Dec. 19, 1944. L. E. TOPHAM 2,365,311

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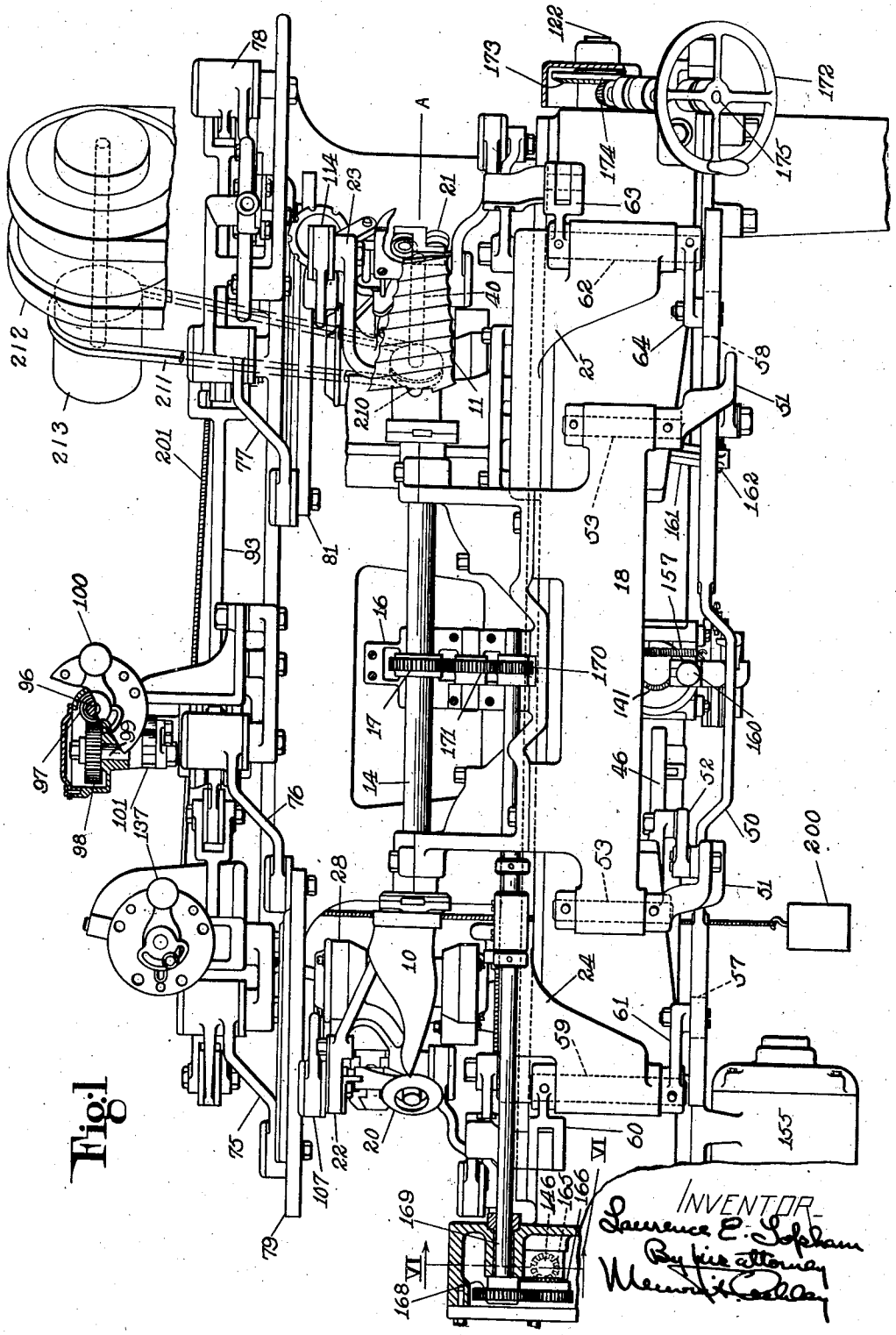


