Oct. 29, 1946. W. F. GROENE ET AL 2,410,026

AUTOMATIC LATHE

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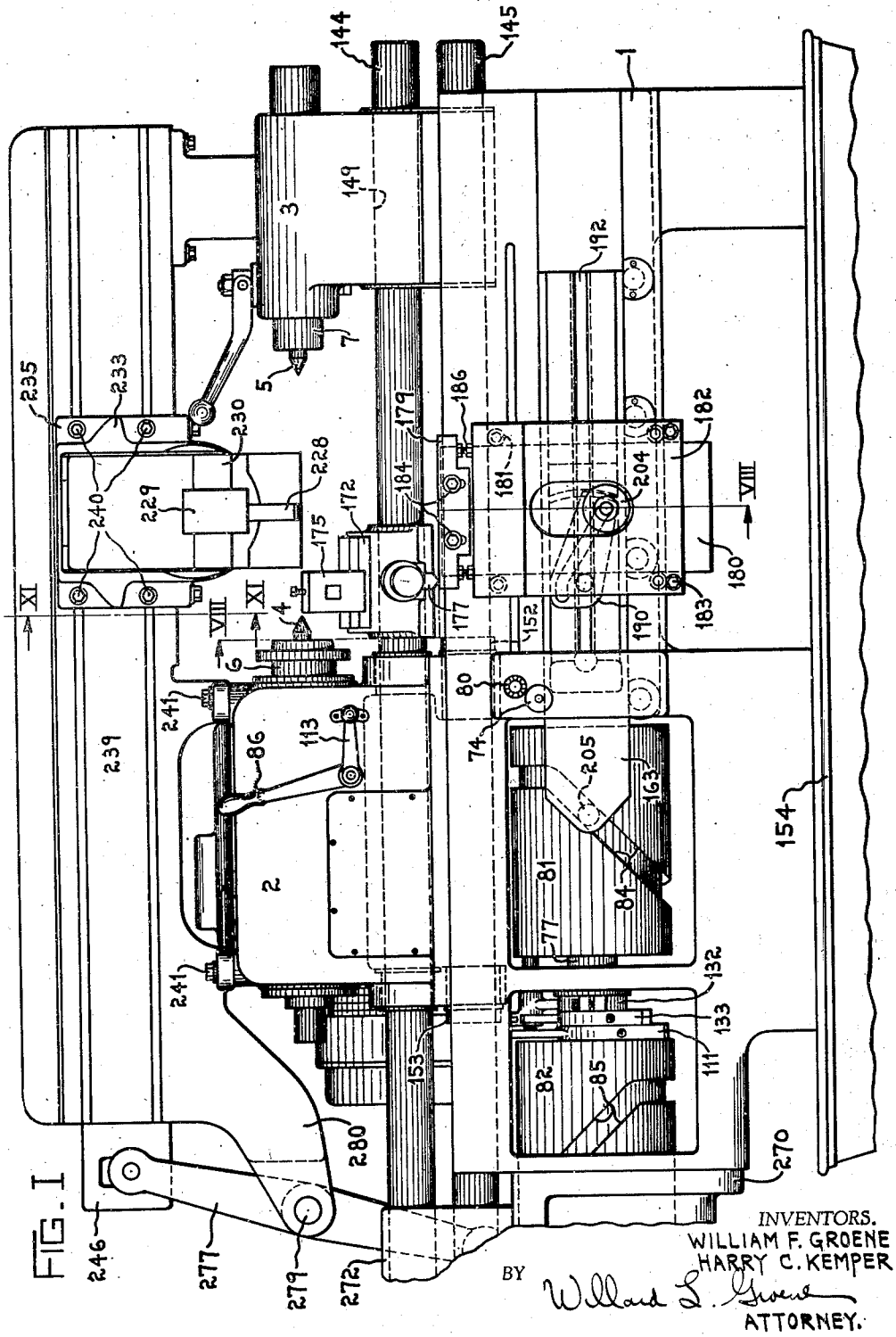


FIG. I

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AUTOMATIC LATHE

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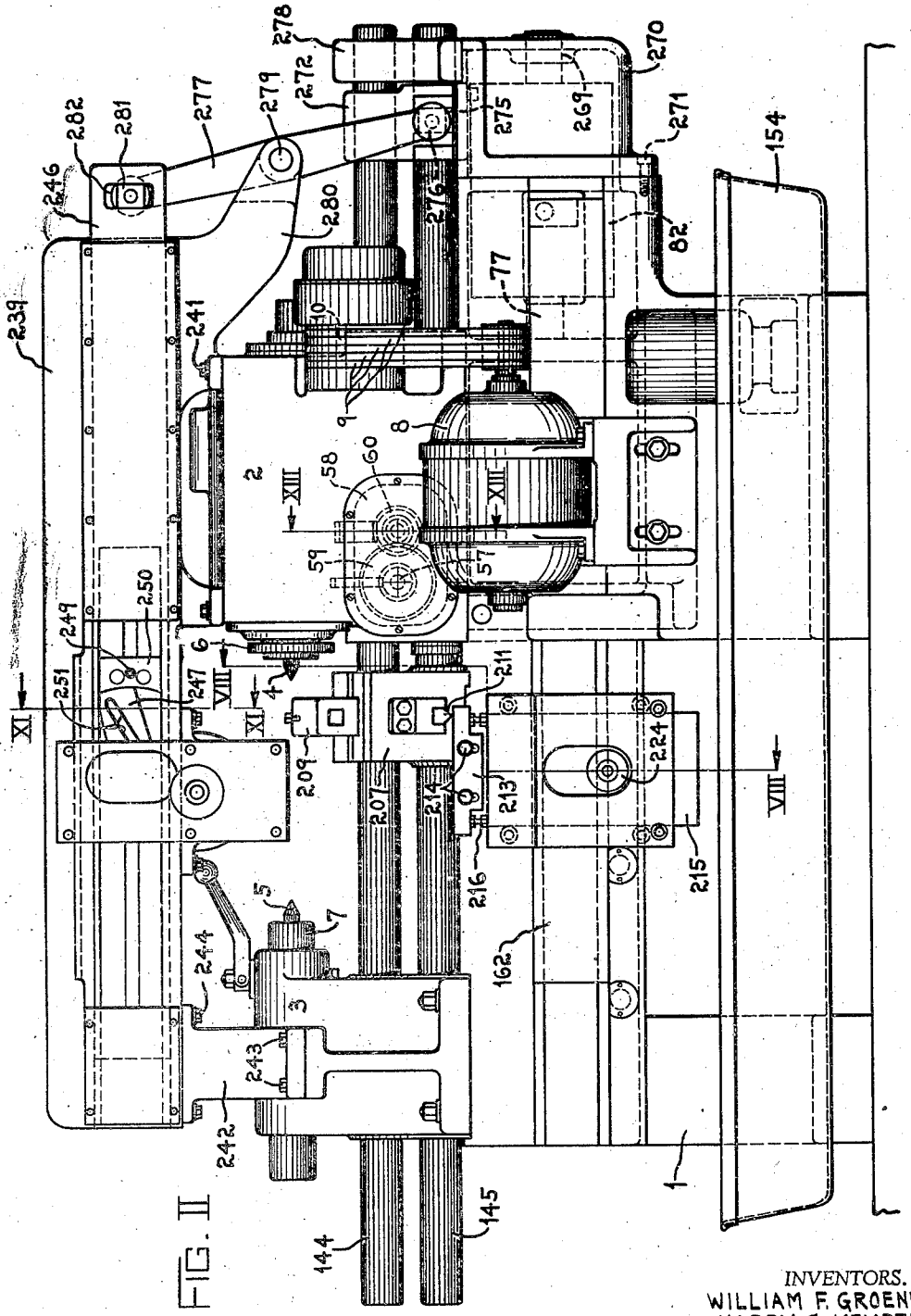


FIG. II

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AUTOMATIC LATHE

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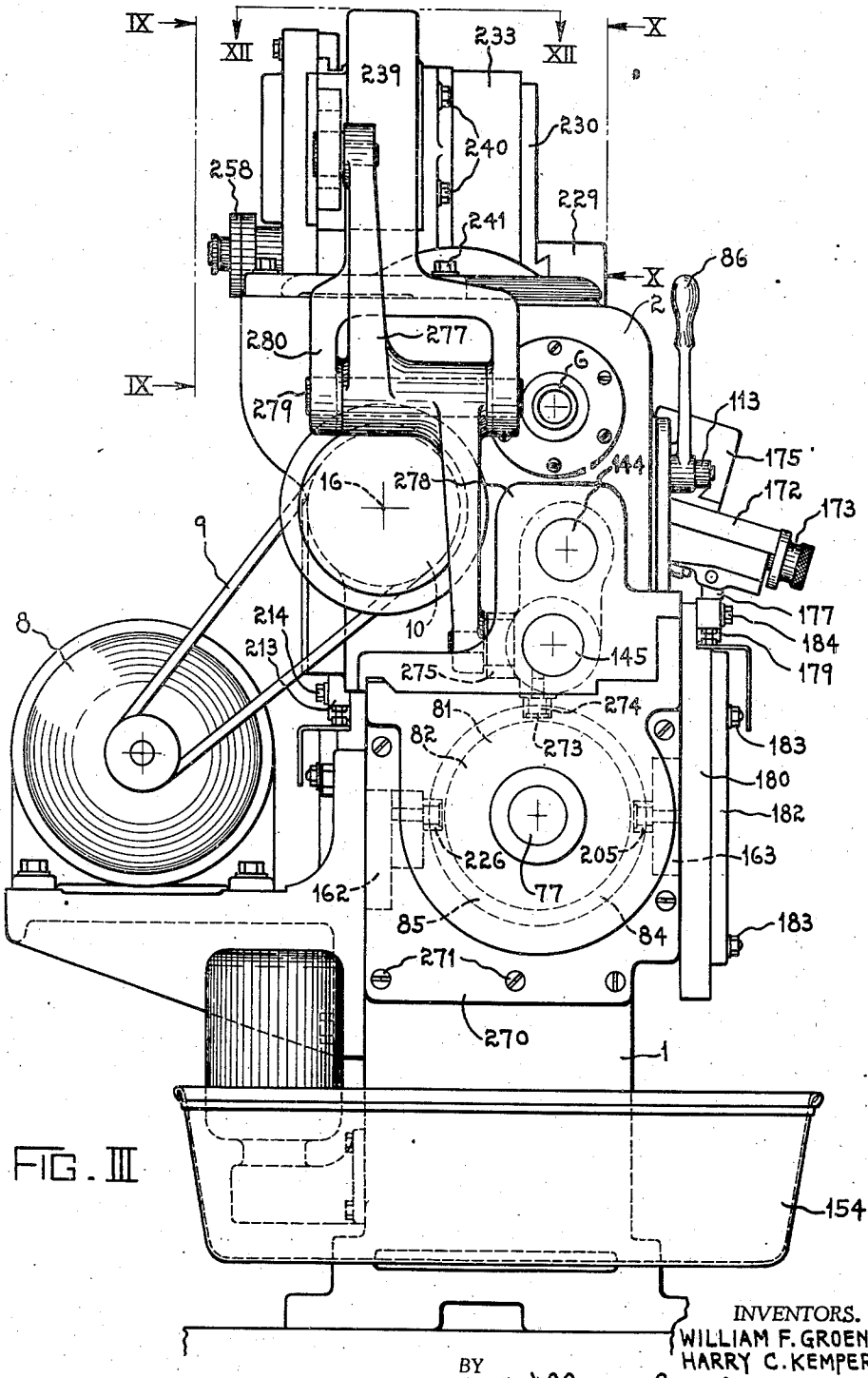


