June 25, 1963 W. UMBDENSTOCK 3,094,822

SPIRAL GRINDING FIXTURE

Original Filed March 4, 1955 6 Sheets-Sheet 1

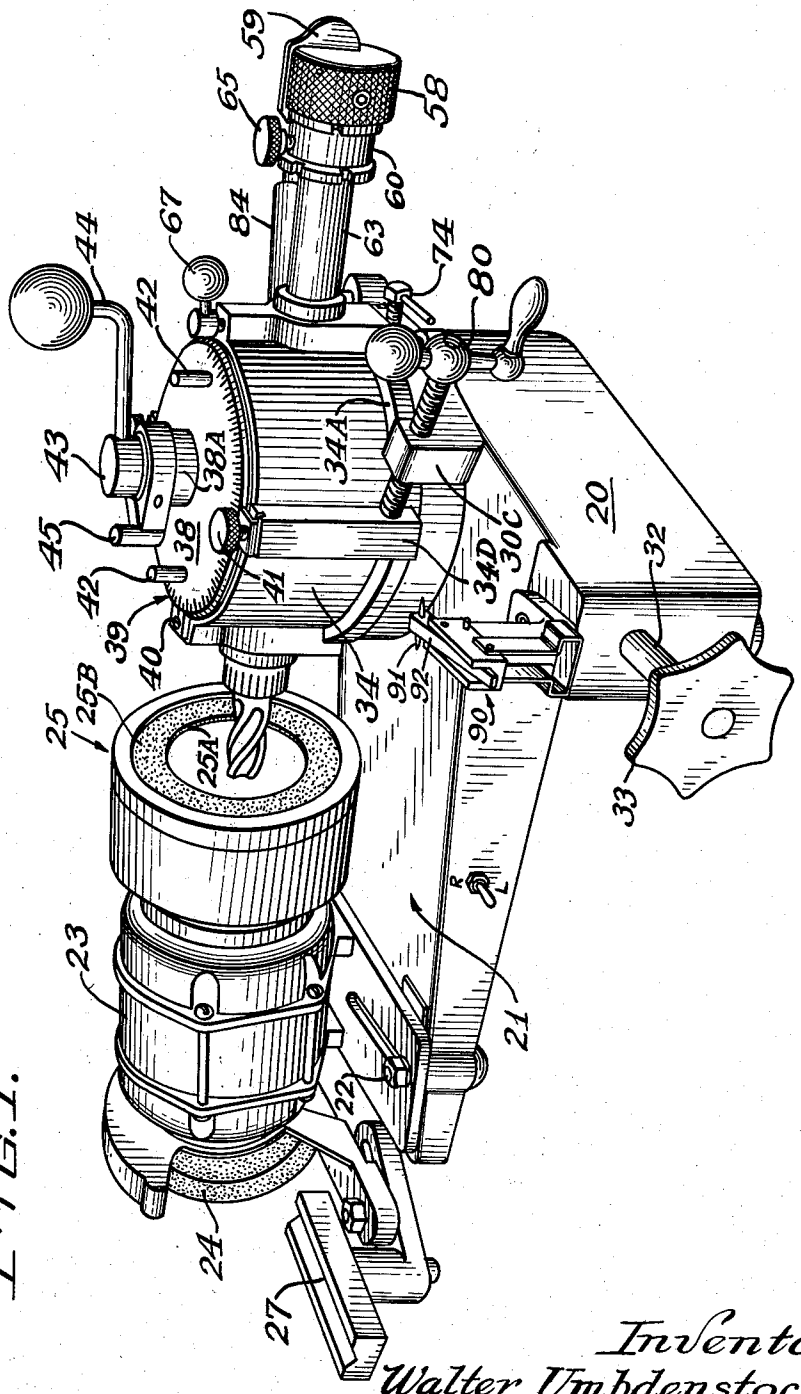

FIG. 1.

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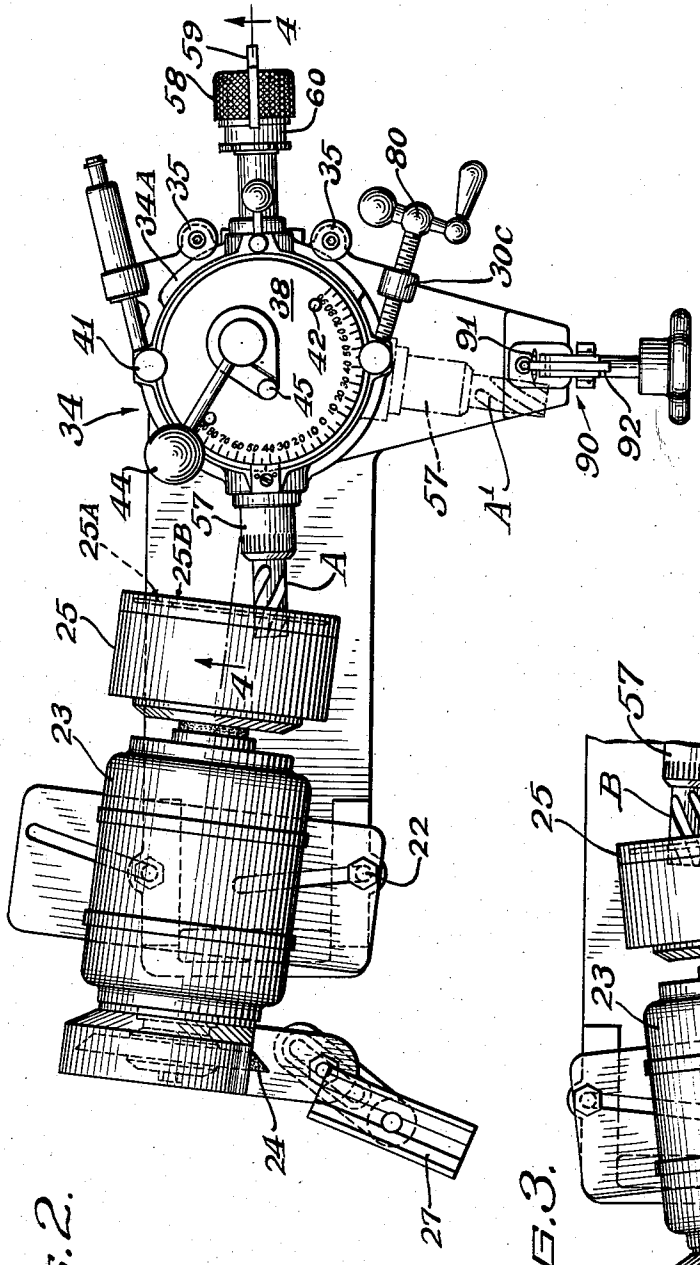

FIG. 2.