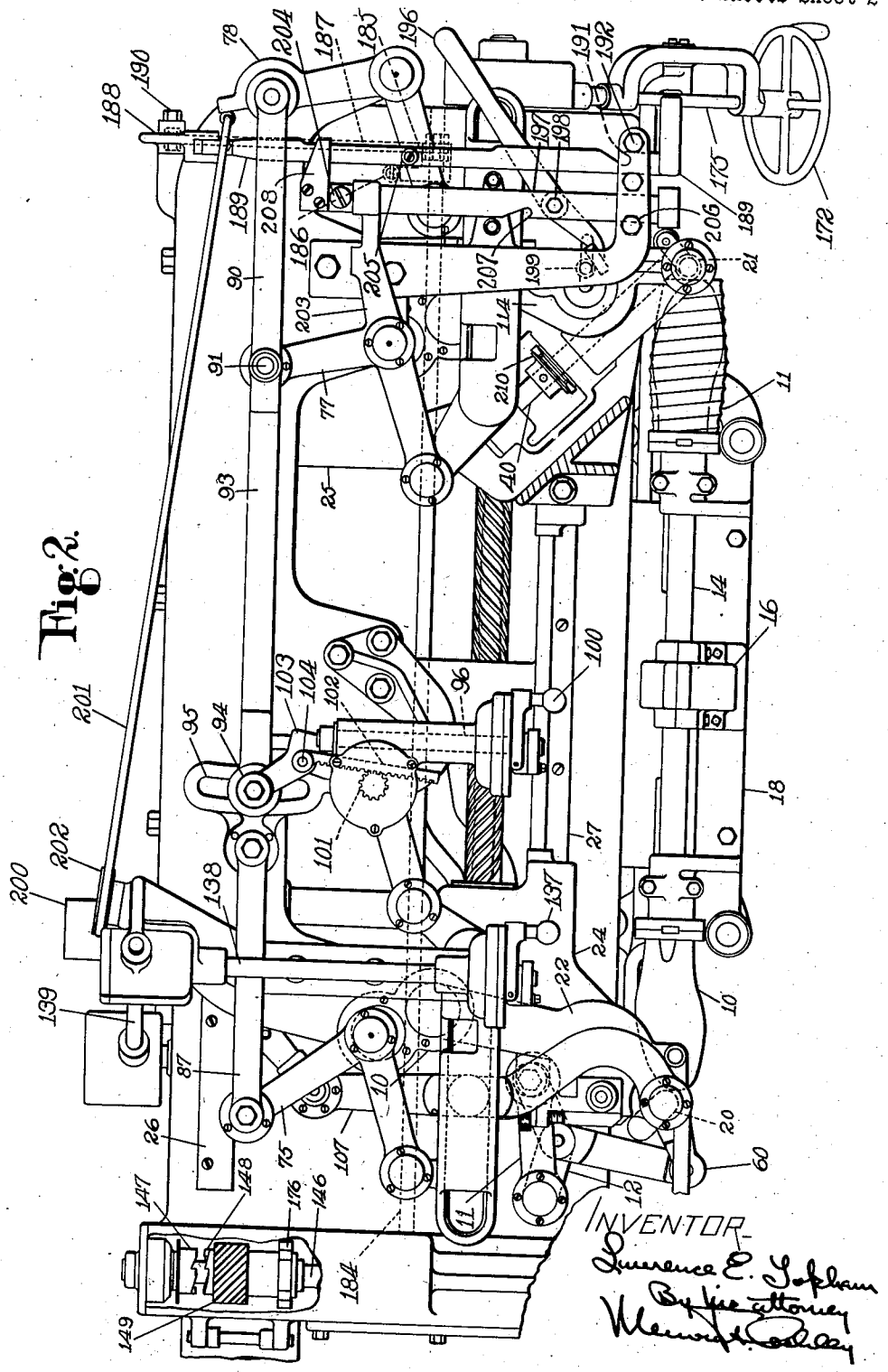
Fig. 1

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Fig. 2.



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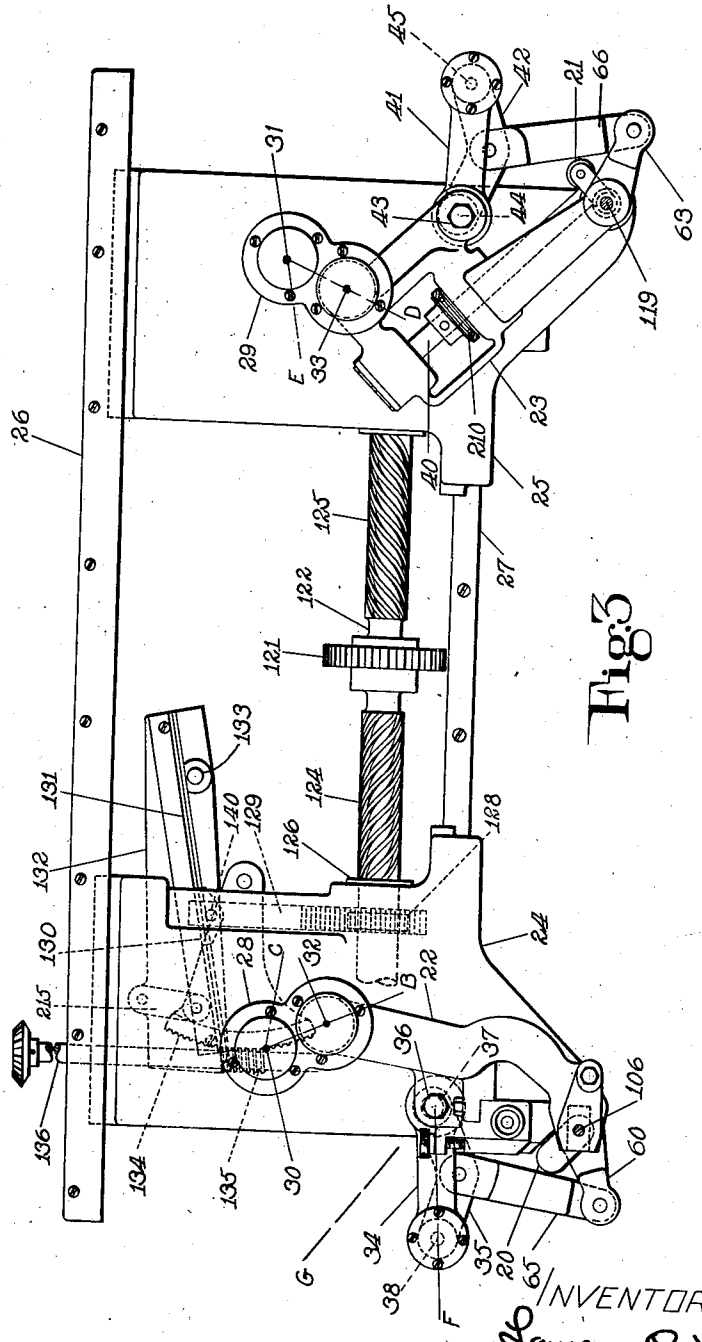


