(No Model.) 4 Sheets—Sheet 1.

C. C. TYLER.

INVOLUTE CURVE SHAPING MACHINE.

No. 551,065. Patented Dec. 10, 1895.

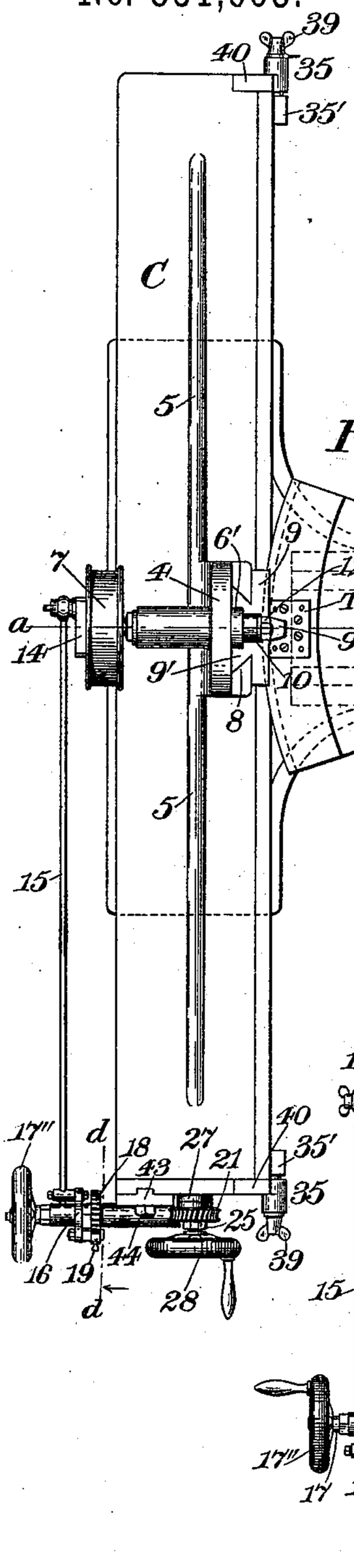

Fig. 1.

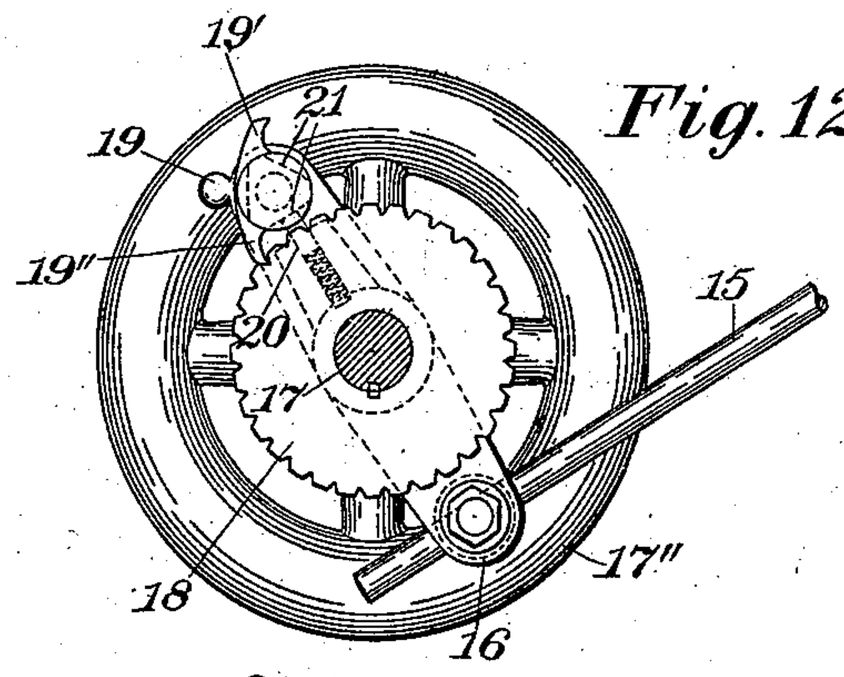

Fig. 12.

Fig. 6.

Fig. 4.

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Inventor:
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By his Attorney,
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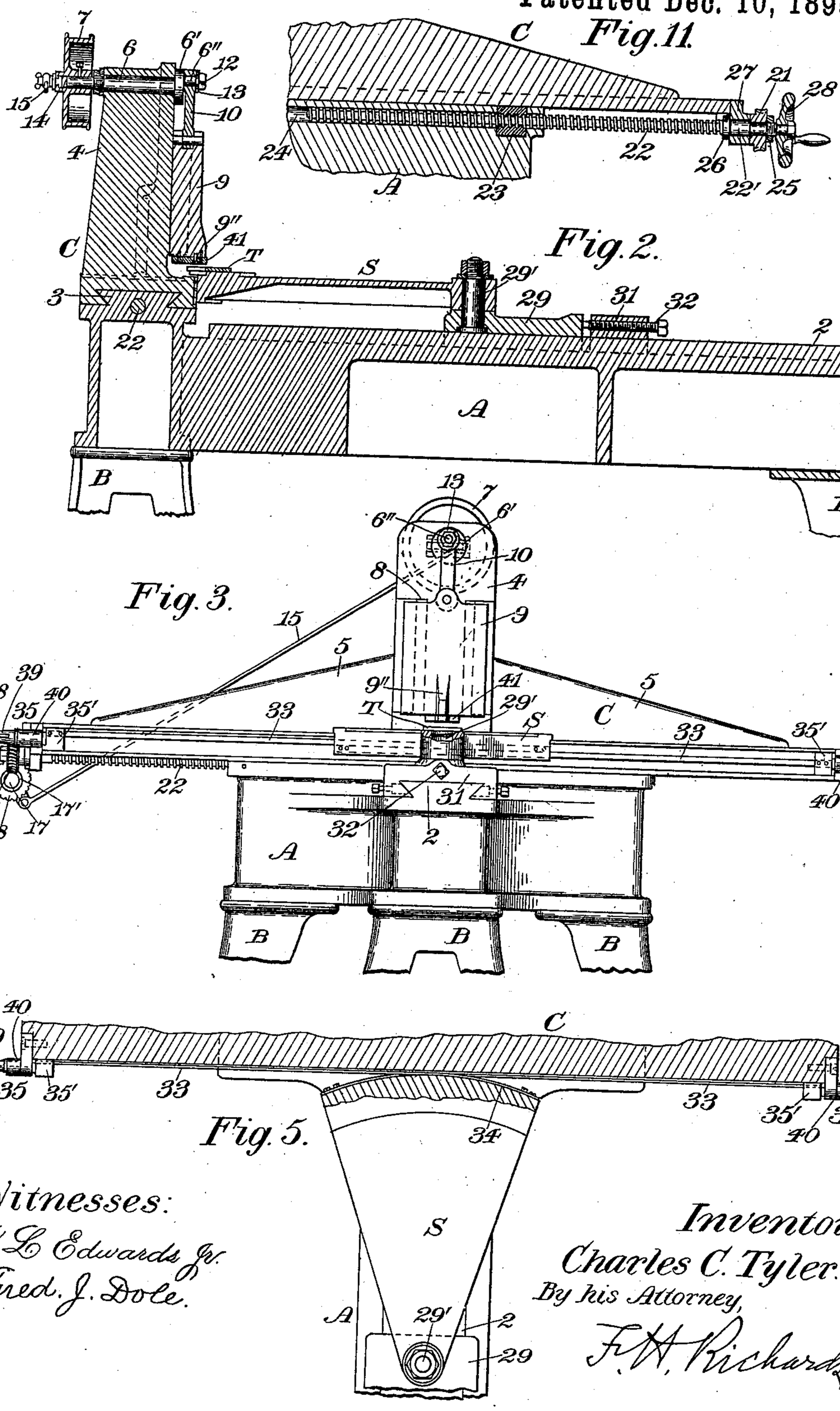
(No Model.)