FIG. III

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AUTOMATIC LATHE

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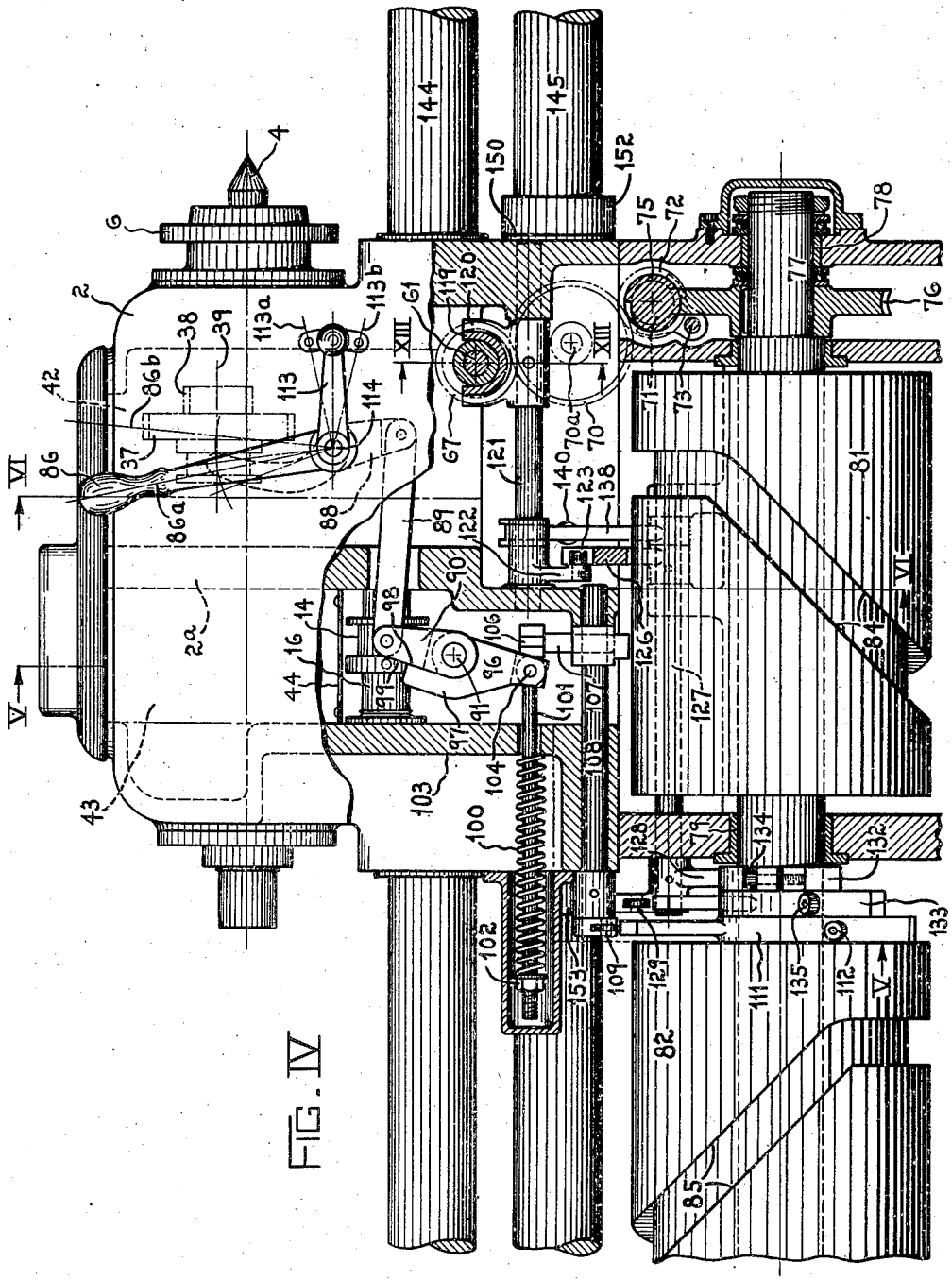


FIG. IV

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AUTOMATIC LATHE

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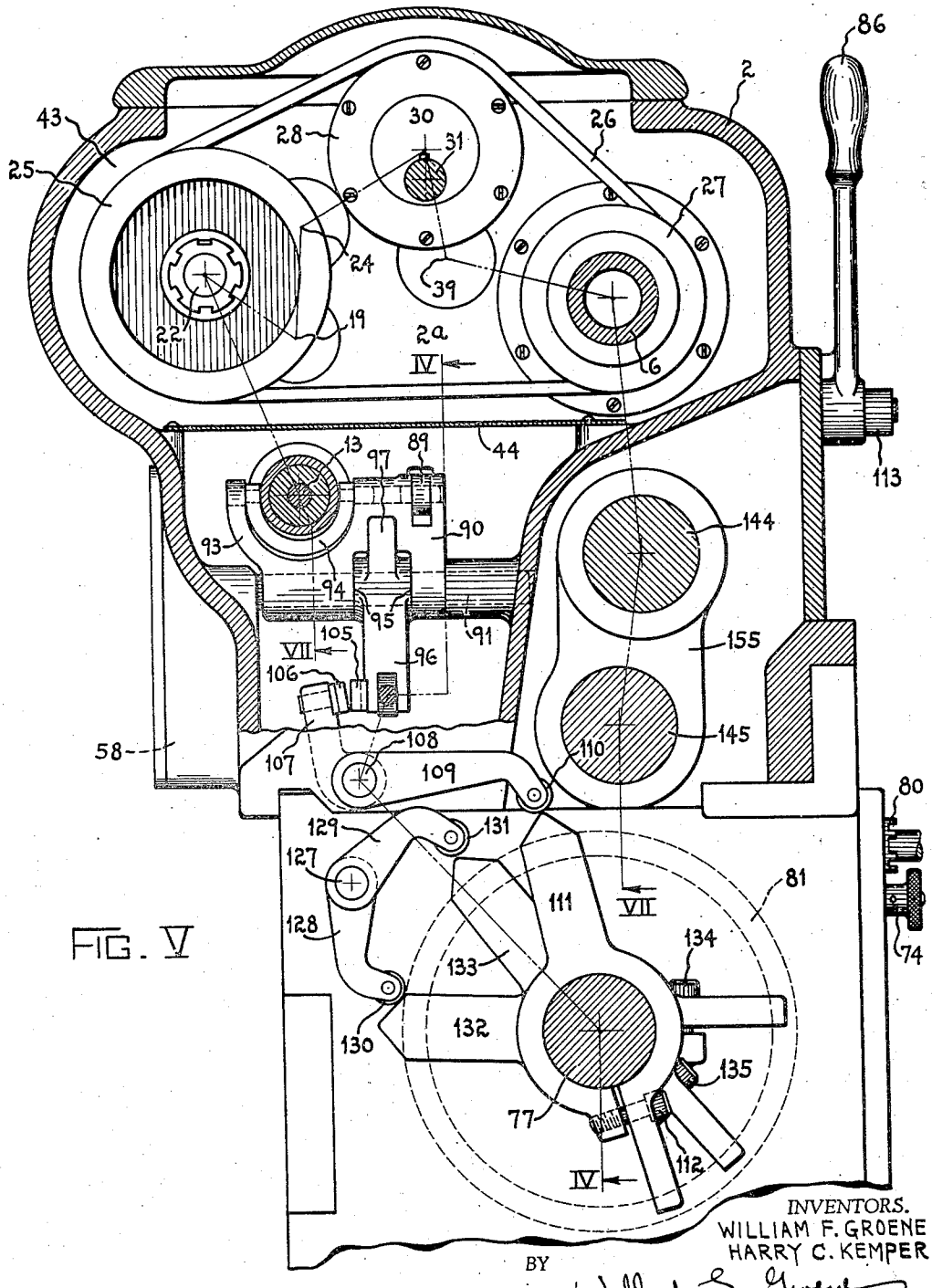


