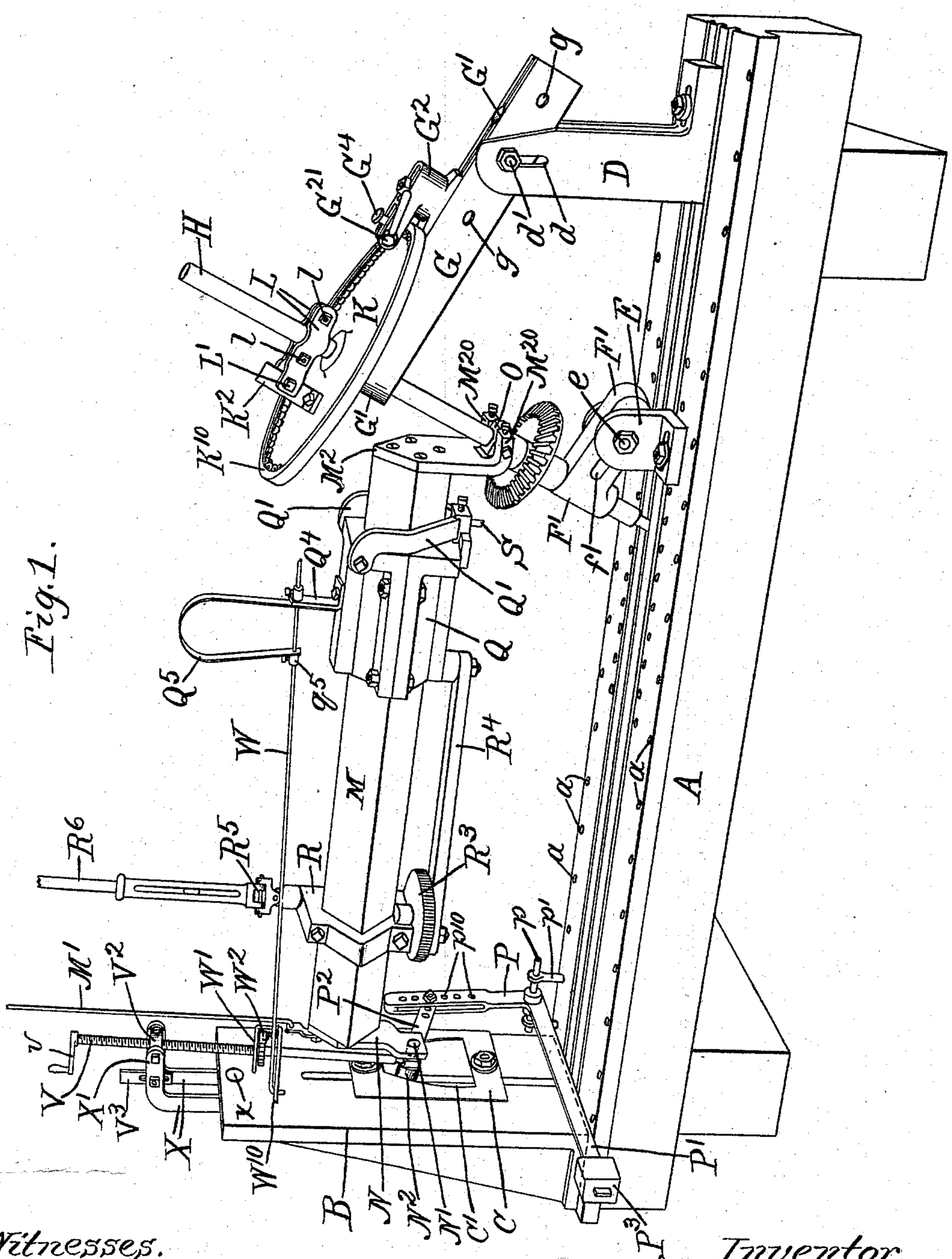
(No Model.) 3 Sheets—Sheet 1.

T. O. PERRY.

GEAR CUTTING MACHINE.

No. 528,025. Patented Oct. 23, 1894.

Fig. 1.