Fig 3

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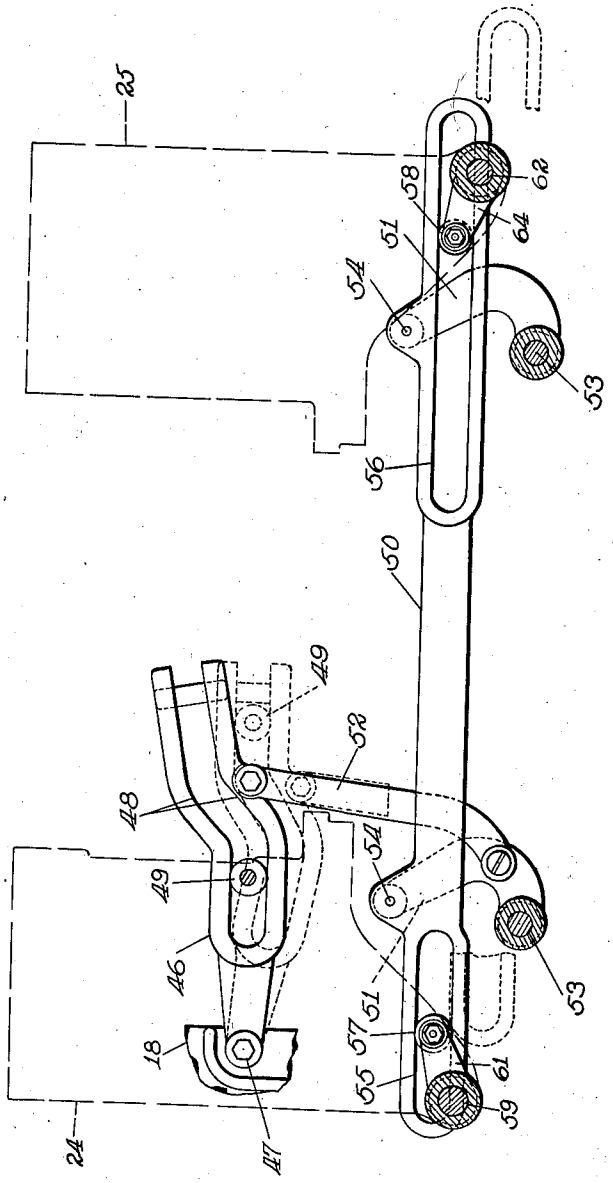


Fig. 4

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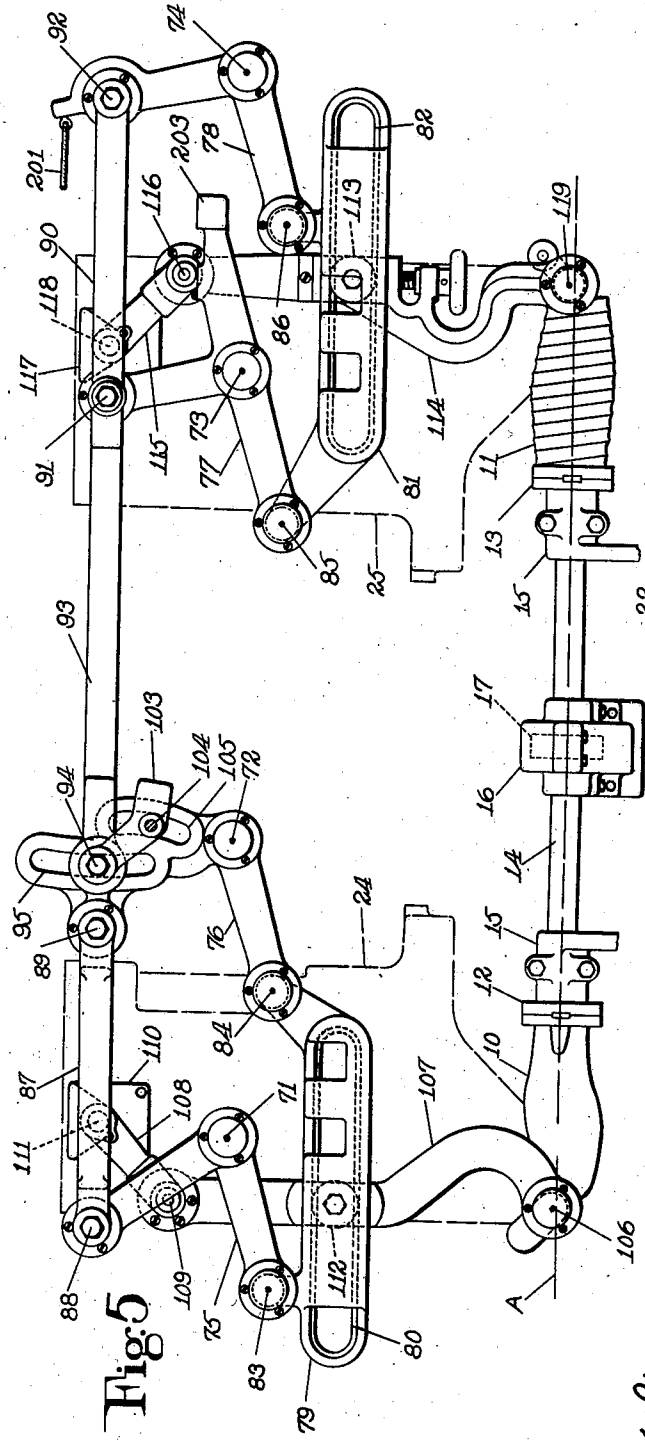