4 Sheets—Sheet 2.

C. C. TYLER.

INVOLUTE CURVE SHAPING MACHINE.

No. 551,065. Patented Dec. 10, 1895.



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(No Model.) 4 Sheets—Sheet 3.

C. C. TYLER.

INVOLUTE CURVE SHAPING MACHINE.

No. 551,065. Patented Dec. 10, 1895.

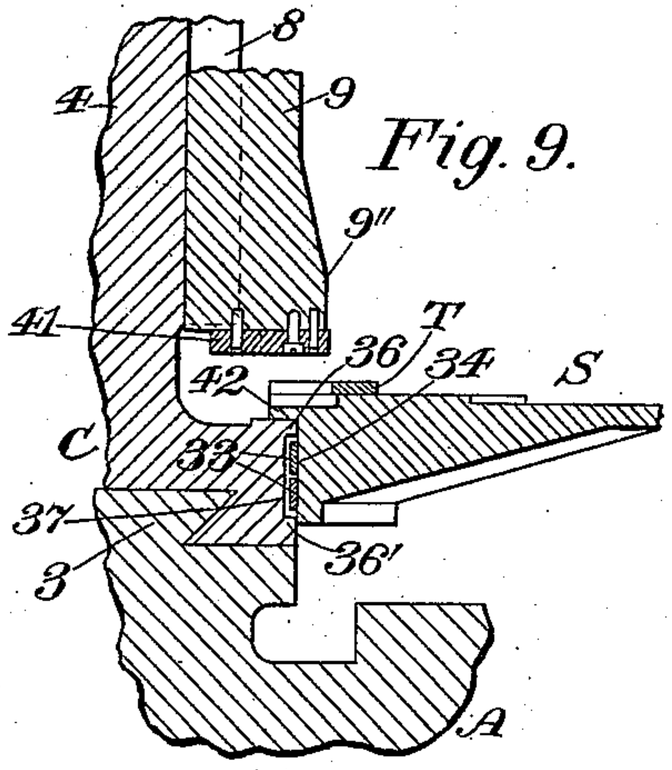


Fig. 9.

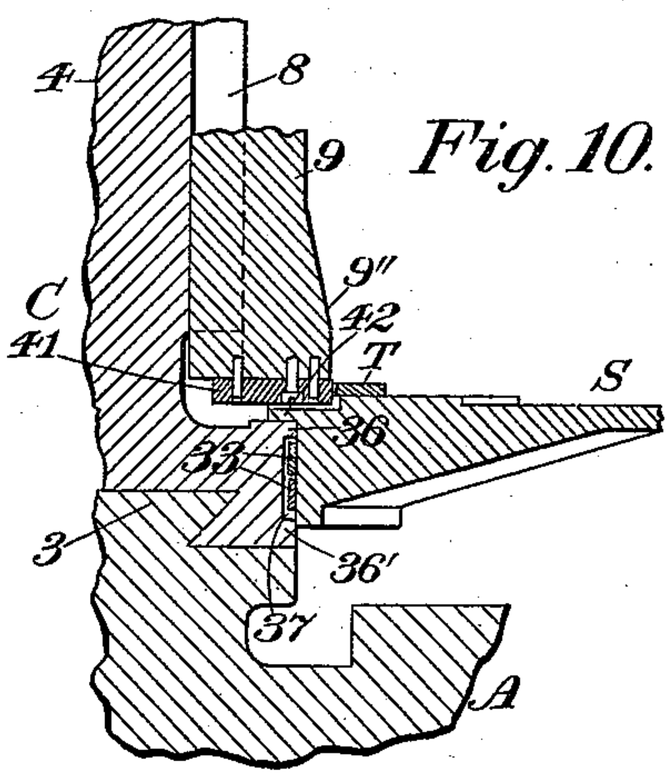


Fig. 10.

Fig. 13.

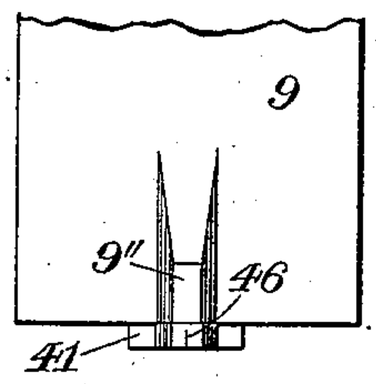


Fig. 14.