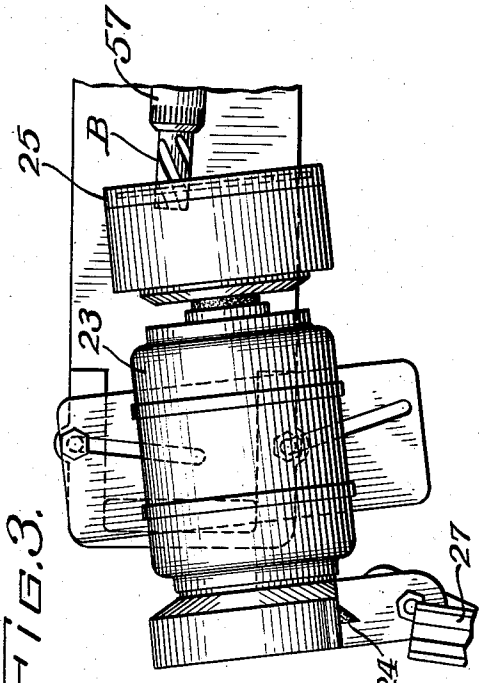

FIG. 3.

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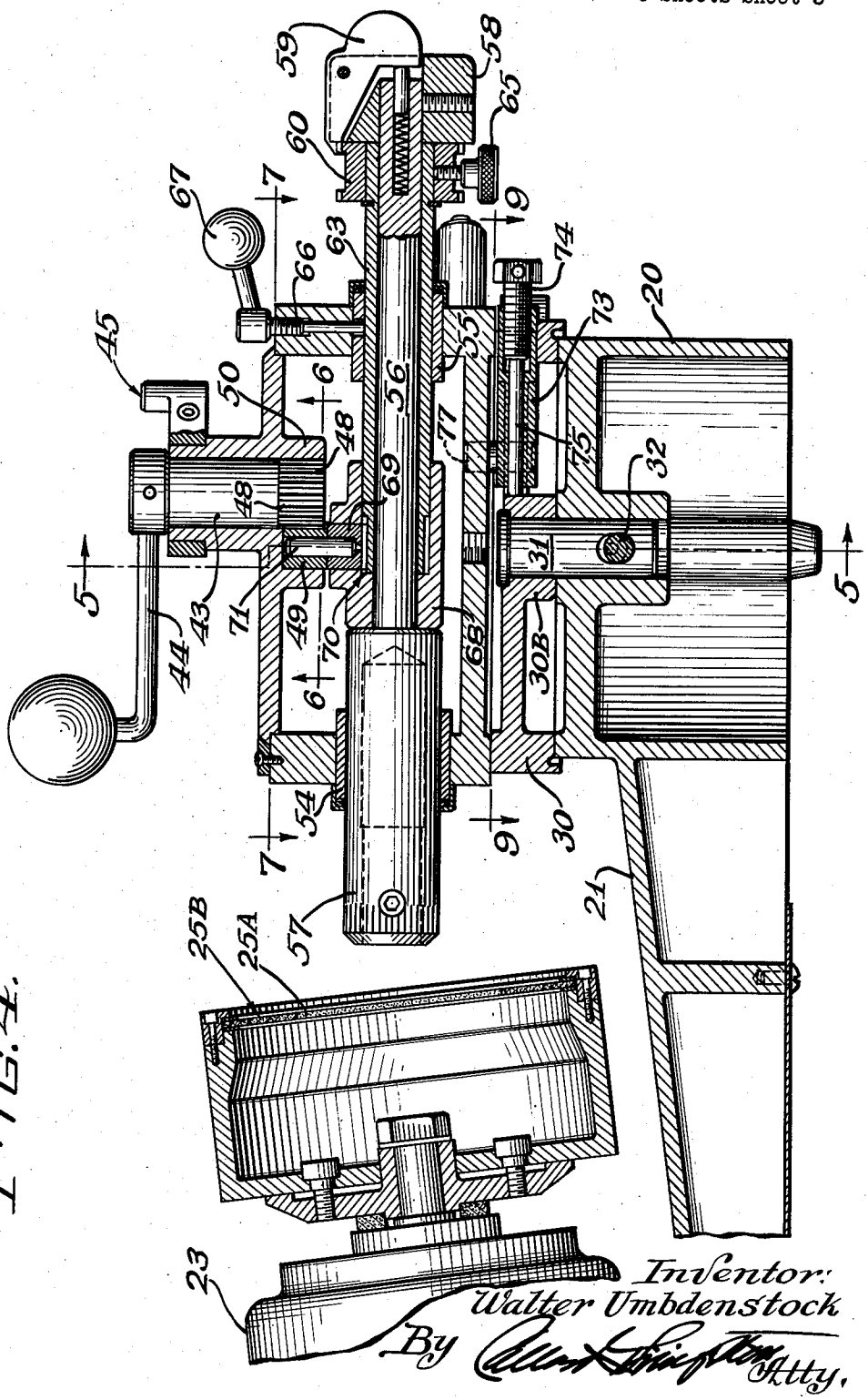

FIG. 4.