FIG. V

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AUTOMATIC LATHE

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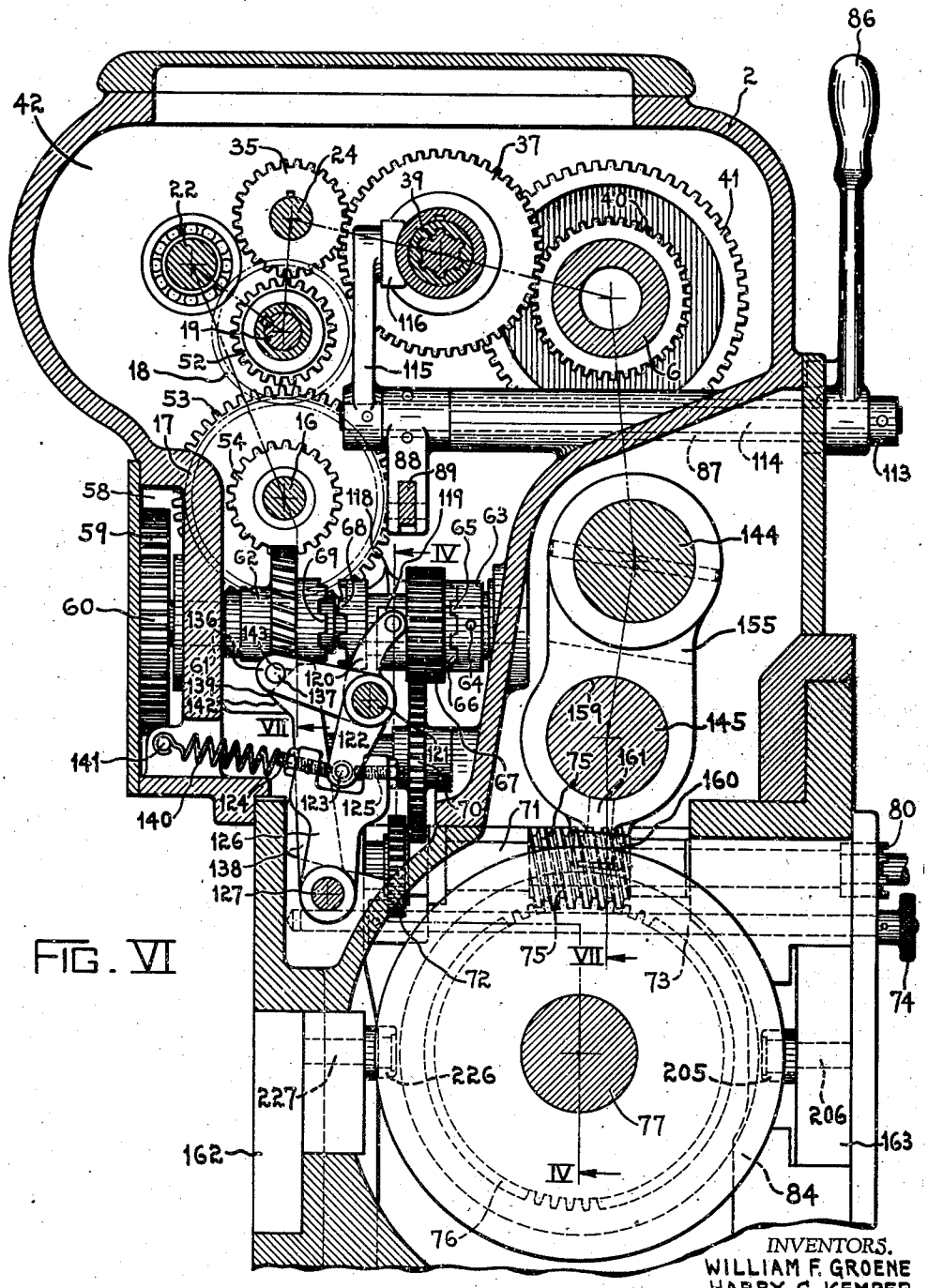


FIG. VI

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AUTOMATIC LATHE

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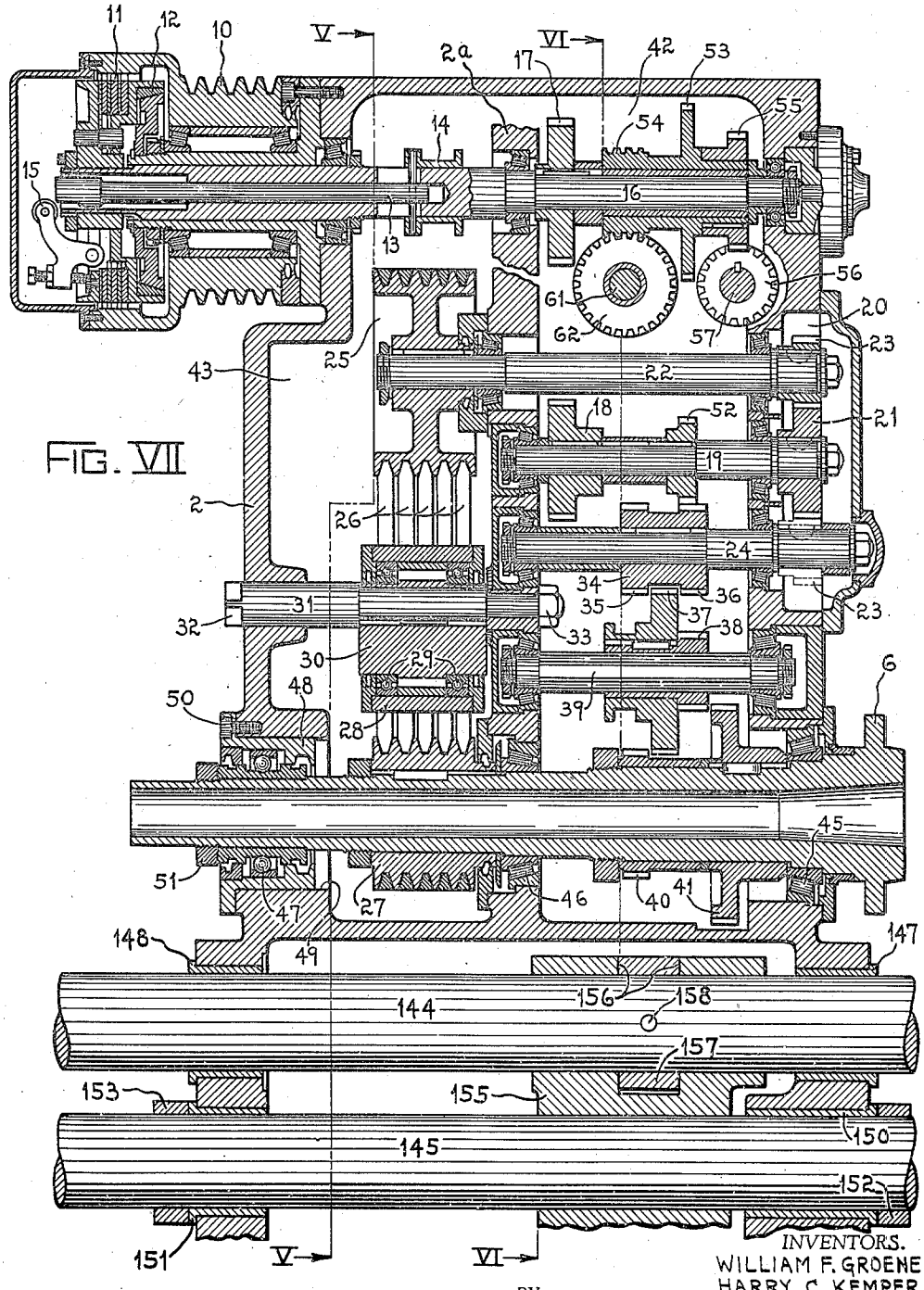


FIG. VII

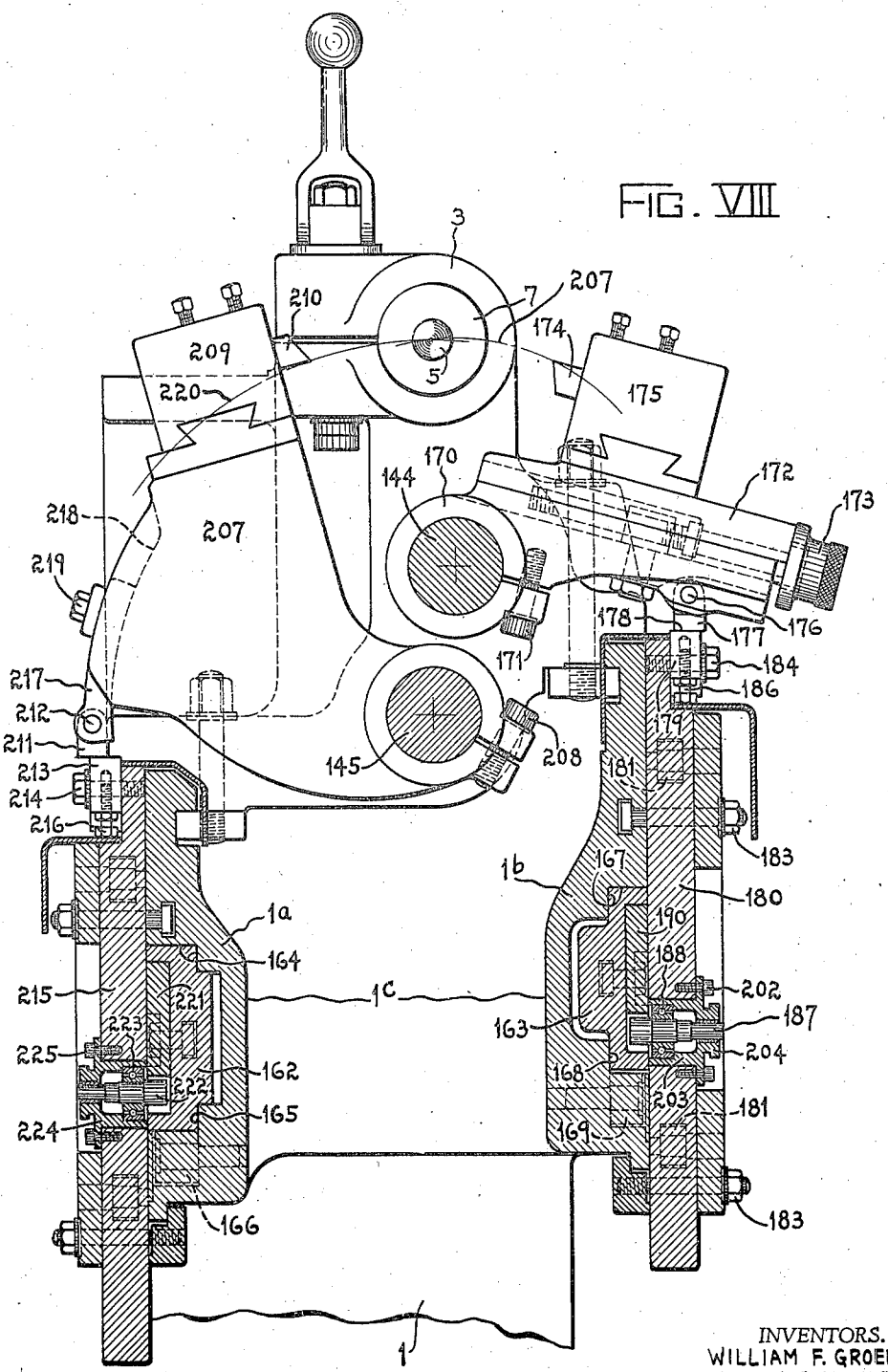
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AUTOMATIC LATHE