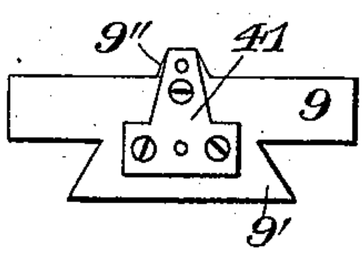


Fig. 15.

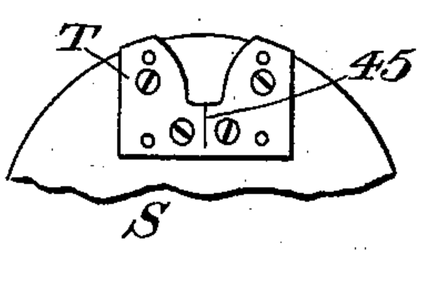


Fig. 7.

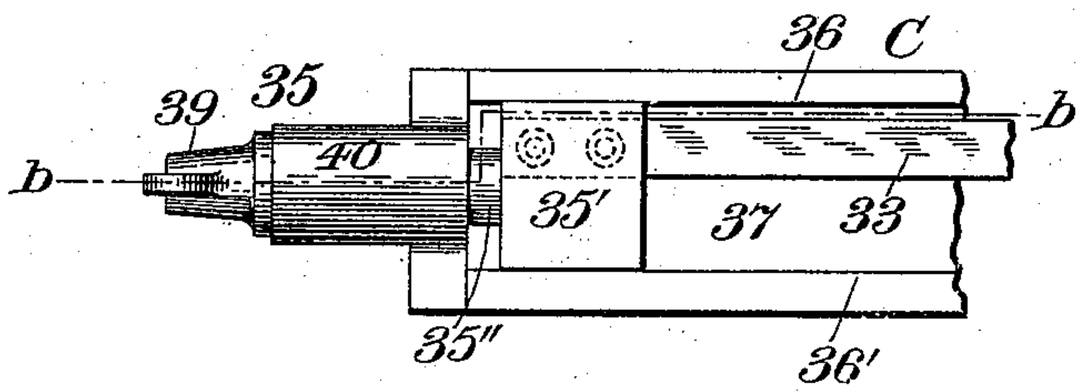
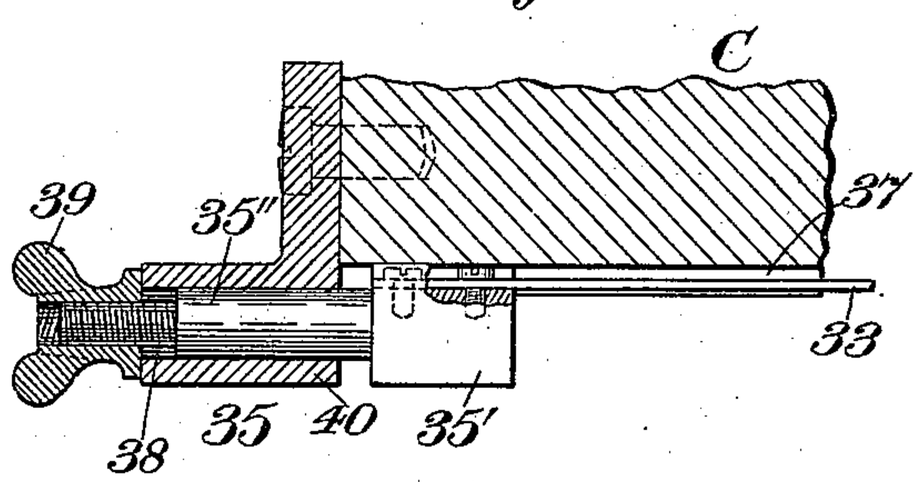


Fig. 8.



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(No Model.) 4 Sheets—Sheet 4.

C. C. TYLER.

INVOLUTE CURVE SHAPING MACHINE.

No. 551,065. Patented Dec. 10, 1895.

Fig. 18.

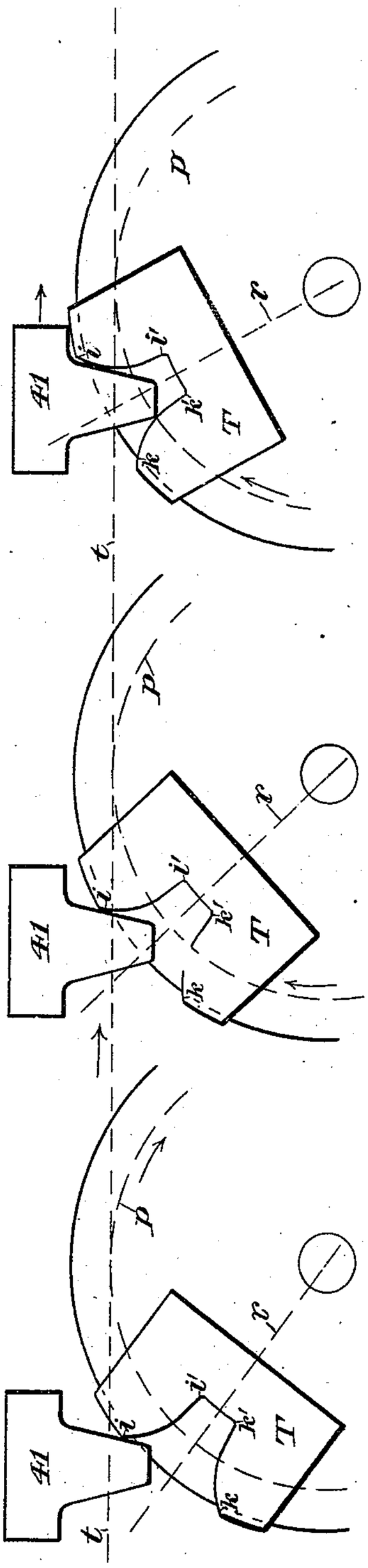

Fig. 17.

Fig. 16.

Fig. 21.