Fig. 5

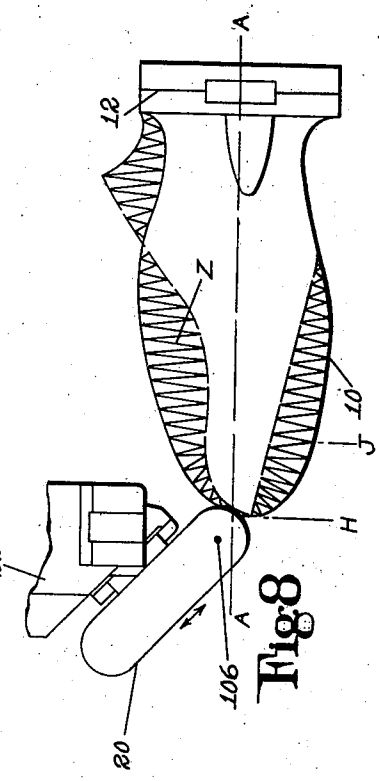


Fig. 8

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Fig:6

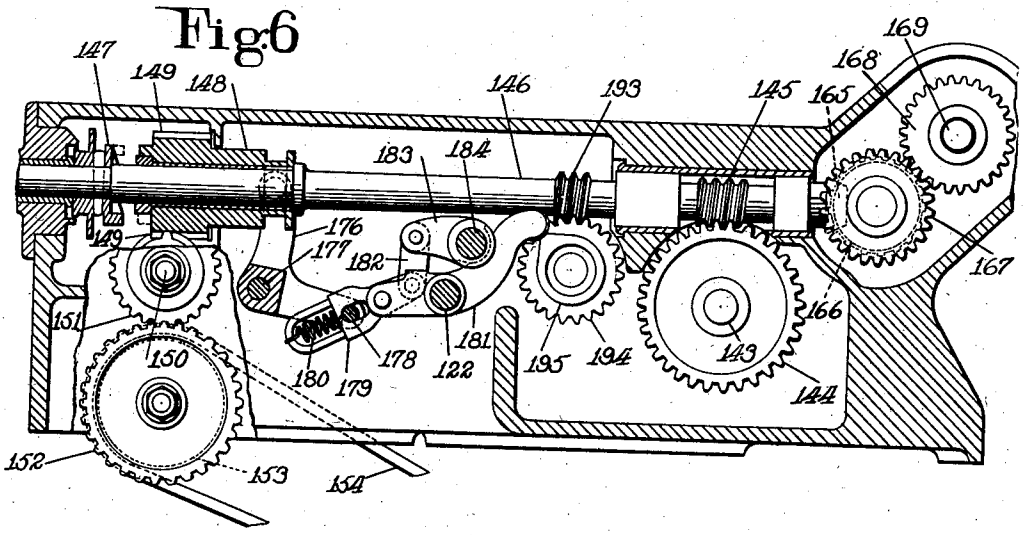


Fig:7

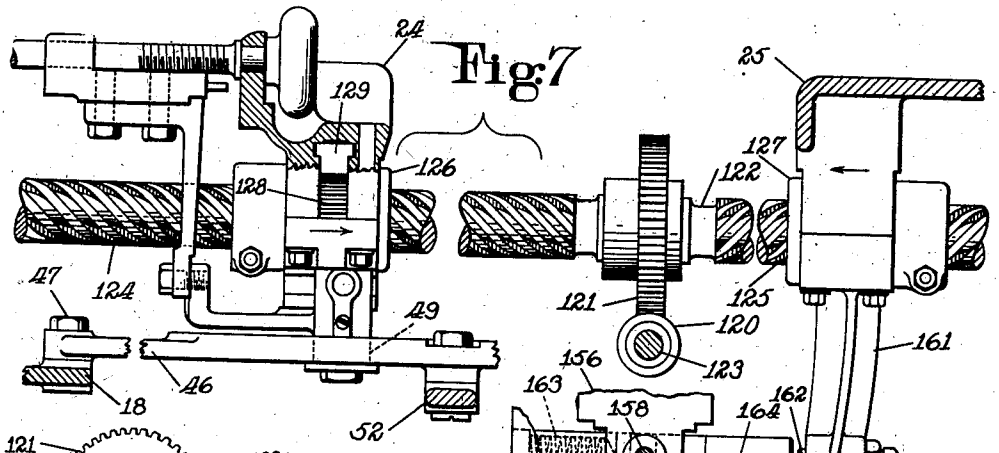


Fig:9

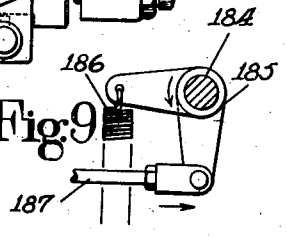
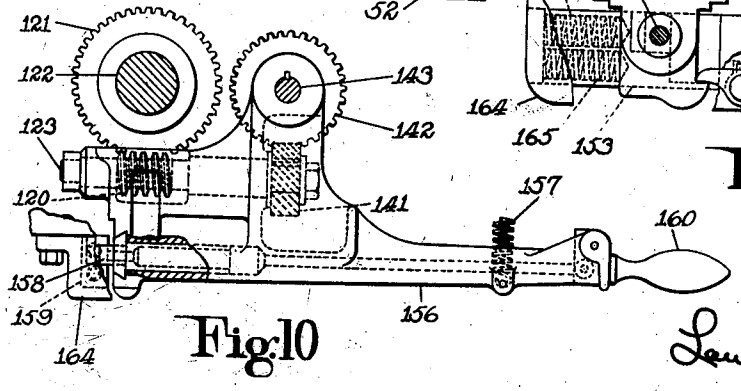


Fig:10



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Patented Dec. 19, 1944 2,365,311

UNITED STATES PATENT OFFICE

2,365,311

COPYING LATHE

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Application March 13, 1943, Serial No. 479,014

4 Claims. (Cl. 142—15)

This invention is concerned with copying lathes and more specifically with the motions of a swing frame that emanate from radial variations of a rotating model. In prior lathes of the swing frame type the swing axis is usually fixed and parallel with the turning axis of the model. Consequently, regardless of whether the model or the model wheel is carried by a swing frame, the relative movements of the model wheel and the turning axis of the model are always in planes at right angles to that axis, except as they are slightly modified by components of relative feeding movement lengthwise of the turning axis.

The right angular relation above mentioned is, of course, ideal only with respect to those portions of the surface of a model that lie parallel with the turning axis and develop no wedging effect, but is tolerable with respect to those portions of the surface that are inclined or pitched with respect to a normal relation, provided the pitch is not so steep as to develop an excessive wedging effect that would cramp the elements or distort the reproduction. These considerations have been recognized in the development of the present invention which is embodied in a lathe capable of turning the forepart of a two-part last without leaving any stub at the toe end, or of turning a heel part without leaving a stub.