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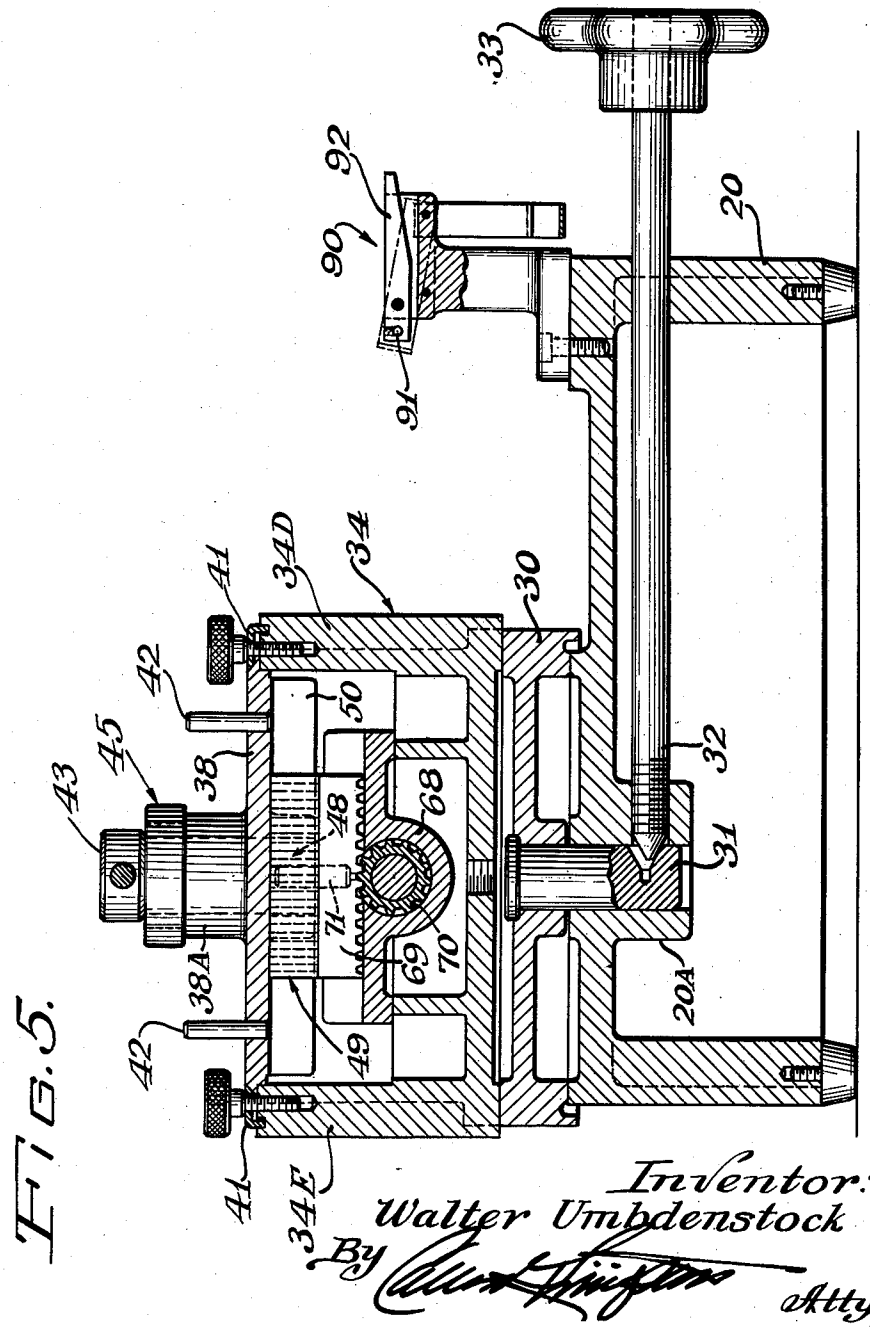

FIG. 5.

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FIG. 6.

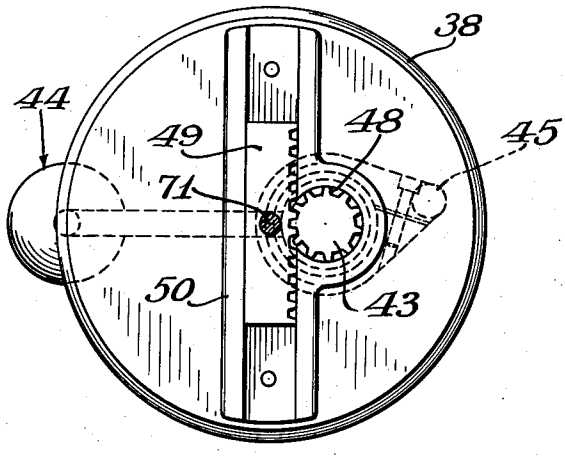

FIG. 8.

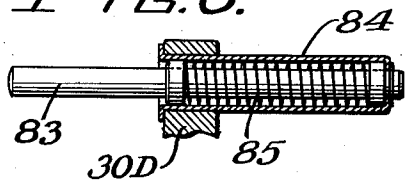

FIG. 7.