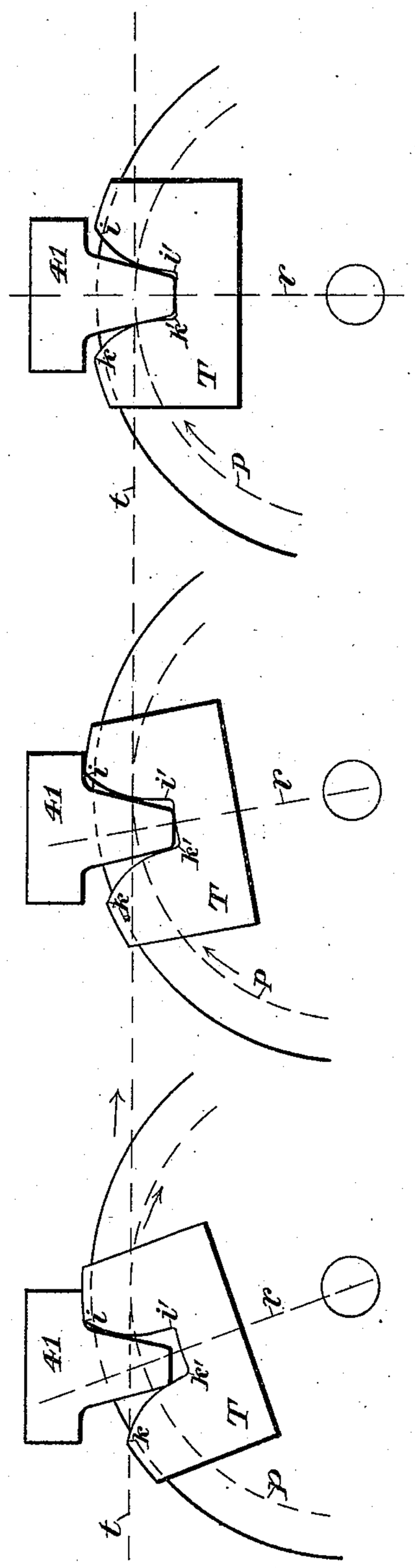

Fig. 20.

Fig. 19.

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UNITED STATES PATENT OFFICE.

CHARLES C. TYLER, OF HARTFORD, CONNECTICUT.

INVOLUTE-CURVE-SHAPING MACHINE.

SPECIFICATION forming part of Letters Patent No. 551,065, dated December 10, 1895.

Application filed February 15, 1895. Serial No. 538,571. (No model.)

To all whom it may concern:

Be it known that I, CHARLES C. TYLER, a citizen of the United States, residing at Hartford, in the county of Hartford and State of Connecticut, have invented certain new and useful Improvements in Involute-Curve-Shaping Machines, of which the following is a specification.

This invention relates to a method of and means for cutting involute curves, and has special reference to a process of and apparatus for shaping the pitch-faces of gear-teeth, the object of the invention being to shape such pitch-faces as theoretically-perfect involute curves by obtaining and maintaining between the article or blank to be shaped and the tool which co-operates therewith an exact relationship and a unison of progressive movements in rectilinear and circular direction, respectively, which progressive movements shall be independent of the cutting operation of the tool, and by also reciprocating one of these co-operating members back and forth through the plane of movement of the other member during its own progressive movement and at a relatively rapid speed as compared with the speed of such progressive movement and without affecting the progressive movement of the reciprocating member by such reciprocation.

In the drawings accompanying and forming part of this specification, Figure 1 is a plan view of a machine embodying means for carrying out my process of cutting involute curves. Fig. 2 is a vertical longitudinal section taken in line *a a*, Fig. 1, and showing the standards or legs thereof removed. Fig. 3 is a front elevation of the same, a portion of the parts being broken away to show the construction. Fig. 4 is a side elevation showing the parts at the left in Fig. 1. Fig. 5 is a horizontal longitudinal sectional plan view of a portion of the blank-carrier and tool-carrier and showing the bands and their adjusting connections for maintaining a constant relationship between the movements of said carriers. Fig. 6 is a detail edge elevation of the blank-carrier or sector and connected portions of the bands secured thereto. Fig. 7 is an enlarged detail front elevation of the adjusting device or regulating means for one of the sector-controlling bands. Fig. 8 is a vertical longitudinal sectional plan view in line *b b*, Fig. 7. Fig. 9 is an enlarged vertical longitudinal sectional detail also taken in line *a a*, Fig. 1, and showing the tool-slide and the cutter raised from the blank. Fig. 10 is a similar view showing the tool-slide and cutter at the limit of their downward movement, with the cutter operating upon the blank. Fig. 11 is a transverse sectional view taken in line *c c*, Fig. 4, and looking in the direction of the arrow. Fig. 12 is an enlarged transverse sectional front elevation taken in the line *d d*, Fig. 1, and looking in the direction of the arrow. Fig. 13 is a detail front elevation of the lower portion of the cutter-slide and of the cutter secured thereto. Fig. 14 is an under side view of the cutter and cutter-slide drawn in projection with Fig. 13. Fig. 15 is a detail plan view of the blank and a portion of the carrier to which said blank is secured; and Figs. 16 to 21, inclusive, are diagrammatic views illustrating successive positions of the cutter and the blank at successive points in the progressive movements thereof and illustrating successive stages in the operation of cutting an involute curve upon the blank in accordance with my invention.

Like characters designate like parts in all the figures.

My invention comprises in part a method of cutting involute curves upon blanks, which method consists in imparting progressive movements in unison, the one in a straight line or rectilinear direction and the other in a circular direction or arc of a circle, to a cutter and a blank, while these members are maintained constantly in operative relation with each other, and in simultaneously reciprocating one of said members back and forth through the plane of movement of the other member, and preferably with a relatively rapid movement as compared with the progressive movements of these members and without altering the position of the reciprocatory member as a whole in the direction of its progressive movement by such reciprocation.

My invention also comprises in part and in combination with a blank mounted for oscillation in an arc of a circle a tool or cutter mounted for rectilinear sliding movement in

operative relation with the blank, means for imparting progressive movements in unison to the blank and the tool and for maintaining said members in operative relation with each other during said operation, and actuating devices for reciprocating one of said members back and forth through the plane of movement of the other member during and irrespective of the progressive movement of such reciprocating member, all of which will be hereinafter more fully described.