A novel feature of the invention is embodied in linkages carried respectively by two feed carriages one of which is a model wheel carriage and the other a cutter carriage. Each linkage includes a swing frame. A model wheel is carried by one swing frame and a rotary cutter is carried by the other. The model and the block or work piece to be shaped are both arranged to turn on a common axis which is preferably fixed. One of the novel features of the swing frames is that the axes of their fulcra or swing centers are transverse to the turning axis of the model and the block. Another is that the fulcra of the swing frames are arranged to "float," each with respect to its feed carriage, but their changes of location due to "floating" are constrained to produce desired alterations in the directions of those movements of the model wheel and the cutter that emanate from the shape of the model.

Still another novel feature of the invention is a supplemental linkage by which the floating fulcra above mentioned are shifted and maintained in coordinated relation as the cutting or turning operation progresses. In the construction herein disclosed, this shifting of the floating fulcra is produced by the feed or traverse of the model wheel carriage, but its amplitude and timing are both arbitrary.

The features above mentioned are embodied in a lathe in which the model is supported entirely by a face plate at the butt end thereof, and the work block is likewise supported. Consequently, as to copying a forepart model, the toe end thereof will turn "in the air" and be entirely accessible for engagement by the model wheel, and similarly, the outboard end of the block will turn "in the air" and be entirely accessible for complete shaping by the cutter.

The invention also provides novel girth-grading means embodied in still another linkage connecting the two linkages heretofore mentioned. The grading linkage is responsive only to those components of movement of the model wheel swing frame that affect the distance between the turning axis and the point of contact where the model wheel engages the model. This linkage communicates corresponding components of motion to the swing frame by which the cutter is carried, and these components may be graded down or up from a 1:1 ratio by adjusting one of the pivotal joints of the linkage toward or from a fixed center of oscillation.

Referring to the drawings,

Fig. 1 is a front elevation partly in section of a copying lathe embodying the invention;

Fig. 2 is a top plan view thereof minus a portion broken away at the lower left;

Fig. 3 is a top plan view of the feed carriages, the swing frames and other parts carried by them, and the length grading mechanism;

Fig. 4 is a top plan view of a linkage operated by one of the feed carriages for altering the lines of movement of the model wheel and the cutter toward and from the turning axis;

Fig. 5 is a top plan view including the turning spindle, a model, a work block, and a linkage by which width grading may be regulated;

Fig. 6 is a sectional elevation of the transmission means intersected by line VI—VI in Fig. 1;

Fig. 7 is a sectional elevation of the length grading mechanism viewed from the front;

Fig. 8 is a schematic view in which zigzag lines represent the path of travel of the point of contact between the model and the model wheel as the latter traverses the former.

Fig. 9 is an elevation of connections related to the clutch-controlling mechanism shown in Fig. 6; and

Fig. 10 is an elevation of gearing and controls related to the length-grading mechanism shown in Fig. 7.

Some features of the illustrated machine are essentially the same as corresponding features of the copying lathe shown and described in Letters Patent of the United States No. 2,072,228, granted March 2, 1937, on a joint application of Topham and Knott. For this reason, features common to both disclosures are described only briefly herein if at all.

As shown in Figs. 1 and 5, a model 10 and a work block 11 are arranged to turn on a common axis A which is preferably fixed. The model cor-

responds to the forepart of a two-part last. Its joint end is affixed to a holder 12 but its toe end is unobstructed, the turning center commonly employed at that end being omitted to enable a model wheel 20 to engage every portion of the surface to be reproduced. In like manner the work block is affixed to a holder 13 and its outboard end turns in the air and affords unobstructed access to a rotary cutter 21. The holders 12 and 13 are both affixed to a spindle 14 journaled in fixed bearings 15. The spindle also has bearings in a gear case 16 and is provided with a gear 17 by which it may be rotated. The bearings 15 and the gear case are parts of the main frame structure 18 by which the various mechanisms are supported.

The model wheel 20 and the cutter 21 (Fig. 3) are carried respectively by swing frames 22 and 23, and the latter are carried respectively by feed carriages 24 and 25. The carriages are movable toward and from each other on tracks 26 and 27 (Fig. 2) and thereby constrained to paths parallel with the turning axis A. The swing frames are connected to their carriages by compound linkages the pivotal axes of which are all parallel with each other but transverse to the turning axis A.

One end of the swing frame 22 is connected to its carriage by a link 28 and the swing frame 23 is likewise connected to its carriage by a link 29. The pivotal connections are formed by concealed ball bearings, and for this reason their pivotal centers are indicated by dots 30, 31, 32 and 33. The centers 30 and 31 are carriage centers, but the centers 32 and 33 swing about them and may be regarded as floating centers. Radius B and radius C represent approximately the range of angular movement of the center 32, and radii D and E represent that of the center 33, but the limits of such movement are variable according to the model selected and regulation of the width-grading mechanism hereinafter described.

The swing frame 22 is also connected to its carriage by an articulate linkage comprising two links 34 and 35. A pivot 36 connects the link 34 and the swing frame, an individual pivot 37 (dotted) connects the link 35 and the carriage, and the pivot pin 38 connects the links to each other. The force of a counterweight 200 (Figs. 1 and 2) is applied to the swing frame 22 by mechanism hereinafter described and the model wheel is thereby held against the rear side of the model with pressure toward the front.

Now, disregarding all other motions, as the center 32 floats in an arc about the center 30 the center 36 will float in an arc about the center 38, and so long as the latter remains on or near radius F the resultant line of travel of the model wheel will be oblique to a plane at right angles to the turning axis A. The maximum obliquity of this line is indicated by an arrow in Fig. 8, but as the model wheel traverses the model from plane H to plane J the obliquity is gradually eliminated. In Fig. 8 the zigzag line Z represents the path of the point of contact between the model wheel and the model. It is to be observed that the lines of travel of the model wheel at the toe end of the model are nearly if not exactly normal with respect to a tangent of the surface of the model. This approximation of normalcy enables the model wheel to bear against the end of the model without developing so much wedging effect as to spring the elements away from their true relations.