Witnesses.
E. T. Wray.
Jean Elliott

Inventor.
Thos. O. Perry
by Burton & Burton
his attys.

(No Model.) 3 Sheets—Sheet 2.

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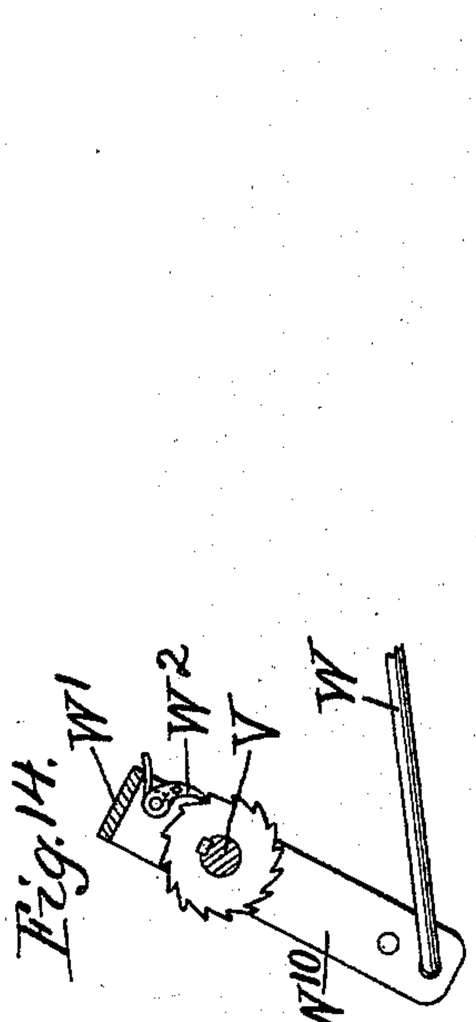
Fig. 14.

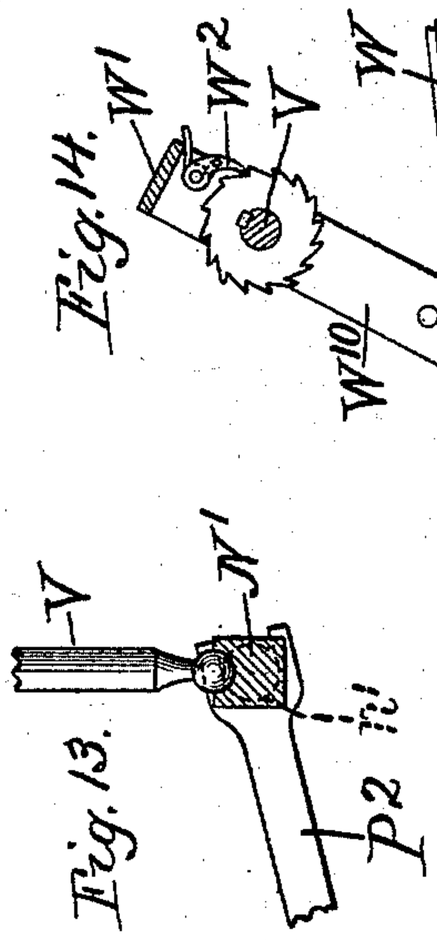
Fig. 13.

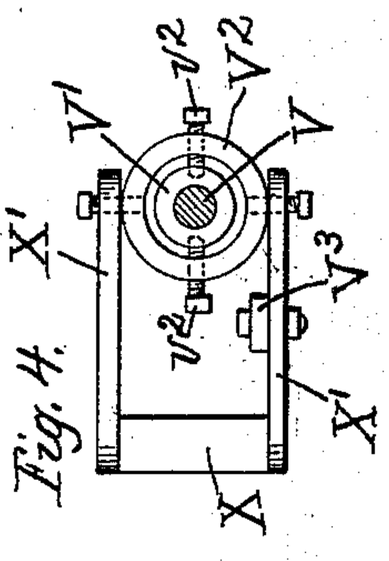
Fig. 4.