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FIG. VIII



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AUTOMATIC LATHE

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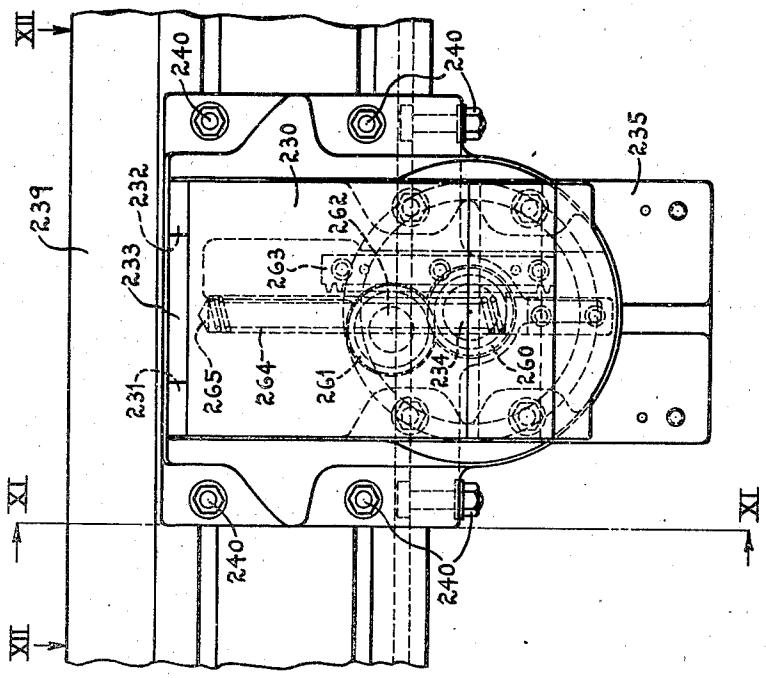


FIG. X

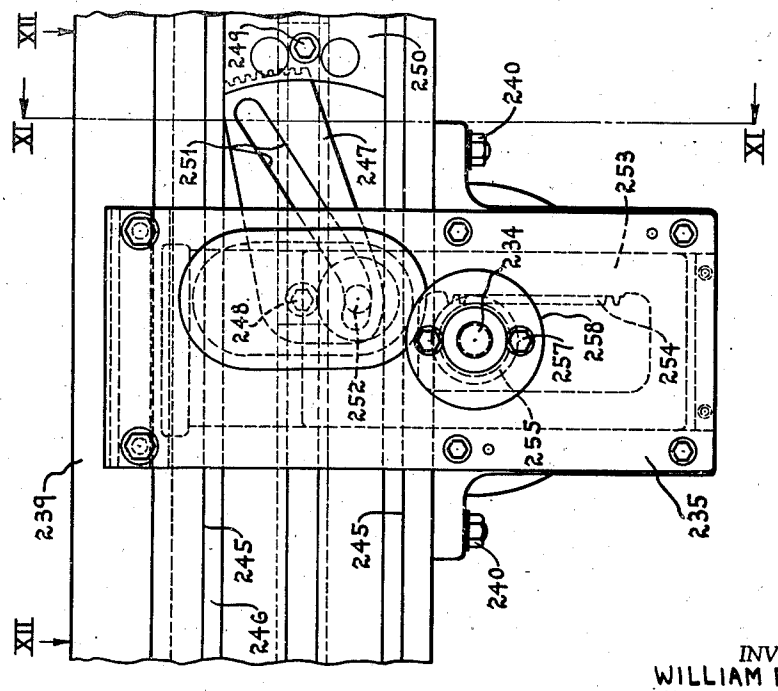


FIG. IX

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AUTOMATIC LATHE

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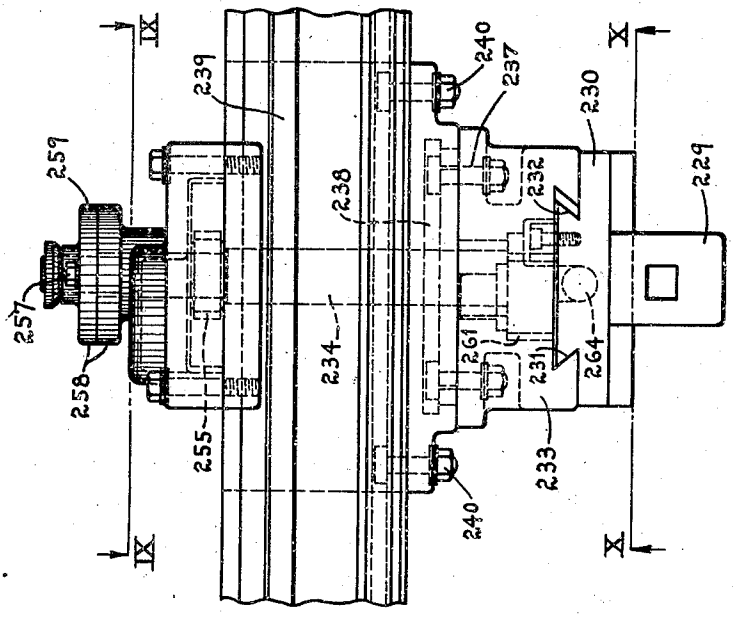