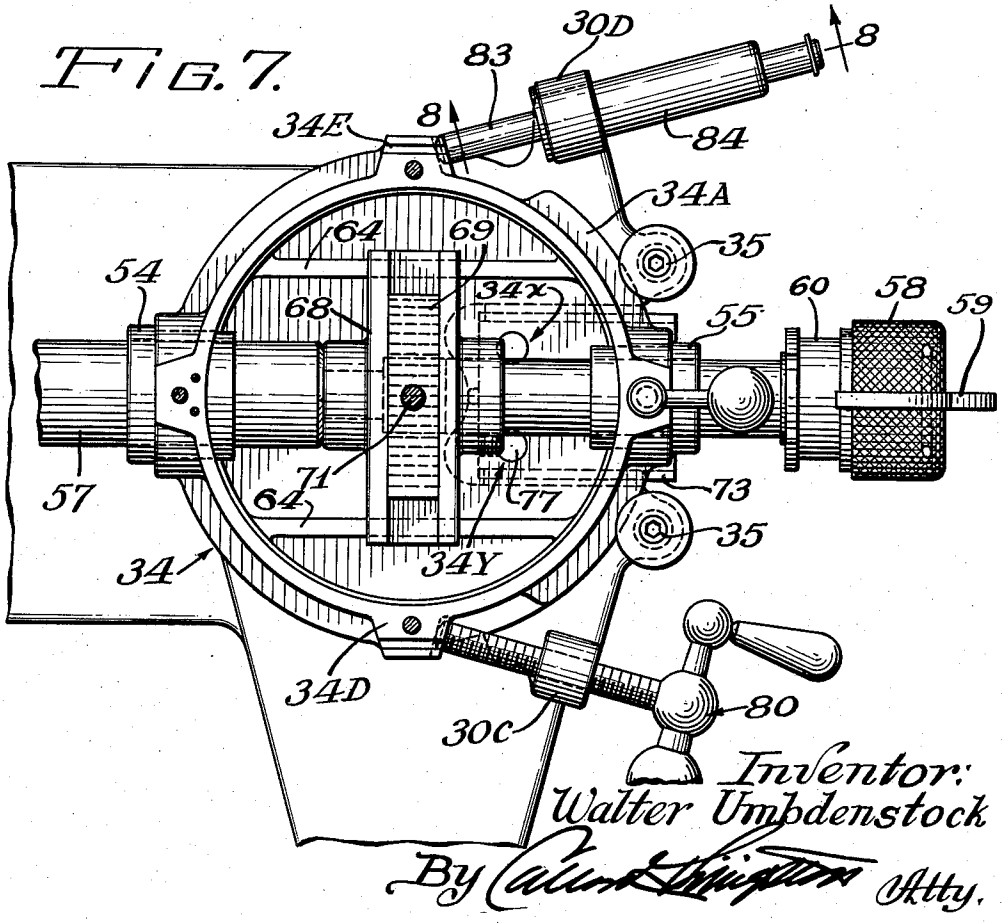

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Fig. 9.

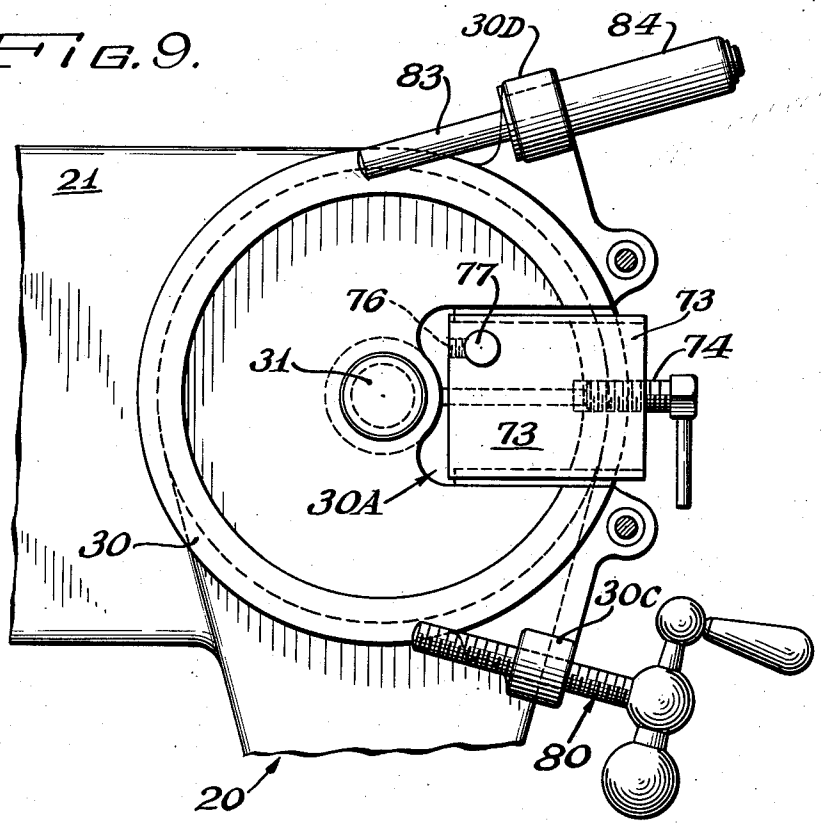


Fig. 11.

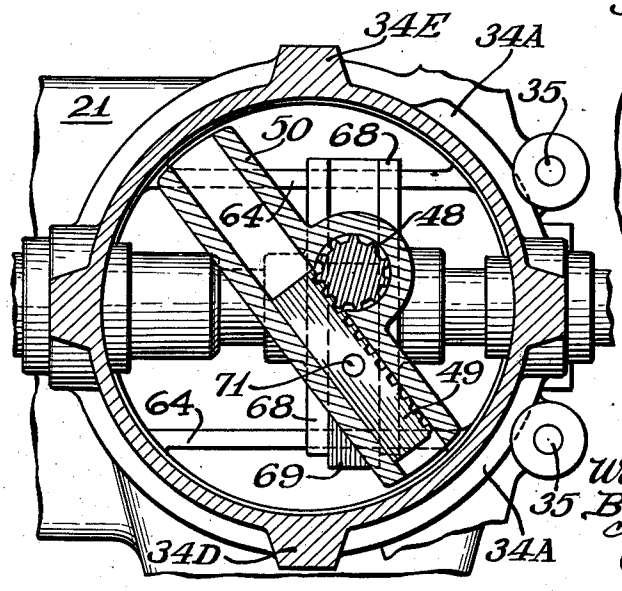
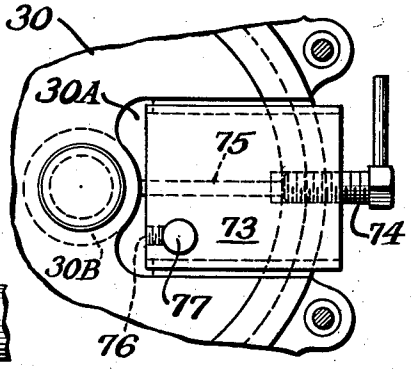


Fig. 10.



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United States Patent Office 3,094,822 Patented June 25, 1963

3,094,822

SPIRAL GRINDING FIXTURE

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Continuation of application Ser. No. 492,282, Mar. 4, 1955. This application Nov. 14, 1960, Ser. No. 69,218
13 Claims. (Cl. 51—225)

This application for patent is a continuation of my prior copending application Serial No. 492,282, filed March 4, 1955, now abandoned, and the invention pertains to machine tools, particularly tool-grinding, dressing, and like machines involving spiral and analogous complex motions and feeds, it being a principal object of the present disclosures to provide improvements in the class of device shown in my U.S. Patent No. 2,375,052, and to afford a compact, spiral grinding fixture of this class which has an improved spiral feed mechanism and generally increased accuracy and versatility, facility of adjustment and operation, together with extended capabilities as to the kinds of grinding and dressing operations it can perform, all in the manner and for the purposes appearing more fully hereinafter.

One of the detailed features of the new grinding fixture is the provision of a compound, spiral-feeding rack means comprising a driving and a driven rack pivotally coupled and slidably seated for relative adjustment and actuation of a simple hand crank to produce either linear, angular, or compound linear and angular displacement of a work spindle.