The framework for supporting the several operative details of a machine constructed in accordance with my present invention and adapted for carrying into effect the method forming a part of such invention may be of any suitable construction, and is shown herein as comprising a substantially T-shaped bed or main frame A, supported upon the usual standards or legs B. The bed A is also shown as having two main guides, one of which, 2, extends longitudinally and centrally of the frame, substantially from end to end of the long arm of the bed, and the other of which, 3, extends transversely of the guide or way 2 and perpendicularly thereto. The guide or way 3 is shown herein as adapted to permit the sliding movement thereon of an auxiliary frame or traveling carrier, which is designated herein in a general way by C, and is also shown as supporting the several operative details for actuating and controlling the movements of the work-carrier and the tool-carrier and also the tool or cutter. This supplemental or auxiliary traveling frame is shown as provided with a central standard or upright 4, approximately in alignment with the guide or way 2 and having lateral strengthening ribs or braces 5 5, connecting this standard 4 with the body of the auxiliary frame. At its upper end the standard 4 is shown as formed with a journal substantially in alignment with the longitudinal axis of the machine and adapted for carrying the main driving-shaft thereof. The main driving-shaft, which is shown at 6 as working in this journal, is provided with the driving-wheel 7, which may be operated from any suitable source of power, (not shown,) this driving-wheel being disposed at the rear end of said shaft, while at the forward end of the same the shaft is provided with a wrist-plate 6′, which serves to limit the longitudinal movement of the shaft in rearward direction and also for carrying an eccentric pin or stud 6″ for controlling the movements of the cutter-slide. At its forward side the standard 4 is shown as also formed with a guideway 8, perpendicular to the plane of the bed of the machine and located immediately below the forward end of the shaft 6. This guideway is preferably in the form of a dovetailed channel, and in this way 8 the tool-slide for carrying the cutter is adapted to reciprocate. In the present instance the slide is shown at 9 as having a main substantially oblong body portion formed or provided upon its side with a dovetailed guide or rib 9′, corresponding in its outline with that of the channel or way 8 in the standard 4. This slide is also shown as having at its upper end a link 10, pivotally connected therewith at its lower end, and at its upper end the link is formed with a journal-opening for carrying the eccentric pin 6″ of the wrist-plate 6′. This pin is preferably screw-threaded at its extreme forward end for the reception of a nut 12, by means of which the link is held in position at its upper end, the usual washer 13 being interposed between the nut and the face of the link. At its lower forward side the tool-slide 9 is also preferably formed with a forwardly-projecting member or overhang 9″, having its side faces substantially corresponding in angular position with the cutting-faces of the die or tool which it is adapted to support.

As a means for actuating the auxiliary frame or tool-carrier C longitudinally upon the way 3 and transversely of the machine the driving-wheel shaft 6 is shown as carrying at its rear end a crank-arm 14, to which is connected in any usual or suitable manner a connecting-rod 15, which is also joined at its other end to a link 16, loosely mounted upon the rear member of a worm-shaft, which is shown at 17 as carried in a journal at the extreme left-hand side of the machine and in parallelism with the longitudinal axis thereof. This worm-shaft is also shown (see Fig. 12) as having fixedly secured thereto and adjacent to its rear end a ratchet-wheel 18, having peripheral teeth, with which a pawl carried by the lever 16 is adapted to engage, to thereby cause the rotation of the shaft. This pawl is shown at 19 as carried at the upper end of the lever 16 by a pivotal connection and as having a substantially triangular body portion, by means of which either one of the two arms 19′ and 19″ may be held in contact with the teeth of the wheel 18. The pawl is normally maintained in engagement with said teeth by means of a spring-pressed bolt, as shown at 20, which bolt engages either one of the co-operative sides 21 of the aforesaid triangular body, according to the position of the pawl. The teeth of the ratchet-wheel 18 are shown as having their pitch-faces sloping in opposite directions in the usual manner, so that said ratchet-wheel may be rotated in either direction, the teeth-engaging ends of the pawls 19′ and 19″ being shaped to properly engage the teeth irrespective of the direction of rotation of the wheel.

As a means for transmitting the movement of the worm-shaft 17 and actuating the traveling frame or carrier C along the way 3 the worm 17′ at the forward end of the shaft 17 is shown as meshing with the teeth of a worm-wheel 21, carried at the left-hand end of a screw-rod 22, working in the screw-threaded bore of a co-operating portion or member 23, carried by the transverse portion of the main frame. This main frame is also shown as having a channel or smooth bore 24 ex-

tending longitudinally of said transverse portion of the frame and in alignment with the bore of the member 23. The screw-rod 22 is shown as held against longitudinal movement at its extreme left-hand end and relatively to the tool-carrier C by means of the usual check-nut and collar 25 and 26, respectively, so that when the screw-rod is rotated within the journal of the bearing 27, in which the smooth portion 22′ of the rod 22 rotates, the carrier C will be moved longitudinally along the way 3 of the main frame in accordance with the direction of rotation of said screw-rod 22. A hand-wheel 28 is also shown as carried at the extreme left-hand end of the rod 22 for the usual purpose of manually rotating said rod. It will be evident that this rod 22 will be rotated in the one or the other direction and the carrier C reciprocated from the left to the right of the machine, or vice versa, according to the direction in which the ratchet-wheel 18 is actuated by the pawl. The speed of rotation of the worm-shaft 17 is also controllable, the length of the crank-arm 14 being preferably adjustable in the well-known manner relatively to the connecting-rod 15 and the driving-wheel 7.

The blank-carrier or work-carrier is shown herein as pivotally connected with the long arm of the main frame and as oscillatory about a pivotal point in the longitudinal axis of said portion of the frame. This work-carrier is also shown as preferably in the form of a sector S, mounted for oscillation upon a vertical stud 29′, rising from a traveler 29, secured upon and normally fixed with relation to the way 2 of the frame. This traveler is shown as having a dovetailed channel in its under side, fitting the dovetailed way of the frame and adapted to travel along this way 2 for the purpose of adjustment of the longitudinal position of the sector; but means, such as the bolts 30, are also provided for engaging the way 2 and holding said traveler in rigid engagement with this way. As a means for obtaining a fine adjustment of the sector in longitudinal direction a second traveler 31, corresponding to 29, is also shown as mounted upon the way 2 and having an adjusting-screw 32 passed longitudinally through such traveler or lock 31 and engaging the main traveler 29. This lock 31 is also normally held in rigid engagement with the way 2, so that when the bolts 30 of the traveler 29 are loosened said traveler 29 may have a fine adjustment longitudinally and toward the rear of the machine.