FIG. XII

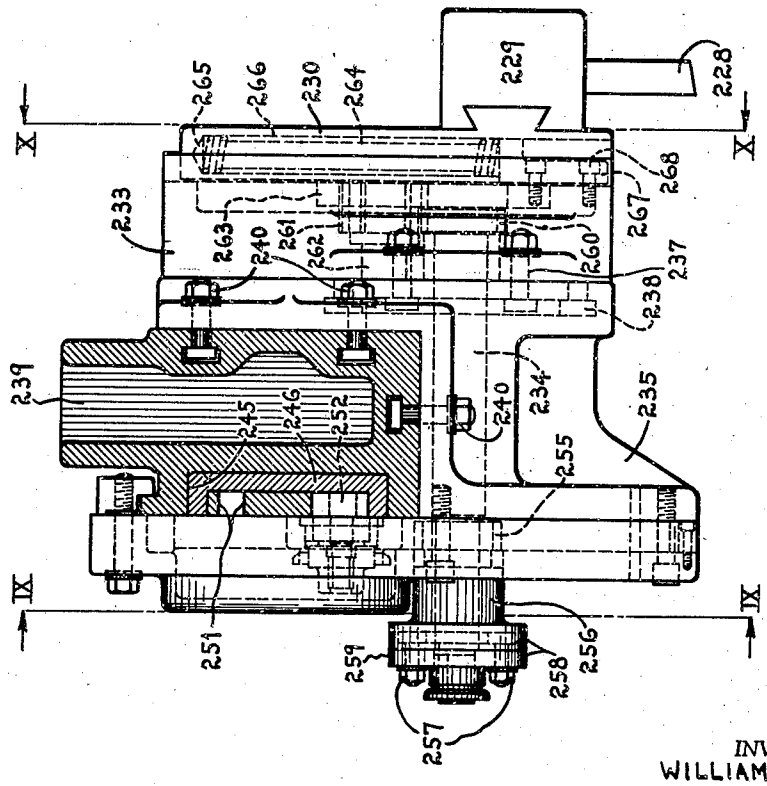


FIG. XI

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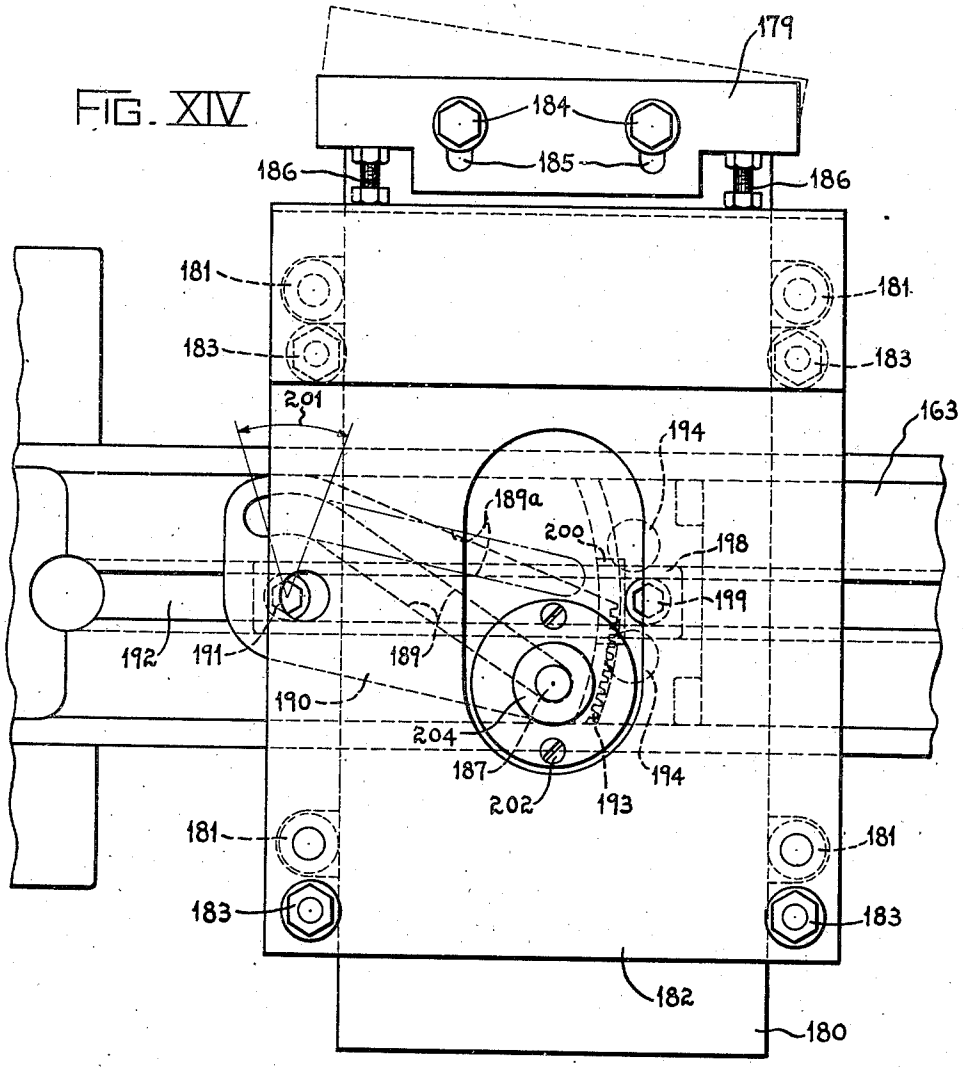
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AUTOMATIC LATHE

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FIG. XIV



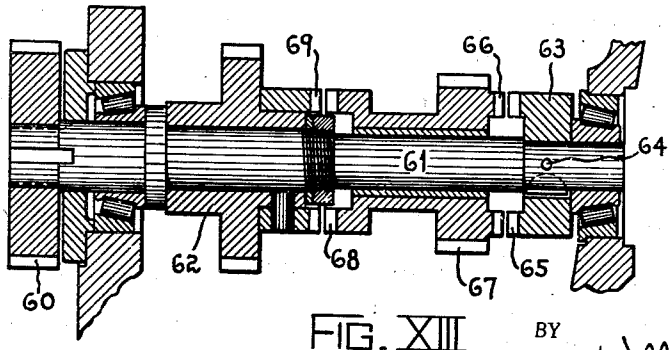


FIG. XIII

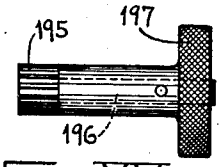


FIG. XV

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Patented Oct. 29, 1946 2,410,026

UNITED STATES PATENT OFFICE

2,410,026

AUTOMATIC LATHE

William F. Groene, Cincinnati, and Harry C. Kemper, Goshen Township, Clermont County, Ohio, assignors to The R. K. Le Blond Machine Tool Company, Cincinnati, Ohio, a corporation of Delaware

Application February 10, 1943, Serial No. 475,342

2 Claims. (Cl. 82—21)

1

This invention pertains to automatic lathes and is particularly related to the transmission and control mechanism for such type of lathes. Primarily the purpose of this invention is to provide an automatic lathe of completely universal character capable of doing any type or class of work possible to be machined on such a lathe. It is also the intent to provide in an automatic lathe a complete range of speeds and feeds for any type of material it is desired to machine.

Another object of this invention is to provide a simplified, compact and efficient feed and rapid traverse drive transmission for actuating the cutting tools to and from the work piece mounted in the lathe.

It is also a further object to provide, in conjunction with this feed and rapid traverse mechanism, a load-and-fire trip mechanism for alternately engaging the feed and rapid traverse motion at the appropriate time in the cutting cycle of the machine.

Another important feature of this invention is to provide a series of tool carrying bars upon which are mounted the tool holders or slides carrying the cutting tools so that one bar extending longitudinally of the lathe spindle axis is located directly below said spindle axis for carrying the turning tools. The second bar is also provided immediately under and directly below the work spindle and first mentioned bar for carrying the facing tools. The result of this unique arrangement is to provide much greater clearance room for the chips cut from the work piece in the lathe and at the same time provide much greater accessibility to both the work and tools of the machine.

A further object is to provide in this arrangement of tool bars extending longitudinal of the axis of the lathe, one above the other with the upper bar mounting the turning tool and the lower bar directly beneath it mounting the facing tool feeding devices, means whereby either the front or rear tools may be alternately or simultaneously utilized for either turning or facing operations.

In conjunction with such tool feeding mechanism mounted on the bars, one above the other, applicants propose to utilize a unique cam actuating mechanism whereby the tools may be brought automatically to a definite predetermined depth of cut and dwell while at the same time cam feeding mechanism is fully adjustable to effect any desired rate of feed while at all times retaining the accurate depth of cut and dwell above mentioned.

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Further features and advantages of this invention will appear from the detailed description of the drawings in which:

Figure I is a front elevation of the automatic lathe of this invention showing the general arrangement of the base, headstock, tailstock, and overhead tool slide.

Figure II is a rear elevation of the automatic lathe shown in Figure I.

Figure III is a left hand end elevation of the lathe shown in Figures I and II.

Figure IV is an enlarged fragmentary view partly in section of the headstock, control mechanism, and feed cams for the tool slides shown on the line IV—IV of Figures V and VI.

Figure V is an enlarged fragmentary transverse section through the lathe headstock and bed on the line V—V of Figures I, IV, and VII, particularly showing the belt drive transmission to the work spindle and the spindle stop trip mechanism.

Figure VI is an enlarged fragmentary transverse section through the lathe headstock on the line VI—VI of Figures IV and VII, particularly showing the feed and rapid traverse drive and control mechanism.

Figure VII is a diagrammatic section through the transmission mechanism of the lathe headstock, particularly showing the headstock driving transmission comprising the gear drive and belt drive mechanism for rotating the work spindle together with the power takeoff mechanism for the feed and rapid traverse movement to the tool slide, shown on the line VII—VII of Figures V and VI.

Figure VIII is an enlarged transverse sectional view through the lathe, on the line VIII—VIII of Figures I and II, particularly showing the facing tool on the lower tool bar and the turning tools on the upper tool bar of the lathe, together with the cam actuating mechanism for feeding said tools relative to the work spindle, the tailstock for the lathe being shown in the background.

Figure IX is a fragmentary enlarged rear elevation of the universal tool slide mounted on the overhead tool bar shown by the line IX—IX in Figures III, XI, and XII, particularly illustrating the cam actuating mechanism having the constant feed to depth and dwell position for any position of adjustment of rate of feed.

Figure X is an enlarged fragmentary front elevation of the universal tool slide on the overhead tool carrier shown by the line X—X in Figures III, XI, and XII.

Figure XI is a left hand end elevation partly

in section on the line XI—XI of Figures I, II, IX, and X.

Figure XII is a plan view of the universal tool slide shown on the line XII—XII of Figures III, IX, and X.

Figure XIII is a vertical section on the line XIII—XIII of Figures II and IV, particularly showing the feed and rapid traverse clutch shaft.

Figure XIV is an enlarged detail view of the cam controlling the rate of feed and dwell for the various cutting tool slides.

Figure XV is a view of the pinion shaft for setting the cam slides.

The lathe comprises a base 1 upon which is rigidly mounted a headstock 2 and the tailstock 3. The work is held in the lathe on the centers 4 and 5 carried respectively in the headstock work spindle 6 and the tailstock barrel 7.

Referring particularly to Figures III and VII the work spindle 6 which carries a suitable chucking device or work arbor for driving the work in addition to the center is driven from the main drive motor 8 which is connected through suitable belts 9 to the clutch and brake pulley 10 which incorporates a driving clutch 11 and brake device 12 which may be actuated by reciprocating the actuating rod 13 by moving the spool 14 which engages the actuating fingers 15 in a conventional manner, for example, as shown in Patent #1,474,112, dated November 13, 1923. Thus main drive power from the motor 8 and the pulley 10 may be connected to the input drive shaft 16 through the friction clutch 11 or may be disconnected from the shaft 16 by this clutch and the shaft 16 and associated headstock transmission gearing stopped rapidly by means of the brake 12.

On the shaft 16 is fixed the gear 17 which is arranged in driving relationship with the gear 18 fixed on the shaft 19 appropriately journaled in the headstock housing 2. The outer right hand end of the shaft 19 extends into a change gear compartment 20 and has mounted on it a gear 21 which may drive the pulley shaft 22 when a change gear 23 is inserted on the outer end of this shaft 22 which meshes with the gear 21 on the shaft 19. Or the gear 23 may be removed and placed on the shaft 24 so that driving power from the shaft 19 may then be transmitted from the gear 21 to the gear 23 on shaft 24 to effect the gear drive to the work spindle.