Another feature is the provision of a grinding head and a work head for producing radial relief from the inside concave periphery of an annular grinding wheel.

A still further feature is the provision of a turret or work head carried on a swivel plate and simple means for selectively producing a variety of movements thereof in conjunction with a spiral feed mechanism of the class described.

In still another important aspect, the invention provides, as a removable part of a grinding fixture, a compact grinding head usable in other fixtures and machines, and including a turret housing having a spirally movable work spindle extending therethrough and a cooperable pair of interpivoted and slidable gear racks, the first one of which is carried on the spindle and the other of which is a pitch-or lead-determining rack and is movable with a rotatable cover plate on the housing so as to travel in a planetary sense about the axis of pivotal connection with the first rack, whereby to cause either, or both, a sliding motion and sometimes also a translatory movement of said first rack and of the spindle with it, when the cover plate is set appropriately, to produce a resulting rotation, or axial shifting, or compound rotary and axial shifting, of the work shaft, right- or lef-handed, depending on the angular setting of the cover plate and the resulting planetary disposition of the pitch rack, all in the manner and for the purposes more fully appearing hereinafter.

Additional objects and advantages relate to the construction and operation of the embodiment of the invention described hereinafter in view of the annexed drawings in which:

FIG. 1 is a perspective view of the new spiral grinding fixture;

FIG. 2 is a top plan view of the same to reduced scale;

FIG. 3 is a fragmentary operating detail of the grinding head of FIG. 2 shown in position for left-hand leads;

FIG. 4 is a partial vertical section taken along lines 4—4 of FIG. 2;

FIG. 5 is a vertical cross section taken along lines 5—5 of FIG. 4;

FIG. 6 is a plan detail of part of the spiral feed mechanism looking up in the direction of lines 6—6 of FIG. 4;

FIG. 7 is a partial plan detail looking down upon lower companion parts of the spiral feed mechanism lying beneath the parts of FIG. 6 and is taken in the direction of lines 7—7 of FIG. 4;

FIG. 8 is a sectional detail taken along lines 8—8 of FIG. 7;

FIG. 9 is a fragmentary plan detail looking down upon the drum head swivel pin for determining right and left leads (9—9, FIG. 4);

FIG. 10 is a fragmentary view of the swivel pin means of FIG. 9 illustrating the setting for right-hand leads;

FIG. 11 is a horizontal sectional detail through the drum head looking down upon the spiral racks in the attitude for producing a right-hand lead.

As viewed in FIG. 1, the new fixture comprises a base casting 20 having a sloping apron 21 on which is seated and adjustably secured, as by nuts 22, a grinder motor 23 having a double-ended shaft on which are carried grinding wheels 24 and 25, the latter being annular to provide an inside arcuate cutting face 25A and a flat front face 25B. A tool rest 27 is carried by the motor frame at wheel 24.

Seated on the base is a swivel plate 30 (FIG. 5) rotatable about a removable pivot and held-down pin 31 fitted into a bored boss 20A in the base casting, said pin being secured and tightened down by a clamp screw 32 having a large knob 33 accessible on the side of the device.

Referring still to FIGS. 1 and 5, the work head includes a turret drum 34 seating on the swivel plate and secured to the latter by clamp nuts 35 (seen in FIG. 2) adapted to be tightened down onto the drum flange 34A.

The top of the turret head is closed by a cover plate 38 (FIGS. 1 and 5) having a marginal scale 39 graduated in degrees to be read relative to an index mark 40 carried on a small hold-down plate which, with clamps 41, keeps the cover plate in position. Spaced finger pins 42 are used to swing the plate when the clamps are loosened.

Exteriorly, the cover plate carries a bored boss 38A in which is journalled a feed-crank spindle 43 having a ball-handled lever arm 44. A rotatable clamp stop 45 is adjustably positionable on the neck of the boss to limit the swing of the feed crank as desired.

As seen in FIGS. 4 and 11, the lower end of the crank spindle carries a pinion 48 meshing with an upper slide rack 49 seating (as in FIG. 6) in a channel casting 50 carried on the underside of the cover plate. This is the driving rack and is also referred to as the pitch rack.

Carried in bearings 54, 55, fitted into the wall of turret or drum-head, is a work spindle 56 having a chuck 57 at one end thereof, and certain indexing knob mechanism 58, 59, 60, at its other end and which are carried on a spindle sleeve 63 to which said mechanism is secured by thumb screw 65, said spindle sleeve, in turn, being locked against longitudinal displacement by a lock screw 66 (FIG. 4) turned with the aid of ball handle 67. For spiral motions the lock screw 66 must be released so that spindle sleeve 63 can move.

Carried on the spindle sleeve is another rack-channel or slide casting 68 (best seen in FIGS. 4 and 5) having a second or driven slide rack 69 therein with teeth on the bottom thereof to mesh (as in FIG. 5) with pinion teeth 70 formed on the free end of the spindle sleeve. The rack carrier 68 is wide enough to ride on a pair of webs 64 which are part of the head casting or turret drum 34.

The upper and lower slide racks 49 and 69 are pivotally interconnected by a coupling pin 71 (seen to advantage in FIG. 11). These two racks and associated pinions and

cranks constitute the spiral-feed means for the work spindle, as will more fully appear hereinafter.

As shown in FIG. 9, the swivel plate **30** has formed thereon a slide track **30A** in which is fitted a slide **73** (FIG. 4 also) having threaded therein a slide-adjustment screw **74** acting on a thrust pin **75** bearing against the collar boss **30B** of the swivel plate and capable of thrusting the slide outwardly when the screw is turned in, for purposes to appear.

At one side of the center line of the slide plate **73** is a bore provided with a set screw **76** to hold an eccentric pivot pin **77** which projects upwardly into one or the other of two eccentrically located pivot holes **34X**, **34Y** located in the turret-head floor (FIG. 7).

By removing the slide **73** and turning it over after resetting the pin **77**, the latter can be made to enter either of the eccentric pivot holes **34X**, **34Y** of the turret head so that the entire work head can be made to move back and forth relative to the normal longitudinal work axis through the grinding wheels when the slide screw **74** is appropriately manipulated, for either right- or left-handed end-grinding, as will appear.