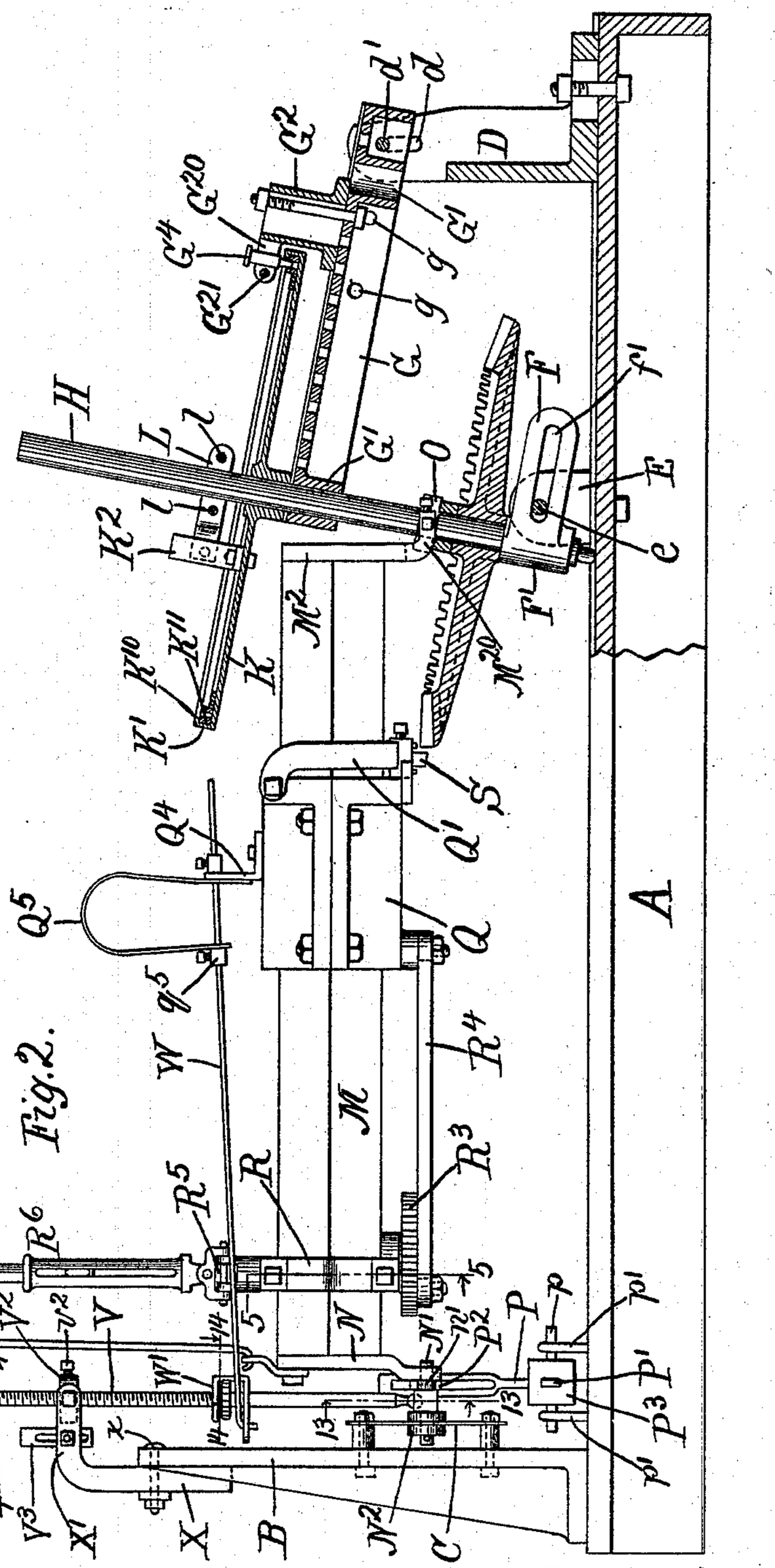
Fig. 2.

Witnesses.
E. T. Wray.
Jean Elliott

Inventor.
Thos. O. Perry
by Burton & Burton
his attys

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T. O. PERRY.

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Fig. 12.