As a means for imparting a progressive oscillating movement to the blank-carrier, and which progressive movement shall be equal along a determined arc to the progressive longitudinal movement of the tool-carrier, the sector S is shown herein as connected with the carrier C in such a manner that the movement of the sector through its arc of oscillation will take place in unison with the longitudinal movement of the carrier C. This intermediate driving connection is shown herein as comprising a pair of bands, such as 33, which are preferably non-flexible in longitudinal direction, and these bands are secured at their inner ends to the corresponding relatively remote ends of the curved face or edge 34 of the sector. Any suitable fastening means may be employed for securing the ends of said bands to this curved face, and in order to prevent interference of these bands with each other they are disposed adjacent to and so as not to override each other. The opposite or outer ends of these bands are secured to the carrier C, and in order to exactly adjust the position of the sector relatively to the carrier take-up or adjusting devices, such as 35, are shown as supported by the carrier adjacent to the opposite ends thereof and secured to said ends of the bands 33. These adjusting devices each comprise, in the preferred construction, a sliding member or block 35′, guided between the walls 36 and 36′ of a guideway 37 at each end and preferably extending from end to end of the forward side of the carrier, and a sliding bolt 35″, screw-threaded at its forward end, is shown as working in a corresponding smooth bore 38 in the end of and running longitudinally of the carrier C. The guide block or member 35′ is preferably formed upon the inner end of the bolt 35″ and constitutes the follower thereof. The position of this follower is shown as regulated by means of an adjusting check-nut 39 upon the outer threaded end of the bolt 35″, said nut engaging by its inner face with and being stopped thereby against the end of the bracket 40, in which the bore 38 is formed. As each of these adjusting devices tends to oppose the outward movement of the other when the slack of the bands 33 is properly taken up, it will be evident that each of said adjusting devices will constitute a positive stop for the other and as a means for controlling in one direction the movement of the sector.

The cutter is shown at 41 as rigidly secured to the under side of the projecting shoulder or overhang 9″, formed upon the lower end of the tool-slide 9. This cutter may be secured to the slide in any desired manner, but so as to have a practically rigid engagement therewith, a series of screws and dowel-pins being shown herein as the connecting means.

The blank to be acted upon by the cutter, and which is designated in a general way by T, is shown as also fixedly secured to the sector S by a fastening substantially similar to that by which the cutter is connected with its slide, and this blank, it will be understood, may be either in the form of a guide having a rough peripheral recess, to be shaped to form a guide or templet for forming the teeth of gear-wheels, or else said blank may be a roughly-formed gear-wheel itself, and the finished teeth may be produced thereon directly by the instrumentalities embodied in this invention. It will be understood, of course,

that the sector S is properly supported at its rear end adjacent to the cutter, and for this purpose said sector is shown as having a projecting or overhanging ledge 42, overlapping and supported upon the corresponding forwardly-projecting ledge or wall 36, formed upon the forward side of the carrier C.

In order to permit the rotation of the screw-rod 22 independently of the worm-shaft 17, this worm-shaft is shown herein as journaled in a bearing which is in the form of a vertically-movable hanger 43 at the left-hand end of the machine, this hanger being shown in Fig. 4 as vertically slotted and held in place normally by means of a screw-bolt 44, passed through said slot and engaging the adjacent end of the carrier C. It will be evident that upon loosening this bolt 44 the hanger or bearing will drop sufficiently to release the worm 17′ from engagement with the teeth of the worm-wheel 21.

The operation of the machine hereinbefore described and embodying means for carrying into effect the method forming part of the subject-matter of the present invention is as follows: The blank T being properly secured in place upon the sector S, the bolt 44 is loosened, and when the worm 17′ is out of mesh with the teeth of the worm-wheel 21 the screw-rod 22 is rotated by means of the hand-wheel 28 until the axis of the sector is approximately in line with the center of the tool or cutter 41, and the cutter is then brought down until the sides thereof are adjacent to the side walls of the recess in the blank, when the hanger 43 is raised and secured by means of the locking-bolt 44 with the worm in mesh with the worm-wheel. The sector is then adjusted transversely of the machine, through the bands 33, by means of the regulating-nuts 39 until the center line or indicator-line 45 of the blank comes opposite the corresponding indicator-line 46 of the cutter. The adjusting-nuts 39 are then turned until the two bands 33 are stretched taut, so that transverse movement of the sector relatively to the carrier C will be prevented. The length of the crank-arm 14 having been properly adjusted to obtain the desired ratio of power transmission between the main shaft 6 and the worm-shaft the pawl 19 is held up out of engagement with the teeth of the ratchet-wheel 18 and the carrier C is actuated a sufficient distance in either direction, as desired, by means of the hand-wheel 28 or the hand-wheel 17″ to bring the sector and the carrier C into position for the cutter to operate upon the blank at the extreme outer end of the face to be shaped. It will be apparent that although the sector is held against movement relatively to this carrier yet the sector has a rolling movement upon its curved face and in contact with the forward face of the carrier C, so that as said carrier and sector move in unison in the one direction or the other one of the bands 33 will be unwrapped from the curved face of the sector and the other of said bands will be wrapped thereon. It will also be apparent that as the movements of the bands 33 throughout the greater portions of their lengths coincide with the direction of movement of the carrier C and that as the directions of such movements do not change until the bands have each passed their common point of tangency to the face of the sector every point in said face will have a progressive movement equal to that of any point in the contiguous faces of the bands, and therefore equal to that of every point in the carrier C, so that the rectilinear movement of any point in said carrier is equal in a given time to the curvilinear peripheral movement of any point in the face of the sector during the same period.