The whole work head may also be swung crosswise of the normal work axis by manipulation of a swing screw **80** (FIG. 7) threadably carried in a post **30C** on the swivel plate. The end of this swing screw bears against a vertical rib **34D** on the side of the head casting.

On the opposite side of the head from the swing screw **80** is a spring backing plunger **83** (FIG. 7) carried in a sleeve **84** fitted into a post **30D** on the swivel plate and carrying a loading spring **85** which urges the nose of the plunger against another vertical rib **34E** on the opposite side of the head to urge the latter oppositely to the advancing effort of the swing screw **80**. The two oppositely-acting swing forces tend to turn the work head (when free to move) about the eccentric pivot pin **77** on the swivel plate as an axis, but this axis is not concentric with the axis of the main clamp pivot pin **31**, and the crosswise swing of the housing is therefore on a different radius from the turning of the swivel plate.

Operation

By loosening the thumb screws **41** and grasping the finger pins **42** the cover assembly may be turned to a desired angular setting with reference to the index mark **40**. In the zero scalar position the upper or pitch rack **49** will lie exactly crosswise of the work spindle and therefore be parallel to the lower or driven rack **69** (as in FIGS. 4, 5, and 6). This zero setting produces no lead, only a rotary motion of the work spindle responsive to turning of the main feed crank **44**.

To produce a spiral motion, the cover plate assembly is turned from the zero setting to the required angle of lead, for instance one resulting in the angular attitude of the pitch rack **49** (shown in FIG. 11). Now when the ball crank **44** is turned, the crank pinion **48** will advance the pitch rack **49** diagonally, thus urging the coupling pin **71** diagonally with force components which tend to displace the lower rack **69** both crosswise and longitudinally relative to the axis of the work shaft, so that the latter will turn and advance simultaneously.

If the pitch rack is set at 90°, it will lie parallel to the work spindle, so that turning of the feed crank will then produce only an axial shifting, and no rotary motion, of the spindle.

All intermediate settings produce different spiral leads, right- or left-hand, depending on the orientation of the pitch rack crosswise of the spindle. For instance, the advance of this rack in the setting of FIG. 11 (the work chuck lying toward the left in this view) will produce a right-hand rotation and lead. The opposite diagonal setting of the pitch rack would produce a left-hand lead.

In FIG. 2 the turret head and motor are set to grind a radial relief on the flutes of an end mill A having a right-hand lead. Preparatory to this operation, the end mill is seated in chuck **57** and the work head is swung to the dotted-line position of the chuck with the end mill A' in position opposite the gauge **90**, which (as shown in FIGS. 1 and 5) includes a feeler point **91** near the end of a pivoted feeler lever **92**, which will remain motionless when the spiral motion means is set to the correct angle of the lead, drill or end mill rotated to cause the flutes to travel spirally along the gauge point. If the setting is wrong, lever **92** will rock slightly up or down, depending upon whether the lead angle is set too fast or too slow.

Having set the turret head and spiral feed for the proper lead, the head is swung back to the position of FIG. 2 and the grinding operations are commenced on the first flute.

When the work piece A is chucked, the index knob **58** is set on the Number 1 position by depressing the finger detent lever **59** (FIG. 4) and turning the knob **58** to the first notch in index collar **60**, the latter usually required some turning relative to the workpiece after loosening of set screw **65** if the flutes have not been exactly positioned in chucking the piece.

The flutes thereafter are successively fed across the abrasive wheel and ground with the desired radial relief by turning the feed crank **44** to the limit of its stroke determined by pre-setting of the adjustable stop **45** (FIG. 2). As each flute is run down, the detent **59** is depressed and the spindle knob **58** is turned to the next index notch for the succeeding flute, until all flutes have been ground.

The disclosed machine is relatively simple, yet is capable of performing highly accurate grinding operations and radial relief work of many kinds ordinarily requiring more complex and costly feed mechanisms and controls of the class described in my prior Patents Nos. 2,445,194; 2,452,702; 2,452,703; and 2,479,281. Such performance is primarily the result of the combination of a concave grinder **25**, **25A** carried on a spindle (here part of motor unit **23**) mounted to swing laterally of the axis of the main work spindle, together with the lateral swings and other special adjustments afforded the latter by the disclosed pivotal mounting of the turret head, as well as the novel spiral-motion means structurally and cooperatively related therewith in the manner described.

FIG. 3 illustrates the reverse positions (compared with FIG. 2) for the annular grinding wheel **25** and the chuck **57** for grinding a relief on the flutes of a left-handed work piece B, it being understood that such reversal will also require reversal of the grinder motor **23** by moving the switch R, L, to the L position (FIG. 1).

In order to grind end mills, the same are chucked, as in either FIG. 2 or FIG. 3, and the small feed screw **74** of FIGS. 4, 9, and 10 is employed in conjunction with the swing screw **80**, after loosening the flange hold-down nuts **35** (FIG. 2).

For a left-handed lead, the slide plate **73** will be set as in FIG. 9 with the off-center pivot pin **77** on the right-hand side of the main pivotal axis (at pin **31**) and vice-versa for a right-handed lead, as in FIG. 10.

The axial end of the work piece, the end mill A, for instance, will be ground on the flat axial face **25B** of the abrasive wheel but the teeth (the stud ends of the several flutes) are not ordinarily ground flat, but are slightly dished by imparting a somewhat arcuate or radial sweep of the milling teeth across the flat face wheel. This arcuate sweep motion includes a slight advance of the work head toward the grinding wheel with a simultaneous but very slight lateral swing in the sense of sweeping across the face **25B**.

Thus, the slide screw **74** is turned in while the swing screw **80** is manipulated to cause the main head body to pivot slightly on the eccentric pin **77** (FIG. 9) and advance the end of the milling tool against the face of the grinding wheel in a very slight sweeping motion.

Changing positions of the eccentric pin **77**, as by turning the slide plate over, simply shifts the center for the radius of the swing about pin **77** to the other side of the

true center of the turret; and manipulation of slide screw 74 shifts the position of pivot pin 77 toward or back away from the grinding wheel, this latter motion being linear or angular depending on whether the swing screw 80 is manipulated at the same time; also, the linear motion can be predirected by setting the swing screw 80 in advance of turning the slide screw 74.