The regulation of the lines of travel of the model wheel is obtained by moving the link 35 (Fig. 3) about its pivot 37 to shift the pivot 38 from radius F to radius G. The pivot 38 is the one about which the link 34 swings as the model wheel moves toward and from the turning axis A. The links 28 and 34 are so situated that when the center 38 is on radius G the lines of movement of the model wheel will be nearly if not exactly at right angles to the turning axis.

The linkage carried by the cutter carriage 25 is similar to but the reverse of that above described and has a corresponding regulating effect on the lines of movement of the cutter 21. The cutter is carried by a driven shaft 40 and this is journaled in bearings in the swing frame 23. The connections between the swing frame 23 and its carriage include not only the link 29 but also the links 41 and 42. The pivot 43 connects the link 41 and the swing frame, an individual pivot 44 connects the link 42 and the carriage, and a pivot 45 connects the links to each other. The pivot 45 corresponds to the pivot 38 and may be shifted in like manner about its carriage pivot 44 to modify or alter the lines of movement of the cutter toward and from the turning axis A in accordance with the principle developed in Fig. 8.

Fig. 4 illustrates a linkage by which the links 35 and 42 may be adjusted with respect to their carriages to shift their pivotal centers 38 and 45 as above pointed out. In reading Fig. 4 it must be borne in mind that the carriages 24 and 25 move toward each other when the lathe is in operation and that the linkage about to be described derives its operating effect from the traverse of the carriage 24. Figs. 3 and 4, both top views, may be considered together and it is to be understood that the elements in Fig. 4 are situated at a level below that of the carriages.

An operating arm 46 underlies the carriage 24 and is connected to the main frame structure 18 by a vertical fulcrum stud 47. Cam surfaces 48 formed in the arm provide a slot which is occupied by a roll 49 under the carriage and carried thereby. As the carriage and the roll travel from left to right they shift the arm 46 from the position represented in full lines to that represented in broken lines. This shifting occurs while the model wheel traverses the model from plane H to plane J (Fig. 8) but beyond that stage the roll 49 traverses a portion of the arm that has no camming effect and merely maintains the arm in one position to the terminus of the traverse. The motion of the arm 46 is imparted to a horizontal bar 50 carried by parallel links 51 one of which is connected to the arm by an operating link 52. The parallel links 51 swing about fixed centers provided by pivot pins 53. These are journaled in the frame 18 (Fig. 1). The bar 50 is connected to the free ends of the links 51 by pivot pins 54.

Although the bar 50 has a lengthwise component as well as a widthwise component of movement only the latter is utilized, the lengthwise component being absorbed or nullified by longitudinal slots 55 and 56 that parallel the paths of the carriages 24 and 25. The slots 55 and 56 are occupied by rolls 57 and 58. A rock shaft 59 journaled in the carriage 24 (Fig. 1) is provided with an upper arm 60 and a lower arm 61, the roll 57 being carried by the latter. In like manner a rock shaft 62 journaled in the carriage 25 is provided with an upper arm 63 and a lower arm 64 by which the roll 58 is carried. Angular movement of the arm 60 is imparted to the link 35 (Fig. 3) by a link 65 to shift the pivotal center 38, and corresponding movement of the arm 63

is imparted to the link 42 by a link 66 to shift the pivotal center 45. The shifting movements of these pivotal centers are not only synchronized but also equalized by the linkage shown in Fig. 4, and the timing and amplitude of the movements are both governed by the design of the cam arm 46 which may be replaced by one of different design for work having different characteristics of shape.

Fig. 5 illustrates girth-grading linkage embodying novel features designed for a lathe of the type under consideration. This linkage is situated at a level above that of the linkage shown in Fig. 3 and is mounted on a superstructure of the frame 18. Some of the pivotal centers of this linkage are provided by concealed ball bearings and for this reason are indicated by dots. Four fixed centers 71, 72, 73 and 74 constitute the fulcra of bell cranks 75, 76, 77 and 78. The bell cranks 75 and 76 carry a bar 79 having a slot 80 while the bell cranks 77 and 78 carry a corresponding bar 81 having a slot 82. The centers 83 and 84 represent pivotal connections for the bar 79 and the centers 85 and 86 represent pivotal connections for the bar 81. A link 87 pivotally connecting the bell cranks 75 and 76 on centers 88 and 89 constrains the bar 79 to parallel movement and maintains the slot 80 in parallelism with the paths of the carriages 24 and 25.

In like manner a link 90 pivotally connecting the bell cranks 77 and 78 on centers 91 and 92 constrains the bar 81 to parallel movements and maintains the slot 82 in parallelism with the paths of the carriages. Although the bars 80 and 81 have components of lengthwise movement as well as components of widthwise movement only the widthwise components are utilized, the lengthwise components being absorbed or nullified by the slots 80 and 81. Moreover, the amplitude of the movements of the bar 81 may be graded up or down with respect to those of the bar 79. For this purpose the bell cranks 76 and 77 are connected by an individual link 93 of which one pivotal connection is on the center 91 and the other provided by a stud 94. This stud is adjustable toward and from the fulcrum or fixed center 72 of the bell crank 76 for the purpose of regulating the grade, but when its distance from 72 is exactly equal to the distances 71—88, 73—91 and 74—92 the ratio of the grade will be 1:1.

The counterweight 200 (Figs. 1 and 2) is connected with the bell crank 78 by a cable 201 that runs over a sheave 202.

To provide for adjusting the stud 94 a slot 95 is formed in the bell crank 76 and the stud extends through it. Moreover, the slot is arcuate and its radius of curvature equals the distance 91—94. When the parts are in the positions shown in Fig. 5 the slot is concentric with respect to the center 91. It is to be observed that the angle 84—72—94, the angle 85—73—91 and the angle 86—74—92 are equal, also that the angle 84—72—89 and the angle 83—71—88 are equal. The location of the center 89 is not changed by adjusting the stud 94 along the slot 95.

