connections between the motor and grinding wheel shafts.

My improved back-lash compensator insures a high degree of accuracy and the reduction of spoilage to a minimum in the grinding of the work during both directions of travel of the work carriage. This device comprises relatively few parts of rugged construction and is easily accessible for purposes of adjustment. It is, of course, applicable to both semi and fully automatic thread grinders and may also be employed with advantage in other machines requiring an efficiently operating compensating mechanism of this kind.

The wheel dressing mechanism and operating means therefor, permitting the use of interchangeable dresser heads for different wheel thread forms is of considerable practical importance and embodies several novel features which contribute to the automatic truing of the grinding wheel to provide the required predetermined thread form thereon with a high degree of accuracy.

The means which I provide for shielding or housing the parts of the several mechanisms and for disposing of work cuttings, wheel grit and other foreign matter is a material factor in lowering the maintenance costs of such a machine, while the machine organization as a whole incorporates the various corelated units in such compact relationship that the machine may be so dimensioned as to present a pleasing appearance and to occupy a minimum of floor space.

As an illustrative example, I have herein disclosed one practical embodiment of my present invention, which has been found highly efficient for the purpose in view and the production cost of which will be comparatively low. However, the numerous novel features above described may be exemplified in various other structural forms and any one or more of such features utilized in the operation of metal working machines designed for the purpose of producing a large variety of different commercial articles.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiment is therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by United States Letters Patent is:

1. In a grinding machine, a work holder, a grinding wheel, a wheel supporting head, means rotatably mounting the wheel on said head, a support for the wheel supporting head, means pivoted to said support for guidably mounting the wheel supporting head on an end face of said support for rocking motion about an imaginary axis remote from said support to position said wheel for rotation in a predetermined plane at an angle relative to the longitudinal axis of the work, means movable with the wheel supporting head and slidably mounted in the support for retaining the wheel supporting head in adjusted position on said support, and means for effecting relative traverse between the grinding wheel and the work.

2. The grinding machine defined in claim 1 in which the guiding means comprises spaced arcuate members pivoted to the support and coacting with an arcuate slot in a side face of the wheel supporting head.

3. The grinding machine defined in claim 1 in which a wheel operating motor is independently mounted to oscillate about a fixed axis spaced from the wheel supporting head support, and separate mechanisms are provided for adjustably positioning said wheel supporting head and motor together with a common manually operable means for simultaneously actuating said mechanisms.

4. In a grinding machine, a traversing work carriage, a slide movable transversely of the line of work carriage traverse, a grinding wheel mounted on said slide, a carriage on the slide movable toward and from said wheel, truing mechanism on said carriage, slide actuating means to position the grinding wheel relative to the work comprising a lead screw, a member

threaded thereon and mounted on the slide against axial movement relative to the lead screw, means for rotating said lead screw to advance the slide toward the work, means to move said carriage relative to the slide and position the truing mechanism with respect to the wheel, means operatively connecting said carriage moving means with said member to rotate the latter relative to the lead screw and move the slide simultaneously with the independent movement of the carriage and truing mechanism to compensate for reduction in grinding wheel diameter by said mechanism, a quick acting cam rotatably mounted on the lead screw against axial movement relative thereto, relatively stationary means coacting with said cam, and means for rotating said cam to move the slide and carriage as a unit and retract the grinding wheel from the work.

5. The grinding machine defined in claim 1, in which said means slidably mounted in the support comprises a rectilinearly movable member carrying a pivoted member slidably coacting with the wheel supporting head to impart rocking movement thereto.

6. In a grinding machine having a wheel supporting slide and a grinding wheel mounted thereon; a wheel truing unit and operating means therefor mounted on the slide for bodily rectilinear movement relative to the slide radially and axially of the grinding wheel, said unit including a base, a truing head, a plurality of relatively reciprocating members mounted in said head and each carrying a wheel truing element, actuating mechanism for said members mounted in said base, and selectively operable means mounted on the slide for adjustably positioning the truing unit and its operating means thereon radially or axially of the wheel.