Numerous other operations can be performed by the novel fixture in dressing or form-grinding multi-fluted drills, cutters, reamers, form tools, step drills, etc. Moreover, the turret head 34 may be easily removed from the swivel plate and bedded in a milling or other machine.

I claim:

1. In a grinding tool a hollow head 34 having a rotatable dial top 38, and a work shaft means including a spindle part 56 and a concentric sleeve part 63 and means journalling the same to project diametrically through said head beneath said dial top for rotative and axial motion; a rack carrier 68 having a shaftway traversed by said shaft means to support the carrier thereon, and also having a rack slideway extending transversely of the shaft means together with an opening communicating from the slideway into said shaftway with said said sleeve part; means providing a driven pinion 70 on the sleeve part exposed to the opening in the slideway; a cross rack 69 reciprocable in said slideway and meshing with said pinion 70; means providing a rack bed 50 on the underside of said dial top to overlie the rack carrier; a pitch rack 49 slidable in said rack bed 50; pivot means 71 pivotally interconnecting said cross and pitch racks along a reference axis which is normal to, and traverses, the major axis of said shaft means as well as the rotative center of said dial top, whereby the latter may be rotatively adjusted to dispose the cross rack in various selected angular relations to the pitch rack; and manual actuating means carried by said dial top and including drive spindle means 43 provided with drive pinion means 48 and means 50 journalling the same on the dial top for rotation about a planetary axis parallel to said reference axis in driving mesh with said pitch rack, said work shaft means being rotatable and/or axially shiftable depending on the angular setting of said dial top, responsive to turning of said drive spindle means.

2. In a grinding fixture, a base having a head seat and sloping apron adjoining the seat; a swivel plate on said seat; a swivel pin removably positioning the plate on said seat; a head slidably carried on said plate; cooperative adjustable eccentric means on the plate and head for shifting the latter slidably on the plate; a spiral-displacement work shaft carried by the head; a rotatively adjustable top plate on said head and a feed crank journalled thereon; compound inter-pivoted rack means and cooperating pinion means on the shaft and crank drivingly inter-connecting said crank and shaft for spiral displacement of the latter by the former responsive to turning of the crank, said rack means including a planetary rack part positionable about the crank-pinion means responsive to rotative positioning of said top plate to change the spiral lead, the axis of said shaft being normal to that of the crank and said pivot pin for the swivel plate and extending generally in the direction of declination of said apron; a power-driven abrasive wheel mounted on said apron with its rotative axis extending generally toward and at an angle of inclination to said shaft axis, said abrasive wheel being adjustably movable in a sense crosswise of said shaft axis.

3. A grinding fixture comprising a base having a sloping apron, a turret seat at the higher end of said apron; a turret head and means mounting the same to swivel on said seat; a work spindle carried by said head to project in a horizontal direction toward said apron and at variously adjusted azimuth angles thereto; spiral-motion drive means carried by said head for selectively imparting spiral, linear, and angular motions to the work spindle; and a grinding unit carried on said apron and adjustably secured thereto for movement into selected positions generally crosswise of the axis of said spindle, said grinding unit including a motor and grinding means driven thereby.

4. In a grinding fixture, a base structure having an upwardly sloping portion with a seat at the upper portions thereof to receive a swivel plate; a swivel plate removably carried on said seat to turn thereon; a turret head slidably seated on said swivel plate to shift radially and arcuately thereon relative to the swivelling axis of said plate, and adjusting mechanism carried by the base and swivel plate and having driving coaction with the turret head for selective operation to shift the latter radially or arcuately on the swivel plate; a work spindle carried by said head; and work-treating means adjustably seated on said sloping base portion for cooperation with work moved by said spindle.

5. In a fixture of the class described, a base structure characterized by having an upwardly sloping surface portion with a tool seat located at the upper part thereof; a a swivel member mounted on said seat; a turret member mounted to shift adjustably on said plate; means for adjustably shifting the turret member both radially and arcuately; spindle means carried by said turret member with its working axis extending in a direction generally downward of said sloping portion, and adjustable-positionable work-treating means mounted at a lower part of said sloping base portion in operative relation to said spindle means.

6. In a spiral motion mechanism, a housing, a spirally-movable shaft means journaled to traverse said housing; dial means carried by the housing and rotatively adjustable into selected angular settings about a reference axis normal to the spiral motion axis of the shaft means; and spiral-motion drive means comprising a cross rack and carrier means supporting the same in said housing for movement with the shaft means in axial displacements of the latter; and also for reciprocatory motion transversely of the shaft means in a plane normal to said reference axis; a pivot carried by said cross rack; a driven gear means coupling with the shaft means and driven by said cross rack; a pitch rack superimposed upon the cross rack and pivotally engaging with said pivot for angular adjustment relative to the cross rack in a plane parallel to the plane of movement of the latter; means movable with said dial means to guide the movement of the pitch rack in selected angular directions corresponding to the setting of the dial means, together with actuating means carried by the dial means drivingly cooperable with the pitch rack for reciprocating the same whereby to impart like movement through said pivot to the cross rack with resultant rotary or linear or simultaneous rotary and linear movements to the shaft means depending upon the angular setting of the dial means.

7. Mechanism according to claim 6 in which said dial means is circular and is mounted in a circular seat part of said housing to turn through a full circle, and said pitch rack is pivotable by the dial means relative to the cross rack through a full circle to follow the dial in like adjustment, whereby right- or left-hand spiral leads may be selectively imparted to the shaft means, together with means for clamping the dial means in selected positions of adjustment as aforesaid.

8. In a spiral-motion fixture, a work shaft means and means mounting the same for rotary and axial motion; a first gear rack; a rack carrier mounted on said shaft means for movement axially with the latter and providing a slide bed totally supporting said first rack for reciprocation directed transversely of the shaft means; dial means and means mounting the same to turn about a reference axis normal to the shaft axis and in a plane at one side of, and parallel to, the plane of movement of said first rack; a second gear rack and means supporting the same

for pivotal movement on said first rack to turn relative thereto in a plane paralleling the plane of reciprocation thereof; means providing a guiding slideway for the second rack and connected for movement with the dial means in a planetary path about said reference axis responsive to turning the dial means into selected position of angular adjustment as aforesaid; a hand lever carried by said dial means; and a driving gear turned by said lever and meshing with the second rack for actuation to reciprocate the same.