Figs. 1 and 2 include a convenient mechanism for adjusting the stud 94. An operating handle 100 in the form of a crank is attached to a shaft 96. Rotation of the shaft is transmitted by a worm 97, a worm wheel 98, and a vertical shaft 99 to a pinion 101. This pinion engages teeth on a rack bar 102 the rear end of which is pivotally connected to a yoke 103 by a pivot stud 104 which extends through a slot 105 in the bell crank 76 and is guided thereby. The grading stud 94 has bearings in the yoke 103 and is shifted thereby.

The motions of the girth-grading linkage are derived from a point 106 on the swing frame 22 (Fig. 3) at which point a link 107 is pivotally connected to the swing frame. The rear end of this link is carried by an arm 108 (Fig. 5) to which it is pivotally connected by a pin 109. The arm is carried by the carriage 24 to which it is connected by a bracket 110 and a pivot pin 111. A roll 112 carried by the link 107 occupies the slot 80 in the grading bar 79 and its components of movement toward and from the turning axis A are thus utilized to actuate the grading linkage.

Still referring to Fig. 5, the movements of the grading bar 79 produce corresponding movements of the grading bar 81, and the effective components of such movements are imparted to the swing frame 23 by a roll 113 and a link 114 on which the roll is mounted. The rear end of the link 114 is carried by an arm 115 to which it is pivotally connected by a pin 116. The arm is carried by the carriage 25 to which it is connected by a bracket 117 and a pivot pin 118. The forward end of the link 114 and the swing frame 23 are connected at a pivotal center 119. The axis of this center intersects the cutting portion of the cutter 21, and in like manner the axis of the pivotal center 106 intersects the corresponding portion of the model wheel 20. The location of the axis last mentioned is indicated by a dot 106 in Fig. 8.

The carriages 24 and 25 are operated by length grading mechanism of the type shown and described in the aforesaid Letters Patent No. 2,072,228. This mechanism is also shown herein in Figs. 2, 3 and 7. As shown in Fig. 7 a worm 120 is provided to drive a worm wheel 121 affixed to a feed shaft 122. The worm is carried by a shaft 123 capable of being moved manually to raise the worm into engagement with the worm wheel to start the rotation of the shaft 122. The feed shaft has a right hand feed screw 124 for operating the carriage 24 and a left hand feed screw 125 for operating the carriage 25. A nut 126 carried by the carriage 24 cooperates with the feed screw 124 while a nut 127 affixed to the carriage 25 cooperates with the feed screw 125. When the shaft 122 is driven by the worm 120 it feeds the carriages toward each other, but the feed screw 124 is steeper than the feed screw 125, the difference in steepness being sufficient to grade down 6½ sizes when the nut 126 is held against rotation. Nevertheless, the nut 126 may be turned with respect to the carriage 24 at a controlled and variable rate to counteract a component of the feeding effect of the screw 124.

A spur gear 128 surrounding the nut 126 and formed thereon is engaged by rack teeth formed on a bar 129. This bar is arranged to slide endwise in a bearing in the carriage 24. Its rear end is provided with a shoe 130 that has tongue and groove connection with a track 131 affixed to a support 132. The latter is connected to the frame 18 by a stationary pivot pin 133 about which it may be adjusted to place the track 131 in parallelism with the carriage tracks 26 and 27 or at various angles of inclination with respect to the latter. A link 215 couples the support 132 and a gear segment 134 with which a manually operable adjusting worm 135 cooperates. The worm 135 is carried by a shaft 136 to which rotation may be transmitted from a hand crank 137 (Figs. 1 and 2) by a train of connections including a shaft 138, a pair of gears (not shown) a shaft 139 and another pair of gears (not shown).

The rack bar 129 and the shoe 130 have a pivotal connection 140 which enables the shoe to partake of the angular adjustments of the track 131. When the latter parallels the carriage tracks the lathe will grade down 6½ sizes, but when the track 131 is inclined at its maximum angle the lathe will have a 1:1 ratio.

Referring to Fig. 10, rotation is transmitted to the worm shaft 123 by a driving train comprising a pair of spiral gears 141 and 142, a shaft 143 (refer now to Fig. 6), a worm wheel 144, worm 145, shaft 146, driven clutch member 147, driving clutch member 148, spiral gears 149, shaft 150, gears 151 and 152, pulley 153, and belt 154. The belt is driven by a pulley (not shown) on the shaft of a motor 155 (Fig. 1).

Again referring to Fig. 10, the worm shaft 123 is journaled in a bearing member 156 suspended from the shaft 143 and arranged to rock thereon for the purpose of shifting the worm 120 into and out of engagement with the worm wheel 121. A tension spring 157 is arranged to effect disengagement, but the member 156 is provided with a spring pressed latch 158 the rear end of which is arranged to be lodged on the upper surface of a block 159 to maintain the worm 120 in its driving position. The member 156 is provided with a handle 160 by which to raise the worm and place the latch above the block 159.

The controlling mechanism last described is supplemented by an automatic knock off (Figs. 1 and 7) designed to release the latch 158 from the block 159 when the cutter carriage 25 reaches the terminus of its traverse. For this purpose a bracket 161 affixed to the cutter carriage is provided with a striker 162 arranged to displace the block 159 against the stress of springs 163 that normally keep the block in its operative position. The block is arranged to slide in a horizontal groove in a stationary supporting bracket 164.

A hand wheel 172 (Figs. 1 and 2) is provided to move the carriages 24 and 25 away from each other when the screw shaft 122 is disconnected from its automatic driving means. For this purpose the right hand end of the screw shaft is provided with a bevel gear 173 in constant mesh with a pinion 174 carried by a shaft 175 to which the hand wheel is affixed.