When belt driving of the lathe spindle 6 is to be done, the gear 23 is placed on the shaft 22 whereby driving power from the main drive motor 8 is transmitted to this shaft and to its pulley 25 which is connected through the belts 26 to a pulley 27 fixed to the work spindle 6 and which belts may be kept in proper tension, Figure V, by means of the eccentric idler adjusting means comprising a pulley 28 mounted on suitable bearings 29 and carried on an eccentric bushing 30 fixed to an actuating stud 31 which has a squared end portion 32 for application of a wrench for rotating the stud 31 to effect adjustment and tension in the belts 26. A suitable lock nut 33 is provided for locking the stud 31 in the desired position.

When gear driving of the work spindle 6 is to be undertaken, gear 23 is placed on the end of the shaft 24 in the compartment 20 whereby the shaft 24 is rotated and the double gear 34 fixed thereon and having the gear portions 35 and 36 will thus be driven. The gear 35 may be engaged by the gear 37 when the shiftable gear comprising the gears 37 and 38 is moved to the left on the shaft 39 while at the same time when gears 35 and 37 are in engagement the gear 37 also engages the gear 40 fixed on the work spindle 6. When the gear 37—38 is shifted to the right on the shaft 39 the gear 38 engages the large face gear 41 fixed on the work spindle 6. In this way two changes of gear drive speeds may be effected in the work spindle 6. Thus by this arrangement the work spindle may be driven directly by belts for the higher smoother speeds required or a gear drive having two selections of speed may also be obtained when the gear 37—38 is shifted to the position where gear 37 engages gear 35 of shaft 24 and gear 40 of the work spindle, or when its gear 37 engages the gear 36 of the shaft 24 and its gear 38 engages the face gear 41 on the work spindle.

In this transmission arrangement it will be noted that there are two compartments in the lathe headstock, namely the lubricant filled compartment 42 which provides lubricant for the gear transmission mechanism and the dry compartment 43 which contains no lubricant and contains the belt drive transmission as shown best in Figures V and VII. A suitable lubricant tight baffle 44, Figure V, is provided in the bottom of the dry compartment 43 so as to prevent any lubricant getting into the belt drive transmission and impairing its efficiency. Another unique feature of this design lies in the fact that the work spindle 6 need not be removed from its journal bearings 45 and 46 when it becomes necessary to replace the belts 26. This is accomplished by providing the rear mounting bearing 47 of the work spindle in a cartridge case 48 which may be entered into a bore 49 in the headstock housing 2 and held in place by suitable screws 50. When it is desired to change the belts 26 the screws 50 are removed and the cartridge case 48 and the lock nut 51 removed from the work spindle. The clearance thus provided between the bore 49 and the work spindle is just sufficient to permit easy removal or insertion of the belts through this opening and around the work spindle 6 so that they may then be easily slipped over the pulley 25 and the idler pulley 28. The cartridge case 48 is then reinserted in the bore 49 and fastened in place by the screws 50 to thus provide a totally enclosed integral headstock containing a lubricant filled gear drive transmission compartment and a dry belt drive compartment in the same head housing. This arrangement, of course, provides the utmost simplicity and efficiency in manufacturing of a lathe headstock incorporating such features.

Power for actuating the cutting tools at feed and rapid traverse motion is derived from the headstock transmission. Referring particularly to Figure VII, on the shaft 19 is fixed a gear 52 which drives the gear 53 rotatably journaled on the shaft 16 and which has formed on a sleeve projecting portion thereof a spiral gear 54 and a second spiral gear 55 fixed to the other end of the sleeve of the gear 53. The spiral gear 55 drives a mating spiral gear 56 carried on a shaft 57 appropriately journaled in the headstock housing 2. This shaft 57 proceeds backwardly to the rear of the headstock into a change gear compartment 58, Figures II and VI, where it has mounted on it a change gear 59 which meshes with another change gear 60 in this same compartment 58 mounted on the shaft 61 appropriately journaled in the lower rearward portion of the headstock housing 2. Also on this shaft journaled against axial movement is the spiral gear 62 which meshes with the spiral gear 54 of the

gear 53 above mentioned. Thus by this arrangement the shaft 61 may be driven at a plurality of different relatively slow speeds or feeding speeds by changing the change gears 59 and 60 in the compartment 58 for effecting different rates of relative feed for the tools of the machine. The spiral gear 62 rotatably mounted on the shaft 61 is driven at a relatively rapid rate by its mating spiral gear 54 so as to effect rapid traverse motion. In order to selectively take off either the feed drive power from the shaft 61 or rapid traverse driving power from the spiral gear 62 the arrangement shown in Figures VI and XIII is provided which comprises a clutch member 63 fixed by suitable pins 64 to the shaft 61 and having clutch teeth 65 which are arranged to engage mating clutch teeth 66 of the output gear 67. This output gear 67 is journaled on the shaft 61 and has clutch teeth 68 which are arranged to engage clutch teeth 69 formed on the gear 62. Thus by shifting the gear 67 so as to engage the clutch teeth 66 with the teeth 65 of the clutch member 63 this gear 67 will be rotated at feeding speed. Shifting this gear 67 to the left, Figure VI, will engage the clutch teeth 68 with the clutch teeth 69 of the gear 62 so as to connect rapid traverse power for rapidly rotating the gear 67. This gear 67 is in constant mesh for any shifted position with the idler gear 70 appropriately journaled on a suitable stud 70*a* in the headstock housing 2. This gear 70 may be connected to or disconnected from driving relationship with the worm shaft 71 by means of a pinion 72 slidably but drivably mounted on the shaft 71 by any suitable splined connection and may be slid on this splined arrangement by means of the control rod 73 having an operating knob 74 projecting through the front of the base 1 of the lathe as best seen in Figure VI. This worm shaft 71 has fixed on it a worm 75 which in turn drives a worm wheel 76 fixed on the cam drum shaft 77 appropriately journaled in suitable bearings 78 and 79 in the base 1 of the machine. A suitable crank handle not shown may be placed on the clutch portion 80 of the worm shaft when the knob 74 is pushed in against the base 1 of the machine as shown in Figure VI so as to rotate the shaft 71 manually for effecting manual positioning of the tools for setting the work and tools prior to the automatic machining cycle. On the cam drum shaft 77 are appropriately mounted the cam drums 81 and 82 having appropriate cam slots 84 and 85 for actuating the various tool slides in their desired movement.

Referring particularly to Figures IV, VI, and VII, the control of the clutch 11 on the input drive shaft 16 is accomplished by means of the main spindle stop and start lever 86 which is fixed to an appropriate sleeve 87 journaled in the headstock housing 2 and having fixed on its inner end a depending lever 88 which is connected by means of a link 89 with another lever 90, Figure V, pivotally mounted on a pin 91 fixed in the headstock housing 2 and having a yoked portion 93 carrying a shoe 94 which might be fitted in the annular groove 95 of the operating spool 14, Figure VII, of the clutch 11. Thus by moving the lever from its position 86*a*, Figure IV, to the position 86*b* the clutch spool 14 will be moved to the left in Figure VII to engage the clutch 11; likewise moving the lever in the opposite direction will disengage the clutch 11 and engage the brake 12 for rapidly bringing the work spindle 6 to a stop.

This operating handle and clutch 11 may be automatically tripped to stop the spindle at a predetermined point in the work cycle from the rotation of the cam drum shaft 77 as follows: Noting Figure V, on the pin 91 and in the cutaway portion 95 formed in the lever 90 is mounted the lever 96 which has an upward projecting lug 97 having a surface 98 engaging the surface 99 of the lever piece 90 but which is free to rotate, as seen in Figure IV, in a counterclockwise direction without effecting rotation of the lever 90. Rocking the lever 96 clockwise actuates the lever 90 and therefore the control lever 86 to the stop and brake position of the clutch 11—12. A suitable compression spring 100 carried on an eyebolt 101 and abutting against the nut 102 engaging the surface 103 of the headstock housing 2 and is connected by means of the pin 104 to the lower end of the lever 96 so as to normally urge this lever 96 in the clockwise or stop and clutch disengaging position. Also on the lower end of this lever 96 is a latch piece 105 which is adapted to be engaged by a mating latch piece 106 fixed on a lever 107 fixed on the rock shaft 108 journaled in the headstock housing 2. Also fixed on the left hand end of this rock shaft 108, Figure IV, is the roller arm 109 carrying a roller 110 which may be engaged by a dog 111 appropriately clamped by a suitable screw 112 on the shaft 77. Normally this arm 109 and lever 107 are moved so as to constantly be urged toward the latch piece 105 of lever 96 so that when the lever 86 is moved to the position 86*b* compressing the spring 100 it will automatically be latched by the piece 105 engaging about the piece 106 so as to hold this lever in the run position for the work spindle. As the cam drum thus rotates through the transmission gearing to the worm 76 on the shaft 77 as already described the dog 111 will rotate around and ultimately strike the roller 110 on the lever 109 at the appropriate time in the cutting cycle as determined by the setting of the dog 111 by means of its adjusting screw 112 on the shaft 77. Thus when the dog 111 does hit the roller 110 the spindle stop lever will be tripped to the stop position since the member 106 will be pulled away from the member 105 by this actuation of the lever 109 allowing the spring 100 to turn the lever 86 to the stop position 86*a*. It will be also noted that since the surface 98 engages the surface 99 of the lever 90 only from the clockwise direction of movement that even though the lever 96 is latched behind the latch piece 106 of lever 107 during the automatic cycle the stop lever 86 could at any time be moved back from position 86*b* to 86*a* manually to immediately arrest the work spindle rotation in the event of an accident or any other incorrect operation of the machine.

The gears 37—38 on the shaft 39 may be shifted axially on this shaft for effecting the two ranges of gear driving of the work spindle 6 by means of the control lever 113 located on the front of the headstock as shown in Figure IV. This lever 113 is fixed on the rock shaft 114 which passes co-axially through the sleeve 87 of the lever 86 and has on its inner end a shifter lever 115 carrying a shifter shoe 116 which engages in the annular groove 117 formed in this gear 37—38, so that rocking of the lever from the position 113*a* to the position 113*b* effects shifting of the gear to its true driving position as described above.