9. In a spiral grinding fixture, a turret head having a chamber and a removable top wall portion therefor formed by a rotatable dial member turning relative to the chamber about a vertical reference axis through the chamber; means providing aligned through-bearings in opposite side wall portions of the head and chamber; spirally-movable shaft means journaled in said bearing means and extending through the head from one side through the other thereof at right angles to and through said reference axis, said shaft means including a spindle part and a sleeve part telescoped thereon; means at one end region of the shaft means outside said head for releasably intercoupling the spindle and sleeve parts; means providing a driven gearing on a portion of the sleeve part in the chamber adjacent said reference axis; a first sliding gear rack and a slide carrier therefor which engages the shaft means in the chamber in close proximity to said driven gearing with said first rack drivingly engaging said gearing means coupling the carrier with the shaft means for axial movement therewith; a second gear rack; means carried by the first rack providing a pivot mounting for the second rack freely permitting angular adjustment of the same relative to the first rack in a plane paralleling the plane of reciprocation thereof; means movable with the dial member in angular adjustment thereof guidingly engaging the second rack to determine the direction of reciprocation thereof according to said adjustment; a driving gear and means journaling the same on said dial means in driving engagement with the second rack; and actuating means movable with the dial means for turning said driving gear.

10. In a spiral motion device, the combination with a linearly shiftable and rotatable spindle means of: spiral-motion mechanism comprising a driven pinion means carried by the spindle means for movement therewith to drive the same in all positions thereof; two linearly-elongated gear racks and means pivotally interconnecting the same in side by side juxtaposition; means providing a slideway for a first one of said racks to direct the latter for reciprocation only in a direction at right angles to the spindle means and in proximity to the latter to drivingly mesh with said driven pinion means; means movable with the spindle means for causing said slideway to move with the spindle means in linear displacement thereof; a settable member and means mounting the same to turn in a plane, at one side of the spindle means and said first slideway, about a reference axis normal to the major axis of the spindle means; means having connection with the settable member for movement therewith in a planetary sense about said reference axis and providing a second slideway in which the second one of said racks is received and guided in reciprocation at angles relative to the first rack determined by the angular setting of said settable member; and actuating mechanism carried by the settable member and including means for reciprocating the second rack operable in all angular positions of the settable member.

11. In a spiral-motion device in combination: a linearly and angularly movable spindle means and driven pinion means carried thereby for rotating the same; a carrier member supportably engaging with the spindle means; a first gear rack mounted for reciprocation on the carrier and driving said pinion; a second gear rack pivoted on the first rack in side-by-side contiguity thereto for angular adjustment relative to the first rack on an axis directed at right angles to the spindle axis; a feed pinion adapted to turn about an axis parallel to that of the rack pivot; means mounting the feed pinion as aforesaid so as to turn to selected positions in a planetary sense about said pivot axis, said feed pinion having driving engagement in all planetary positions with said second rack whereby to reciprocate the latter in various directions relative to the first rack depending on the angular planetary position selected for said mounting means for the feed pinion; said second rack producing resultant effort on the first rack through said pivotal connection therewith, responsive to turning of said feed pinion, which effort will impart linear or axial movement, or both movements simultaneously, to the spindle means, depending upon the angular planetary position selected as aforesaid, with said first rack at all times constrained to reciprocate only in a direction lateral to the spindle axis, and said carrier being displaced, if at all, only co-linearly of the spindle axis.

12. In a spiral motion device, in combination with spindle means and means mounting the same for rotary and axially shifting motion, improvements in mechanism for imparting both motions to the spindle means, simultaneously or selectively, comprising namely: a rack carrier having a first elongated rack bedding channel therein for a cross rack and having a bore beneath said channel through which said spindle means passes transversely of the length of the channel; means coupling the carrier with the spindle means for axial translation with the latter while permitting rotary movement of only the spindle means; a spindle-rotating gear keyed with the spindle means with gear portions exposed in said channel; an elongated cross rack slidably seated in said cross-rack channel for movement transversely of the spindle axis and meshing with said exposed gear portions of the spindle gear to rotate the latter and the spindle means responsive to sliding of the cross rack; a dial plate and means mounting the same for rotation about a center above said carrier in a plane paralleling the plane containing the path of movement of the cross rack; means on the side of said plate confronting said carrier and cross rack defining a second bedding channel for a pitch rack and located eccentrically of said center; an elongated pitch rack slidably received in said second channel with portions juxtaposed with the cross rack; pivot means coupling said racks concentrically on an axis containing said center in the dial plate; gear means carried by the dial plate and driving the pitch rack in its bedding at selected angles included between the lengthwise axis and an axis normal of the spindle means determined by the angular position of the dial plate about said center; said pitch rack resultantly imparting force through said pivot means to the cross rack to shift the latter in its bedding channel; said cross rack resultantly imparting a force through said carrier to said spindle means at least in a certain range of settings of the dial plate to shift the spindle axially and also to rotate the spindle gear to turn the spindle means.

13. In a spiral motion mechanism, a spindle means and means mounting same to rotate and also to shift axially; two independent gear racks and separate channel carriers each slidably seating one of said racks, a first one of said carriers seating the first of said racks being mounted on said spindle means and coupled thereto to shift axially therewith; a spindle gear keyed with the spindle means to rotate therewith and disposed in juxtaposition to said first carrier in driving mesh with the first gear rack such that sliding movement of said rack effects rotation of the spindle means; a pivot pin drivingly interconnecting the first of said racks with the second rack with the latter in close juxtaposition thereto and the pivot pin axis directed transversely of the axis of the spindle means; a driving gear for the second rack and rotatively adjustable means mounting said driving gear and the second carrier with said second rack therein interconnected to the first rack as aforesaid for planetary travel about the rotative axis of said pivot pin and in mesh with said driving gear and with

the axis of said pin paralleling the axis of said driving gear throughout said planetary travel, said driving gear being rotatable to move the second rack at selected angles to the axis of the spindle means depending on the adjustment of said rotatively adjustable mounting means; whereby to impart sliding movement to the first rack and drive said first carrier to shift the spindle means axially, provided the angle of movement of the second rack relative to the spindle means axis is less than 90 degrees on either side of a normal to the axis of the spindle means.

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