Referring again to Figs. 1 and 6, the shaft 146 also transmits rotation to the model 10 and the work block 11. The train of connections for this purpose comprises a pair of bevel gears 165 and 166, spur gears 167 and 168, shaft 169, and spur gears 170, 171 and 17. The three gears last specified are enclosed in the gear case 16.

Fig. 6 includes starting and stopping mechanism capable of being operated manually to start the shaft 146 and of being operated both manually and automatically to stop the shaft. This mechanism is to all intents and purposes the same as the corresponding mechanism shown and described in the aforesaid Letters Patent No. 2,072,228, although the handles for controlling it are arranged differently.

The driving clutch member 148 is loose with respect to the shaft 146 and is movable to and from engagement with the driven clutch member 147. A bell crank 176 for shifting the member 148 is arranged to rock on a fulcrum pin 177 and is provided with a pin 178 by which it may be operated. This pin extends through a slot in a rocker 179 and is additionally connected to the rocker by a tension spring 180 that causes the rocker to shift the member 148 into and out of engagement. The rocker is carried by a lever 181 loosely mounted on a bearing portion formed on the left-hand end of the shaft 122. A link 182 connects the rocker and an arm 183 affixed to a controlling shaft 184. This shaft extends to the right-hand end of the lathe (Fig. 2) where it is provided with a bell crank 185 (Fig. 9). A spring 186 normally rocks the shaft 184 in a counterclockwise direction but manual controls also connected to the bell crank 185 provide for rocking the shaft clockwise. A link 187 and a lever 188 (Fig. 2) connect the bell crank and the rear end of a manually engageable bar 189. The lever 188 is mounted on a fulcrum stud 190.

When the bar 189 is pulled forward a hook 191 on one edge thereof may be caught and held by a latching stud 192. The operator will make this engagement when he wants automatic stoppage of the work spindle 14 at a predetermined position in its cycle of revolution. This will place the arm 183 in the position shown in Fig. 6, the clutch then being engaged to drive the shaft 145. A worm 193 on this shaft drives a worm wheel 194 by which a cam 195 is carried, and when the high part of the cam rocks the lever 181 the latter swings the rocker 179 downward far enough to put the spring 180 in a position to retract the clutch member 148. To restart the shaft 146 while the high part of the cam 195 is against the lever 181 as shown in Fig. 6, the operator has only to disengage the bar 189 (Fig. 2) from the stud 192 and let go. Then the spring 186 will depress the arm 183 (Fig. 6) and thereby rock the rocker 179 clockwise. This will shift the member 148 to the member 147.

To retract the model wheel and the cutter from the turning axis the operator will pull forward a hand lever 196 (Fig. 2) supported by a longitudinally movable bar 197 and connected thereto by a pivot stud 198. The left-hand end of the lever is arranged to bear against a fixed fulcrum pin 199. As the bar 197 is pulled forward a lug 204 carried thereby will engage an arm 203 formed on the bell crank 77, and thereby move the entire width-grading linkage. If the bar is pulled far enough a hook 207 formed thereon may be caught on a detent 206, and if the other bar 189 has not already been set in its stopping position it will be pulled to that position by the bar 197. For this purpose the bar 197 carries a lug 208 arranged to engage a lug 205 carried by the bar 189.

The cutter shaft 40 (Fig. 1) is provided with a grooved pulley 210 for a transmission belt 211. An electric motor 212 is supported above the swing frame 23 by the superstructure of the frame 18, and its armature shaft is provided with a cylindrical drum 213 by which the belt is driven. The drum has sufficient length to maintain the driving connection despite the sidewise shifting of the belt due to the travel of the cutter carriage 25.

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

1. In a copying lathe, a work holder and a model holder constrained to rotation about a turning axis, two feed carriages constrained to paths parallel with said axis, means for moving said carriages oppositely with respect to each other but with related amplitudes of traverse, swing frames carried by said carriages respectively and constrained to swing about parallel axes transverse to said turning axis, a cutter and a model wheel carried respectively by said swing frames, and means connecting said swing frames

to synchronize their girthwise motions as their carriages move oppositely in traverse.

2. In a copying lathe, two feed carriages constrained to straight parallel paths, mechanism for moving them with a graded ratio of traverse, pivotal linkages carried by said carriages respectively, each of said linkages including a swing frame and links having two pivotal connections therewith and two pivotal connections with its carriage, a model wheel and a cutter carried by said swing frames respectively, mechanism by which one pivotal connection of each of said two is coupled with the corresponding one of the other two for dual adjustment to alter the lines of movement of the model wheel and the cutter, and means operable by movement of one of said carriages for imparting adjusting movement to said coupling mechanism.

3. In a copying lathe, feed mechanism including a pair of feed carriages constrained to parallel paths, a pair of links carried by each of said carriages and constrained to swing about parallel axes transverse to said paths, a pair of swing frames each of which is carried by a pair of said links, adjustable means carried by each of said carriages to shift one of said axes with respect to the other, a model wheel carried by one of said swing frames and a cutter carried by the other, and mechanism by which said adjustable means are adjusted simultaneously to alter the direction of the lines of movement of the model wheel and the cutter.

4. In a copying lathe, feed mechanism including a pair of feed carriages constrained to parallel paths, a pair of links carried by each of said carriages and constrained to swing about parallel axes transverse to said paths, a pair of swing frame each swing frame carried by a pair of said links, a model wheel carried by one of said swing frames and a cutter carried by the other, and width grading mechanism including two pairs of bell cranks movable about fixed parallel axes, two track bars, one for each of said pairs of bell cranks and connecting them in pairs, two parallel links, one for each of said pairs of bell cranks and connecting them in pairs to maintain the track bars parallel with the paths of said carriages, an adjustable grading link connecting said pairs of bell cranks, means connecting one of said track bars and the cutter swing frame to impart girthwise movements to the latter, and means connecting the model wheel swing frame and the other one of said track bars to render both track bars and both pairs of said bell cranks responsive only to girthwise movements of the model wheel swing frame.

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