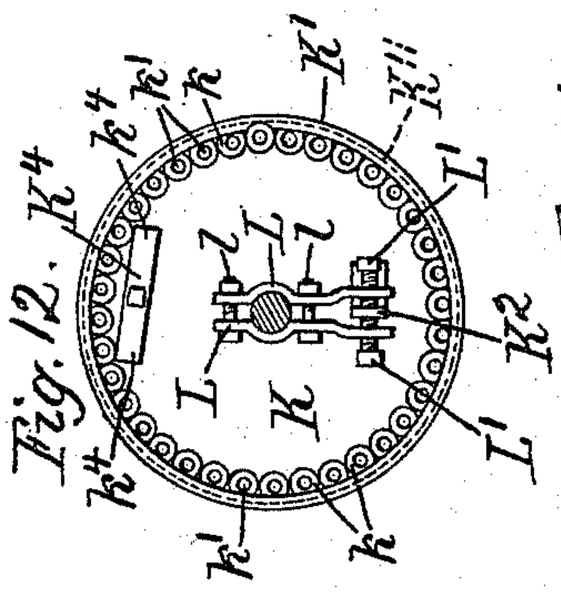


Fig. 3.

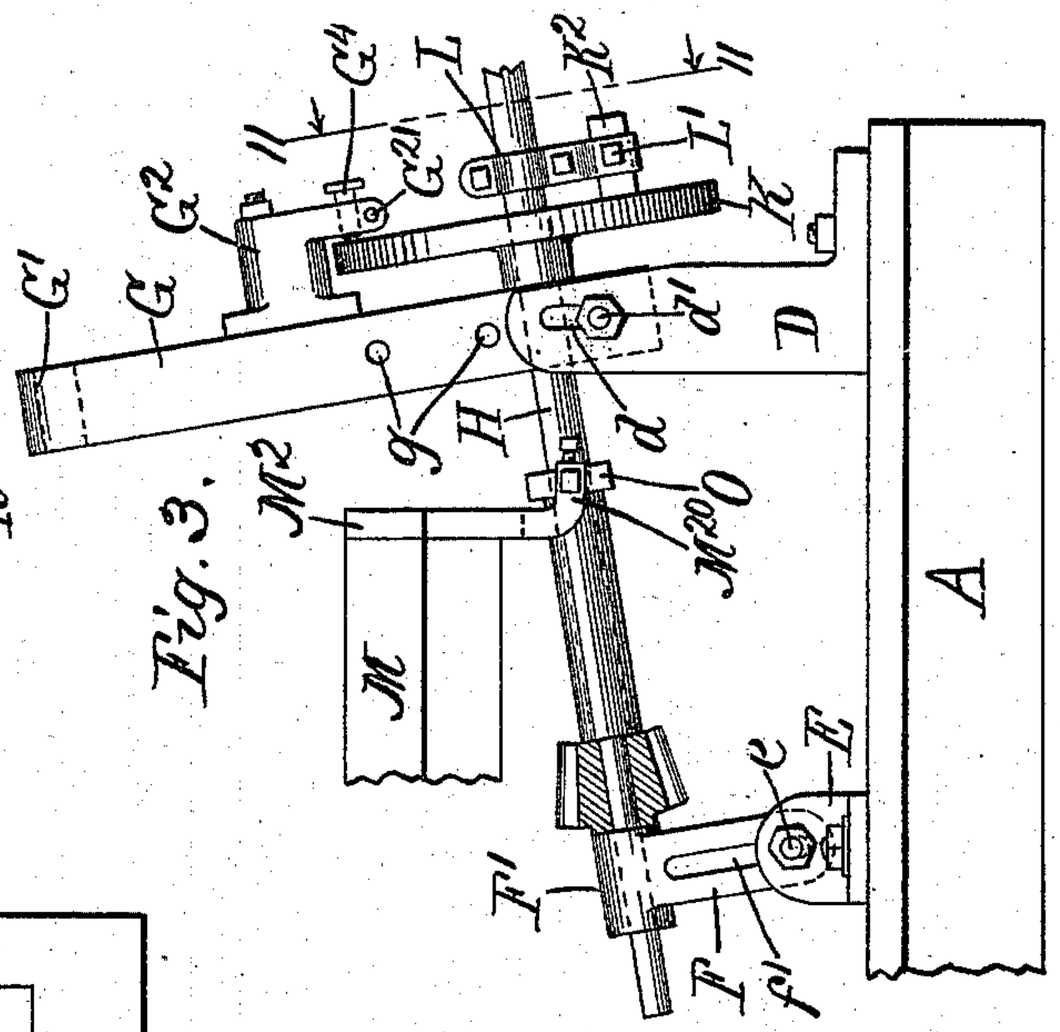


Fig. 11.

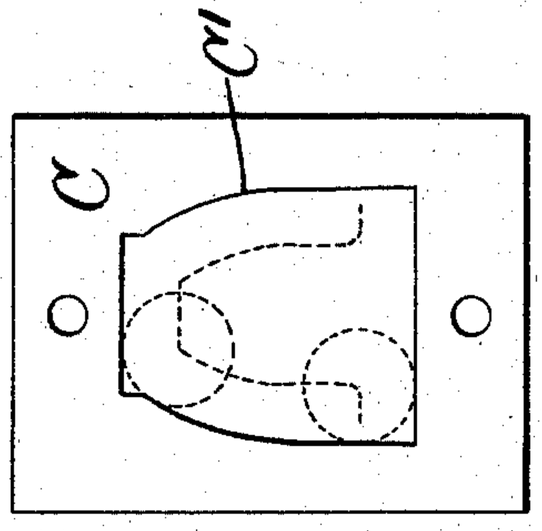