7. A wheel truing unit for grinding machines as defined in claim 6, in which said actuating mechanism includes coacting members and connecting means between one of said coacting members and the relatively reciprocating members of the truing unit.

8. A wheel truing unit for grinding machines as defined in claim 6, in which said actuating mechanism includes a common operating member having means directly coacting with means on each of said relatively reciprocating members, a non-reversible motor, and means housed within said base operatively connecting said motor with said operating member to simultaneously actuate said relatively reciprocating members.

9. In truing mechanism for grinding wheels, an upper base section and a lower base section, a member carrying a truing element mounted on the upper base section for reciprocating motion, an oscillatable shaft journalled in said upper base section, an actuating element for said member fixed to said shaft, a slotted arm housed within the upper base section and fixed to said shaft, a motor operated crank housed within the lower base section and having means movable in the slot of said arm toward and from said shaft to transmit a slow effective traverse to the truing element in one direction across a face of the grinding wheel and a relatively rapid retracting movement of said element in the opposite direction, and means separably connecting said base sections with said arm operatively connected to said crank.

10. In a grinding machine, a traversing work carriage, a wheel slide movable transversely of the line of work carriage traverse, a grinding wheel mounted on said slide, means for actuating said slide to position the wheel relative to the work comprising a lead screw, means for manually rotating said screw to feed the wheel to the work, a relatively stationary member, and a manually operable quick-acting cam rotatably mounted on the lead screw and coacting with said stationary member to rapidly retract the wheel slide.

11. In a grinding machine having a wheel supporting slide and a grinding wheel mounted thereon; a wheel truing unit and a non-reversible operating motor therefor mounted on the slide for bodily rectilinear movement relative to the slide radially and axially of the grinding wheel, said unit including a base, a truing head, a plurality of relatively reciprocating members mounted in said head and each carrying a wheel truing element, actuating mechanism for said members mounted in said base, and selectively operable means mounted on said slide for adjustably positioning the truing unit and its operating motor thereon radially or axially of the wheel.

12. In a grinding machine having a wheel supporting slide and a grinding wheel mounted thereon; a wheel truing unit and operating means therefor mounted on the slide for bodily rectilinear movement relative to the slide radially and axially of the grinding wheel, said unit including a base comprising two separable sections, a truing head, a plurality of relatively reciprocating members mounted in said head and each carrying a wheel truing element, actuating mechanism for said members having coacting parts thereof operatively mounted and housed within each of said base sections, and selectively operable means mounted on said slide for adjustably positioning the truing unit and its operating means thereon radially or axially of the wheel.

13. In truing mechanism for grinding wheels, a base having upper and lower separable sections, a member carrying a wheel truing element, means mounting said member on the upper base section for rectilinear movement in a plane substantially parallel to the upper surface of said upper base section, an oscillatable actuating element coacting with said member and having a shaft journalled in the upper base section, a slotted arm fixed to the shaft of said actuating element, a motor operated crank rotatably mounted in the lower base section in spaced relation to said shaft and having means movable in the slot of said arm toward and from said shaft to impart a slow effective traverse to the truing element in one direction across a face of the grinding wheel and a relatively rapid retracting movement of said element in the opposite direction, a stop switch for the crank operating motor mounted in the lower base section, and means on said arm to actuate said switch and stop the motor after each retracting movement of the wheel truing element.

14. In a grinding machine, a grinding wheel, wheel truing mechanism, a carriage on which said mechanism is mounted, means for actuating said carriage to feed the truing mechanism to the periphery of the wheel including an operating shaft, means for rotating said shaft in one direction comprising a dial member rotatable relative to said shaft, means for indexing said dial member, a pawl carried by said dial member, a ratchet fixed to said shaft to coact with said pawl, and relatively stationary adjustable means coacting with a part fixed to said dial member to control each feeding movement of the carriage

to true the grinding wheel in successive increments of predetermined amount.