Referring now to Figs. 16 to 21, inclusive, which illustrate diagrammatically the movements of the cutter (which, of course, correspond in progressive direction with the movements of the carrier C) and the blank upon which the cutter operates, and which views also illustrate the co-operative movements of the cutter and the blank for the cutting of but a single curve, it will be observed that all of the points in but a single arc of movement will have equal movements as compared with points in the cutter or in the carrier C, to which the cutter is secured, and it will also be evident that the points which have such equal movements must lie in that arc which defines the pitch-circle or pitch-line of the gear-tooth the side or pitch-face of which is to be shaped. In Fig. 16 the cutter is shown as positioned in progressive direction, so that it is adjacent to the point where it begins to shape the adjacent roughly-formed pitch-face of the blank T, and it will be evident that as the cutter and the blank are carried in the directions indicated by the arrows and the cutter is reciprocated with a relatively rapid movement back and forth in its path of progressive movement and through the path of movement of the blank the tool will cut the blank upon an involute curve, owing to the gradual approach of successive points in the pitch-line of the gear-tooth to the rectilinear path of the bands 33, and to that end of the normal of the involute whose locus is the point of tangency of the respective bands 33 with the curved surface of the sector. The successive stages in the operation of cutting the involute curve $i\,i'$ are shown in these views, as is also the gradual approach of the successive points in the pitch-line p toward the tangent t.

Although it is evident that the tool for forming the pitch-face of a gear-tooth might be so shaped as to cut only those faces which are disposed in the same direction relatively to each other, it is preferable to employ a cutter, as shown herein, the two sides of which are disposed at the same angle to the forward side of such cutter, so that when the cutter reaches the position shown in Fig. 21 the continued progressive movements of the carrier

C and the sector will cause said blank to shape the involute *k k'*, which defines the oppositely-disposed faces of the gear-teeth. It will be evident that this continued operation of the carrier C and the sector will cause the formation of an involute symmetrical with the involute *i i'*, but disposed upon the opposite side of the intermediate radius *r*.

Having thus described my invention, I claim—

1. In a machine of the class specified, the combination with a blank and with a cutter, of means for progressively-actuating the blank and the cutter in unison and in the same direction, the one in a straight line, and the other in an arc of a circle, and for maintaining the same in operative relation with each other during said operation; and actuating-devices for reciprocating one of said members back and forth through the plane of the other, during and irrespective of the progressive movement of the reciprocatory members, substantially as described.

2. In a machine of the class specified, the combination with a blank-carrier and with a tool-carrier connected for movements in unison, and in the same direction; of means for progressively-actuating said carriers, the one in a straight line, and the other in an arc of a circle; a cutter carried by said tool-carrier and progressively-movable therewith, and actuating-devices for reciprocating said cutter back and forth through the plane of movement of the blank-carrier, and during and independently of the progressive movement of the tool-carrier, substantially as described.

3. In a machine of the class specified, the combination with a blank-carrier and with a tool-carrier connected for movements in unison, and in the same direction; of means for progressively-actuating said carriers in either direction, the one in a straight line, and the other in an arc of a circle; a cutter carried by said tool-carrier and progressively-movable therewith; and actuating-devices for reciprocating said cutter back and forth through the plane of movement of the blank-carrier during and independently of the progressive movement of the tool-carrier, substantially as described.

4. In a machine of the class specified, the combination with a tool-carrier and with a blank-carrier connected for movements in unison and in the same direction, of a guideway carried by the tool-carrier and disposed perpendicularly to the plane of said progressive movement of said carrier; a tool-slide mounted in said guideway, and adapted for reciprocation therein; a cutter carried by, and movable with, said tool-slide; means for progressively-actuating the carriers, the one in a straight line, and the other in an arc of a circle; and actuating-devices for simultaneously reciprocating the tool-slide and the cutter back and forth through the plane of movement of the blank-carrier, substantially as described.

5. In a machine of the class specified, the combination with a reciprocatory tool-carrier and with an oscillatory sector connected for movements in unison, and in the same plane; of means for progressively-actuating said members in either direction simultaneously, the one in a straight line, and the other in an arc of a circle; a cutter mounted upon said tool-carrier, and movable back and forth through the plane of movement of the sector; and actuating-devices for reciprocating said cutter back and forth through the plane of movement of the sector and with a relatively-rapid movement, as compared with the progressive movement of the sector.

6. In a machine of the class specified, the combination with a reciprocatory tool-carrier and with a sector mounted for oscillation in the plane of movement of said carrier; of power-transmitting bands connected respectively at their outer ends to opposite ends of the tool-carrier, and at their inner ends to the respective relatively-remote ends of the curved face of the sector; and actuating-devices for reciprocating the tool-carrier, and thereby oscillating the sector with a speed of peripheral movement, equal to the rectilinear movement of the tool-carrier, substantially as described.

7. In a machine of the class specified, the combination with a reciprocatory tool-carrier and with a sector mounted for oscillation in the plane of movement of said tool-carrier; of power-transmitting bands connected respectively at their outer ends to the tool-carrier and at their inner ends, to the respective relatively-remote ends of the curved face of the sector; adjusting-devices carried by the tool-carrier, and adapted for adjusting and holding said bands; and actuating-devices for reciprocating the tool-carrier, and thereby oscillating the sector with a speed of peripheral movement, equal to the rectilinear movement of the tool-carrier, substantially as described.

8. In a machine of the class specified, the combination with the main frame; of a tool-carrier mounted for reciprocation thereon; a sector mounted for oscillation upon said frame, and adjustable toward and from the tool-carrier, transversely of the direction of movement of said carrier; means for progressively-actuating the tool-carrier and the sector in unison, and in the same direction, the one in a straight line, and the other in an arc of a circle; a cutter carried by, and movable with, the tool-carrier; and actuating-devices for reciprocating said cutter back and forth through the plane of the sector during and irrespective of the progressive movement of the tool-carrier, substantially as described.