Fig. 8.

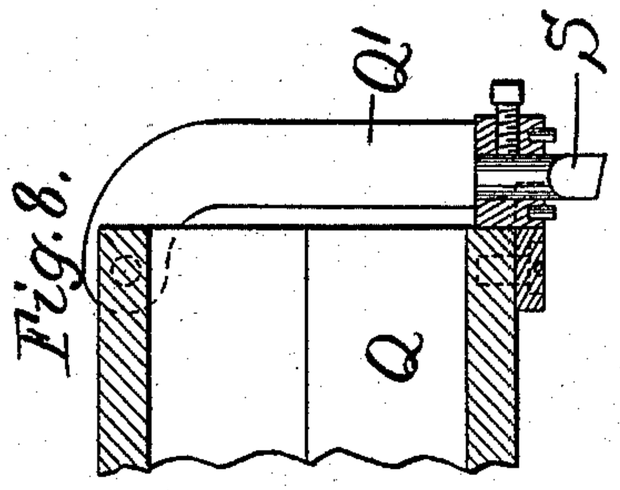


Fig. 5

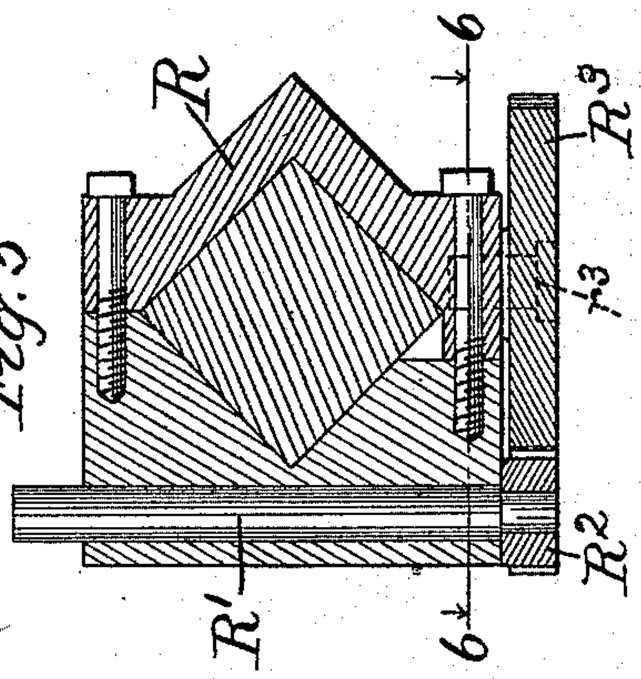


Fig. 6.