15. In a grinding machine, a grinding wheel, wheel truing mechanism, a carriage on which said mechanism is mounted, means for actuating said carriage to feed the truing mechanism to the periphery of the wheel including an operating shaft, means for rotating said shaft in one direction comprising a collar fixed to said shaft, a relatively rotatable dial member adjustable with respect to said collar, a one-way driving connection between said dial member and shaft, means to releasably lock said dial member in any adjusted position thereof to said collar, and relatively stationary adjustable means coacting with a part carried by said dial member to control each feeding movement of the carriage to true the grinding wheel in successive increments of predetermined amount.

16. In a grinding machine, a grinding wheel, wheel truing mechanism, a carriage on which said mechanism is mounted, means for actuating said carriage to feed the truing mechanism to the periphery of the wheel including an operating shaft, a hand wheel assembly mounted on said shaft comprising means for rotating said shaft in one direction, relatively stationary adjustable means coacting with a part carried by said assembly to control each feeding movement of the carriage to true the grinding wheel in successive increments of predetermined amount, an operating motor for the truing mechanism and a normally open starting switch therefor, and means actuated by said part carried by the hand wheel assembly to control operation of said switch to closed position.

17. In a grinding machine, a traversing work carriage, a work holder rotatably mounted on said carriage, a drive shaft for said holder, a lead screw for traversing the work carriage, power driven operating means for said shaft and lead screw including a sleeve loosely mounted on said drive shaft and operatively connected with a power driven element, gearing connecting said sleeve with the lead screw, compensating means connecting said sleeve and drive shaft to compensate for backlash in the connecting gearing, comprising a collar keyed to said drive shaft, a drive block fixed to said collar, a block rotatable with said sleeve adapted to coact with said drive block to transmit rotation to said shaft, and a manually operable worm mounted in said sleeve coacting with the last named block to adjust the same relative to said drive block and to connect said adjustable block and sleeve for unitary rotation relative to said collar.

18. In a metal working machine, means for rotatably supporting the work, a slide movable transversely of the axis of rotation of the work, a work fashioning wheel and a head for supporting said wheel with its axis of rotation transverse to the direction of movement of the slide, means for mounting the wheel supporting head on a vertical end face of the slide for rocking motion in a vertical plane about an imaginary axis remote from the slide to position the wheel for rotation in a plane at a predetermined angle to the rotative axis of the work, a wheel operating motor directly supported on the other end of the wheel slide for rotative movement about an axis coinciding with said imaginary axis, adjusting means for the wheel supporting head and slide operatively connected with said wheel head including vertically movable members on opposite ends of the slide individual to said wheel supporting head and motor, and manually operable means for adjusting said members to simultaneously and equally adjust the positions of the wheel supporting head and motor relative to said slide and maintain a parallel relation of the rotative axes of the wheel and motor.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,412,778	Cummer et al.	Apr. 11, 1922
1,438,682	Bath et al.	Dec. 12, 1922
1,627,090	Hanson	May 3, 1927
1,634,386	Schramm et al.	July 5, 1927
1,666,737	De Leeuw	Apr. 17, 1928
1,739,753	Flanders	Dec. 17, 1929
1,862,583	Skriba	June 14, 1932
1,892,388	Edgar	Dec. 27, 1932
1,910,649	Svebelius	May 23, 1933
1,935,328	Munn	Nov. 14, 1933
1,946,888	Tougas et al.	Feb. 13, 1934
1,981,263	Croft	Nov. 20, 1934
1,983,286	Godziewski	Dec. 4, 1934
2,006,783	Ackley	July 2, 1935
2,080,206	Holmboe	May 11, 1937
2,087,662	Bysshe et al.	July 20, 1937
2,176,676	Lupo	Oct. 17, 1939
2,187,227	Flanders	Jan. 16, 1940
2,251,961	Snader	Aug. 12, 1941
2,292,875	Flanders	Aug. 11, 1942
2,294,494	Wilson	Sept. 1, 1942
2,310,977	Mathys	Feb. 16, 1943
2,311,263	Stewart	Feb. 16, 1943
2,317,226	Seyferth	Apr. 20, 1943
2,333,341	Scrivener	Nov. 2, 1943

FOREIGN PATENTS

Number	Country	Date
626,863	France	May 21, 1927