Feed and rapid traverse power may be alternately applied to the cutting tool of the lathe automatically at a predetermined position of the cutting cycle of the machine. This automatic

control of the feed and rapid traverse movement is effected from the rotation of the cam drum shaft 77. Referring particularly to Figures IV, V, and VI it will be noted that the clutch gear 67, Figure VI, has an annular groove 118 in which is mounted a shoe 119 which is carried by a yoke 120 fixed to the rock shaft 121 journaled in the headstock 2 of the lathe. On this rock shaft 121 is mounted a downwardly depending link 122 which has a projecting pin 123 which may be engaged by the screws 124 and 125 of the fork shaped lever 126 fixed on the rock shaft 127 journaled in the headstock housing 2. This rock shaft 127 proceeds to the left, Figure IV, and has fixed on its outer end a pair of levers 128 and 129 each with rollers 130 and 131 respectively. The arm 128 having the roller 130 is engaged and operated so as to rotate the rock shaft 127 in a clockwise direction by the trip dog 132 while the lever 129 has its roller 131 engaged by trip dog 133 which rotates the rock shaft 127 in a counterclockwise direction, as seen in Figure V. Both of these dogs 132 and 133 are respectively clamped at their desired circumferentially oriented position on the cam drum shaft 77 by suitable clamping screws 134 and 135 respectively. It will thus be seen that as the cam drum shaft 77 rotates the dog 132 will strike the roller 130 so as to cause the rapid traverse motion to take place by engaging the clutch teeth 68—69 whereas the shifter 133 when it engages the roller 131 and lever 129 the feed clutch 65—66 will be engaged to effect the feeding motion in the cam drum shaft and tool slide of the lathe.

In order that the transition from feed to rapid traverse or from rapid traverse to feed may take place by snap action motion so that at no time shall the cam drum shaft 77 get to a neutral position and therefore stop the entire operation of the machine, a special arrangement is provided for flipping the clutch gear 67 from one position to the other. This comprises leaving a substantial space for lost motion between the shoe 119 and the annular slot 118 in the gear 67 and in providing a lever arm 136 having a pin 137 which is carried fixedly to the shaft 121 so as to rock or swing with the motion of the shaft 121. A detent lever 138 having a detent point 139 and pivotally mounted about the shaft 127 is normally urged into yieldable position against the pin 137 by means of the tension spring 140 attached to the lever 136 and to a pin 141 fixed in the headstock housing 2. The point 139 of the detent lever 138 is so arranged that as the shaft 121 is rocked to cause disengagement of the clutch gear 67 with either of its respective clutches, that the lost motion between the shoe 119 and the slot 118 permits the pin 137 to ride a little beyond the point 139 in the direction it is moving so that just as the shoe 119 begins to engage the other side of the slot 118 for removing or disengaging the clutch the remainder of the motion will take place due to the sliding of the pin 137 down the surfaces 142 or 143 each side of the point 139 in a snap action fashion so that the clutch will then be moved immediately to disengage one clutch or immediately engages the other series of clutches so that at no time is there a position where the clutch gear 67 is in a neutral or no clutch engaged position. This is essential in order that the cam drums on the shaft 77 at all times be rotating in either rapid traverse or feed so that the trip dogs 111, 133, and 132 may at all times be moved to effect control of the levers 109, 129, and 128. The said screws 124 and 125 in the lever 126 are primarily for the purpose of accurately positioning the various levers 128 and 129 with respect to the clutch gear 67 so as to provide the proper degree of accuracy of movement of all of these members during the automatic operating cycle of the machine.

Referring particularly to Figures I and VIII it will be noted that extending longitudinally of the base of the lathe is the upper tool supporting bar 144 and the lower tool supporting bar 145 both located with their axes substantially in a vertical plane passing through the work spindle axis 146 of the lathe. In this particular exemplary disclosure the bar 144 is journaled for sliding and rocking motion in appropriate bearings 147 and 148 in the base 1 of the lathe as best shown in Figure VII and is similarly supported in appropriate bearings 149 in the tailstock 3. The lower tool bar 145 is supported in bearings 150 and 151 in the base 1 of the lathe and is permitted to rotate in said bearings but is restricted from axial sliding motion in this particular instance by appropriate collars 152 and 153 clamped to the bar 145. It will be noted that this arrangement of the bars 144 and 145 one above the other and lying substantially in a vertical plane passing through the axis of rotation of the work spindle that there is no obstruction on either side of this central vertical grouping of the bars 144 and 145 so that chips cut from the work piece mounted on the work spindle axis have free access to drop down past these bars into a relatively wide chip collecting compartment in the base 1 comprising the vertical longitudinally extending rear portions 1*a* and 1*b* forming the compartment 1*c* through which the chips readily drop into the pan 154 below the base 1 of the machine. Also since there are no obstructions from these bars far removed from the vertical plane passing through the axis of the work spindle, the operator is not interfered with in reaching to the tools and working from either side of the machine to thus make a practical machine operation in a line-up where one operator would operate a plurality of machines and be required to operate the machine from either side. Also adequate chip space is thus provided which is a very important feature of a lathe of this automatic type which produces chips at a very rapid rate during its rapid production of work pieces.

The upper bar 144, while free to rotate, is also given axial sliding motion by means of the actuating block 155, shown best in Figures VI and VII, which has a slotted portion 156 in which nicely fits a collar 157 fixed on the bar 144 by a suitable pin 158 so as to permit the bar 144 to rotate in the bearings 147 and 148 of the headstock and also in the tailstock bearings. In this way the block 155 accurately controls the axial movement of the bar 144. The actuating block 155 has a bore 159 which nicely fits over the lower bar 145 and slides thereon so as to support the block 155 against swinging about the bar 144. On the lower end of this block 155 is a cam roller 160 carried on a pin 161 fixed in the block 155 and which roller 160 may engage in a cam track 84 on the cam drum 81 so that rotation of the drum 81 on the shaft 77, through the mechanism described, will cause axial displacement of the member 155 along the lower bar 145 and to thus cause axial motion in the upper bar 144 through the medium of the collar 157.

Extending longitudinally of the base 1 and parallel with the work spindle axis of the lathe is the actuating cam slide 162 carried in suitable guide

way surfaces 164 and 165, and on the anti-friction supporting rollers 166 in the web member 1a of the base 1 and the cam slide 163 is carried in guide ways 167, 168, and on the supporting rollers 169 in the web portion 1b of the base 1 of the machine in this particular arrangement the turning tools or tools which feed substantially parallel to the axis of rotation 146 of the work spindle are mounted on the upper tool bar 144 and comprise a tool slide base 170 which may be clamped to the bar 144 by means of a clamping screw 171 and which has mounted on top of it a tool slide or holder 172 having an adjustable screw 173 for accurately moving it to set the cutting tools 174 in the tool block 175 to proper depth and accuracy of cut. On this tool slide base 170 is pivotally mounted on a pin 176 an abutment finger 177 which engages the top surface 178 of the form bar 179. The form bar or plate may be clamped to the vertical cam plate 180 carried between guide rollers 181 in a bracket 182 fixed to the base 1 of the machine by suitable screws 183. By suitable bolts 184 passing through clearance holes 185 the form bar 179 is held on the cam plate and may be set at any desired adjusted position of either parallel or taper turning by means of the adjusting screws and nuts 186. The cam plate 180 has a suitable cam engaging roller pin 187 carried on a suitable anti-friction ball bearing 188 for easy rotation when bearing against the cam surfaces. This roller pin 187 engages in a slot 189 formed in an adjustable cam 190 which is pivotally mounted around a T-slot bolt 191 held in a T-slot 192 formed in the cam slide 163 so that it may be swung around this T-slot bolt 191 to effect different angular positions of adjustment such as shown in Figure XIV indicated at the 189a position of adjustment of the cam slot for a minimum of angularity to the cam while the position 189 shows the steepest position. At the other end of the cam 190 is cut a rack 193 whose arcuate shape is radially positioned from the axis of pivoting of the cam around the T-slot bolt 191. A suitable bore 194 is formed in the end of the slide 163 for insertion of a pinion gear 195 carried on a shaft 196 (Figure XV) having an operating knob 197 for easy positioning of the cam 190 to the desired angular setting. A clamp 198 operated by a suitable bolt 199 and having a lipped portion 200 may be tightened to lock the cam 190 in any desired angular position of setting, after which the bolt 191 is similarly tightened to rigidly hold the cam for operating the machine.

Referring particularly to Figure XIV, it will be noted that the portion of the cam embraced by the angle 201 is radially positioned with respect to the point of pivoting around the bolt 191 and this portion of the cam is so arranged as to give the proper dwell and accurate positioning of the tools to the work and by means of this constant radial positioning of the angular portion 201 of the cam slot 189 the cam may be set to any desired angular position of feeding while at the same time always maintaining the same dwell or finish position of the tools. When readjusting the cam to any desired position of setting along the T-slot 192 of the cam slide 163 it may be desirable in some instances to withdraw the engaging roller stud 187 which may readily be done by removing the screws 202 and pulling out the carrying cartridge on the stud 203 by means of its manipulating handled portion 204 as best seen in Figure VIII.

This front cam slide 163 has fixed on it a roller 205 carried on a stud 206 fixed in the cam slide which engages a cam slot 84 of the cam drum 81 so that rotation of this cam drum 81 causes sliding motion in the cam slide 163 which also carries the cam 190 which thereby actuates the stud 187 to cause vertical sliding movement in the cam plate 180 and through the medium of the form bar 179 bearing against the abutment block 177 to swing the tool holder in the arcuate path of feeding 207, Figure VIII, to present the tools 174 to or from the work. This motion may be utilized either as performing facing operations with the tools 174 or the cam drum 81 may be so arranged as to effect motion sufficient to merely cause the tool relief in the turning tools 174 from the work during their longitudinal return movement.