9. In a machine of the class specified, the combination with a reciprocatory tool-carrier, of an oscillatory sector having its free end or curved face supported upon said tool-carrier; means for progressively-actuating the tool-carrier and the sector in unison and in the

same direction, the one in a straight line, and the other in an arc of a circle; a cutter carried by and movable with the tool-carrier; and actuating-devices for reciprocating said cutter back and forth through the plane of movement of the sector and irrespective of the progressive movement of the tool-carrier, substantially as described.

10. In a machine of the class specified, the combination with a frame provided with a guideway; of a reciprocatory tool-carrier mounted on said frame; a traveler mounted to slide on said guideway; a blank-carrier pivoted on said traveler, and adapted to oscillate in the plane of movement of said tool-carrier; means for holding said traveler in adjusted position; an independently-movable traveler also mounted on said frame, and adapted to slide on said guideway, said independent traveler being provided with an adjusting device adapted to engage the front face of said blank-carrier traveler, to adjust said blank-carrier, relatively to said tool-carrier; means for holding said independent traveler in adjusted position; and mechanism for oscillating said blank-carrier, substantially as described.

11. In a machine of the class specified, the combination with a traveling carrier provided with a guideway on its front face; of a reciprocatory tool-carrier mounted on said frame; a sector mounted to oscillate in the plane of movement of said tool-carrier; an adjusting device carried by said traveling-carrier and adapted to adjust said sector, relative to said tool-carrier, consisting of a screw-threaded sliding-bolt mounted on said traveling carrier; a follower secured to the inner end of said bolt, and adapted to slide in the guideway of the traveling carrier; a device for actuating said bolt; power-transmitting bands connected, respectively, at their outer ends to said follower, and at their inner ends to the respectively, relatively-remote ends of the curved face of the sector; and mechanism for longitudinally reciprocating said traveling carrier, substantially as described.

12. In a machine of the class specified, the combination with a frame provided with a dovetailed-guideway; of a reciprocatory tool-carrier mounted on said frame; a traveler provided with a dovetailed-channel on its under side adapted to slide on said dovetailed-guideway; a blank-carrier pivoted on said traveler, and adapted to oscillate in the plane of movement of said tool-carrier; means for holding said traveler in adjusted position; an independently-movable traveler also provided with a dovetailed-channel, mounted upon said dovetailed-guideway and adapted to slide thereon, said independent traveler being provided with an adjusting device adapted to engage the front face of said blank-carrier traveler to adjust said blank-carrier, relative to said tool-carrier; and means for holding said independent traveler in adjusted position; and mechanism for oscillating said blank-carrier, substantially as described.

13. In a machine of the class specified, the combination with a frame; of a traveling carrier mounted to slide thereon; an oscillating blank-carrier; a reciprocatory tool-carrier mounted on said traveling carrier, and adapted to reciprocate in the plane of movement of said blank-carrier; mechanism for operating said tool-carrier; a worm-shaft mounted on, and extending transversely of the traveling carrier; a ratchet-wheel mounted on said worm-shaft; a link also mounted on said shaft, and carrying a pawl adapted to engage said ratchet-wheel; means connecting said link and tool carrier mechanism for operating said worm-shaft; and mechanism connecting said worm-shaft and traveling carrier for longitudinally reciprocating said carrier, substantially as described.

14. In a machine of the class specified, the combination with a frame, of a traveling carrier mounted to slide thereon; an oscillating blank-carrier; a reciprocatory tool-carrier mounted on said traveling carrier, and adapted to reciprocate in the plane of movement of said blank-carrier; mechanism for operating said tool-carrier; a worm-shaft mounted on, and extending transversely of the traveling carrier; a ratchet-wheel mounted on said worm-shaft; a link also mounted on said shaft, and carrying a pawl adapted to engage said ratchet-wheel; means connecting said link and tool-carrier mechanism; a worm-shaft mounted on, and extending longitudinally of said traveling carrier; a worm-wheel on said longitudinally-extending worm-shaft adapted to mesh with said transversely-extending worm-shaft, and adapted to be operated by said shaft, and longitudinally reciprocate said traveling carrier, substantially as described.

15. In a machine of the class specified, the combination with a frame; of a traveling carrier mounted to slide thereon; an oscillating blank-carrier; a reciprocatory tool-carrier mounted on said traveling carrier, and adapted to reciprocate in the plane of movement of said blank-carrier; mechanism for operating said tool-carrier; a worm-shaft mounted on, and extending transversely of the traveling carrier; a ratchet-wheel mounted on said worm-shaft; a link also mounted on said shaft, and carrying a pawl adapted to engage said ratchet-wheel; means connecting said link and tool carrier mechanism for rotating said worm-shaft; mechanism connecting said worm-shaft and traveling carrier for longitudinally reciprocating said carrier; mechanism for raising and lowering said transverse worm-shaft to engage, and disengage said shaft from the mechanism connecting said worm-shaft and traveling carrier; and a device for actuating said traveling carrier, independent of said transverse worm-shaft, substantially as described.

16. In a machine of the class specified, the combination with a frame; of an oscillating blank-carrier; a traveling carrier mounted to longitudinally reciprocate on said frame; a reciprocatory tool-carrier mounted on said traveling carrier, and adapted to reciprocate in the plane of said blank-carrier; mechanism for operating said tool-carrier; a crank-arm connected to said tool-carrier operating mechanism; a worm-shaft adjustably and transversely mounted on said traveling carrier; a ratchet-wheel on said worm-shaft; a link also on said worm-shaft; an actuating device connecting said link and ratchet-wheel; a rod connecting said link and crank-arm; and mechanism connecting said worm-shaft with said traveling carrier, to longitudinally reciprocate said carrier, substantially as described.

17. In a machine of the class specified, the combination with a frame; a traveling carrier adapted to reciprocate longitudinally thereon; a reciprocatory tool-carrier mounted on said traveling carrier; an adjustable traveler mounted on said frame; means for holding said traveler in its adjusted position; a sector pivoted on said traveler, and adapted to oscillate in the plane of movement of said tool-carrier; an independently-movable traveler also mounted on said frame; an adjusting device mounted on said independently-movable traveler, and adapted to engage the front face of the sector traveler, to adjust said sector, relative to said tool-carrier; means for holding said independent traveler in adjusted position; and mechanism for oscillating said sector, substantially as described.

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