Turning motion for the tools 174, that is the longitudinal or parallel feeding of the tools with respect to the work spindle axis 146 is accomplished as above described by longitudinally or axially sliding the bar 144 to which the tool slide base 170 has been rigidly clamped by the screw 171 through the medium of the block 155 also operating on the cam drum 81. Thus in this particular exemplary arrangement it is possible to have facing or radial infeeding of the tools 174 with respect to the tool spindle axis or to have longitudinal feeding of the tools along said axis. Also in instances where pure turning is to be done the tools 174 are moved parallel to the work spindle axis by axially sliding the bar 144 and arranging the surface 178 of the form bar 179 in parallel relationship to the work spindle axis and by so arranging the cam 190 that it will have no motion effecting the vertical movement of the cam plate 180 during the normal turning operations. This cam 190 however would in this instance have certain relief portions cut in it where the cam plate 180 would drop down slightly just after the completion of the turning operation on the work so as to relieve the tools therefrom, during the return movement of the bar 144 in bringing the tools 174 to initial cutting position.

It is also to be noted that taper turning can be readily done with this construction by merely setting the form bar 179 in angular relationship to the work spindle axis in proportion to the desired taper to be cut on the work piece. Pure facing operations would be accomplished with the front tools 174 by merely having the cam plate 190 fully operative to effect vertical movement in the cam plate 180 during which time the bar 144 would be locked against axial motion and would have only rocking motion for the tools 174.

In this disclosure also is shown a similar set-up for actuating the facing tools which are carried on the bar 145 by means of the facing tool holder 207 which may be clamped to the lower tool bar 145 by a suitable clamping screw 208 and which has mounted on it a tool block 209 carrying the facing tools 210. Similarly this facing tool holder 207 has an abutment block 211 mounted on a suitable pivot pin 212 which engages the form bar 213 which is similarly held into place by screws 214 on the cam plate 215 and which may be adjusted in the desired position by the adjusting screws 216, in a fashion similar to that for the arrangement for actuating the cutting tools 174. In this instance however the abutment block 211 is carried on an adjustable piece 217 which may be locked in various positions in the arcuate guideway 218 by means of the clamping bolt 219. In this way a greater range of relative positioning of the tools

210 with respect to the work spindle axis may be effected along its arcuate path of feeding 220. The cam slide 162 similarly carries a cam 221 like the cam 190 just described for the front tool slide turning tool 174 which actuates a roller pin 222 carried in a suitable anti-friction bearing 223 in the cartridge 224 held in place by screws 225 on the vertically movable cam plate 215. This cam slide 162 similarly has a roller like that of the cam slide 163 indicated at 226 carried on a stud 227 (Figure VI) which engages in a suitable cam track 84 in the cam drum 81. In this instance of utilizing the rear tool holder 207 on the bar 145 primarily for facing or radial infeeding of the tools 210 along the arcuate path of feeding 220, bar 145 is confined against axial movement by the collars 152 and 153 and that purely vertical motion in the cam plate 215 effected through the medium of the roller pin 222 and movement of the cam slide 162 by the cam drum 81 is utilized. It is to be further noted that in this particular arrangement because of utilizing the lower bar 145 for facing rather than the front bar, that lesser arcuate path of feed 220 is provided and a greater range of facing may thus be undertaken. By maintaining the bars 144 and 145 substantially in the same vertical plane passing through the work spindle axis the chips are easily disposed of as they drop freely into the pan of the lathe and also easy access to the cutting tools is thus provided from either side of the machine.

The cam drum 81 is designed with appropriate cam slots (not here shown in detail as this mechanism is readily understood and well known in the art) for actuating the block 155 and the cam slides 163 and 162 in appropriate sequential relationship to effect the various operations desired of the lathe of both tool reliefs and feed motion either radially into the work for facing or longitudinally of the work for turning.

In addition to the cutting tools 174 and 210 just described there may be provided additional tooling comprising the cutting tools 228, Figures I, XI, and XII carried in appropriate tool block 229 mounted on a vertical universally mounted tool slide 230. This tool slide 230 is mounted on suitable dovetail guideways 231 and 232 on a base 233 which is mounted on a swivel around the axis of an actuating shaft 234 appropriately journaled in the supporting housing 235 to which the base plate 236 is fixed by means of suitable T-slot bolts 237 operating in a concentric annular T-slot 238 formed in the base plate 236. This base plate 236 in turn is mounted to the overhead tool supporting rail 239 by suitable T-slot bolts 240, as best seen in Figure XI. In this way the tool slide base 233 may be set to any desired angular position so that the cutting tool 228 may be fed at relatively steep angles for cutting such work as bevel gear blanks and the like.

This overhead tool supporting rail 239 is mounted on the headstock by suitable means such as the bolts 241 and is carried on a pedestal 242 appropriately mounted on the tailstock by screws 243 and connected to the overhead rail by screws 244. In this overhead tool supporting rail 239 and guided in the guideway 245 as best seen in Figures II and IX is the cam slide 246 which carries an actuating cam 247 of similar design to that of the cams 190 and 221, Figure VIII, already described. This cam may similarly be adjusted by manipulating the clamp bolt 249 and its clamp 250 for setting the desired rate of feed for the cutting tool 228. This cam 247 has a cam slot 251 which actuates a pin 252 fixed in a slide plate 253 having a rack 254 formed integral with it which rack in turn is in engagement with a pinion 255 carried on the actuating shaft 234 and which may be connected to it in driving relationship through the medium of the hub 256 to which it is integrally connected when the setting screws 257 of the orienting coupling 258 are properly clamped. The outside portion 259 of the coupling 258 can be positively attached to the actuating shaft 234. The purpose of this coupling 258 is to permit the proper orientation of the pinion and rack with relationship to the cam for starting the tool at the right end of the desired position for beginning the cutting operation.

On the other end of the actuating shaft 234 is fixed a pinion 260 Figures X and XI which drives a mating pinion 261 carried on a suitable stud 262 fixed in the base plate 233 and driving a rack 263 fixed on the tool slide 230. A suitable compression spring 264 is used to normally force the tool slide away from the work piece to at all times take out any slack between the rack and pinion and cam driving mechanism just described during the turning operation and to prevent the tool slide 230 and the tools 228 from dropping down toward the work piece when cutting action is relieved therefrom and which would otherwise make it difficult to do accurate finishing with this cutting tool. This is accomplished by spring 264, engaging in the upper portion 265 of a suitable bore 266 formed in the slide 233 and bearing against a guide block 267 rigidly fixed to the base plate 232 by suitable screws 268. It can thus be seen that as the cam slide 246 is moved back or forth in the guideways 245 its cam actuating means and roller pin 252 will rotate the shaft 234, the rack 254 and pinion 255, and the pinions 260 and 261 which actuate the rack 263 fixed on the slide 230.

The cam slide 246 is actuated in its guideways 245 from the cam drum 82 mounted on the cam drum shaft 77 as best seen in Figures II, III, and IV. The shaft 77 is supported at its outer end in a suitable bearing 269 in a bracket 270 appropriately fixed to the left hand end of the base 1 of the machine by suitable screws 271 best seen in Figure III. On the tool supporting bars 144 and 145 is slidably mounted the actuating block 272 having a downward depending roller 273 carried on a suitable pin 274 fixed in the actuating block 272 and which roller 273 operates in an appropriate cam slot 85 formed in the cam drum 82. By this arrangement the block 272 is slid along on the bars 144 and 145 independent of any motion these bars may have. On one side of the block 272 is provided a pair of lugs, Figure II, forming a slot 275, in which operates a shoe 276 carried in the end of a lever arm 277. The outer end of the bars 144 and 145 adjacent the blocks 272 is supported by a supplemental bracket 278 carried on the bracket 270 fixed to the end of the base 1 of the machine. In this way support is given to the tool bars 144 and 145 for holding the actuating block 272 in proper operative position relative to the cam drum 82. The lever 277 connected through the sleeve 276 to the actuating block 272 is mounted on a pivot pin 279 held in a bifurcated downwardly projecting integral support portion 280 of the overhead rail or tool supporting member 239 and has in its upper end a shoe 281 which operates in an elongated cross slot 282 formed in the cam slide

246 so that as the cam drum 82 rotates it will slide the actuating block 272 along on the bars 144 and 145 thus rocking the lever 277 and thereby sliding the cam slide 246 in the member 239 to effect feeding of the cutting tool 228 to and from the work piece in the lathe. It is to be further noted that the cam 82 is mounted on the same shaft as the cam drum 81 so that all of the cutting tools including the cutting tool 228 mounted on the tool slide 230 may be operated in a predetermined sequential relationship relative to one another. By appropriately setting the swivel slide 233 around to any desired position the cutting of any steep range of tapers desired with this overhead tool feeding arrangement may be undertaken.

Having fully set forth and described our invention what we claim as new and desire to secure by United States Letters Patent is:

1. In a lathe having means for receiving and rotating a work piece about a first axis, a bar journaled for rotation on a second axis parallel to said first axis, a tool holder adjustably secured to said bar and adapted to hold a tool in cutting engagement with a work piece in said lathe, plate means guided for translation on said lathe in a direction spaced from and angularly related to said second axis, a form bar adjustably mounted on said plate means, to contact and pivot said holder about the axis of said bar, a cam slide means on said lathe, translatable parallel to said axes, and a connection between said slide means and plate means, said connection including a cam pivoted on one said means and a pin on the other of said means adapted to coact with said cam to variably transmit motion from said slide means to said plate means.

2. In a lathe having a base, a headstock and a tailstock on said base having centers to receive and rotate a work piece upon a first axis, in combination, a tool bar mounted for pivotal and axial translation in said stocks on a second axis parallel to said first axis, tool holder means adjustably secured to said bar, a plate guided for translation on said base in a direction spaced from, and normal to said second axis, a form bar adjustably fixed to said plate and having a cam edge engaging said holder, a cam slide in said base, adjustable cam connections between said slide and plate, and a single means having a cam slot therein connected to said bar to effect translation of said bar and said slide.

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