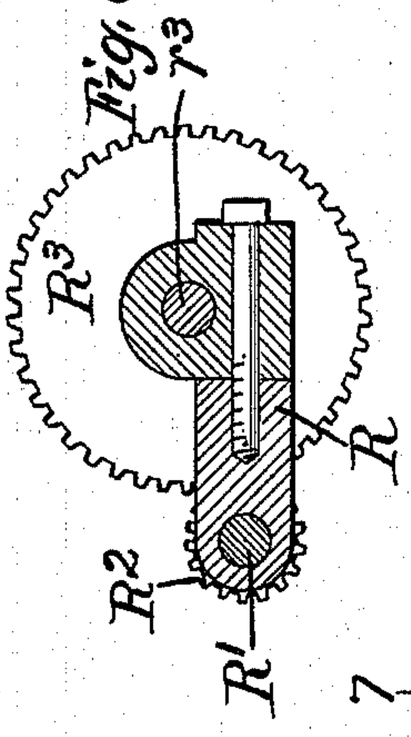


Fig. 7.

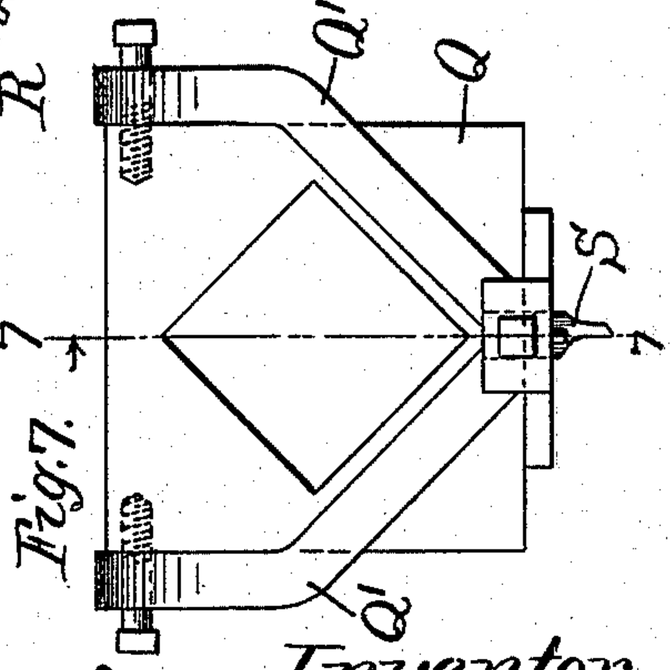


Fig. 9.

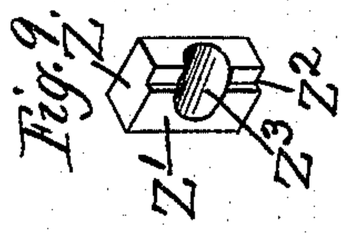
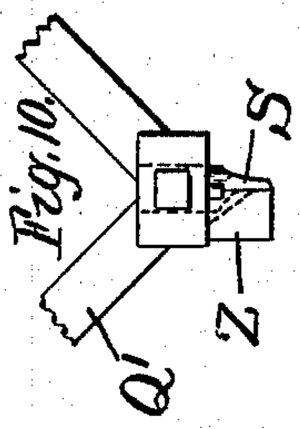


Fig. 10.



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UNITED STATES PATENT OFFICE.

THOMAS O. PERRY, OF CHICAGO, ILLINOIS.

GEAR-CUTTING MACHINE.

SPECIFICATION forming part of Letters Patent No. 528,025, dated October 23, 1894.

Application filed January 25, 1894. Serial No. 498,059. (No model.)

To all whom it may concern:

Be it known that I, THOMAS O. PERRY, a citizen of the United States, residing at Chicago, in the county of Cook, and State of Illinois, have invented certain new and useful Improvements in Gear-Cutting Machines, which are fully set forth in the following specification, reference being had to the accompanying drawings, forming a part thereof.

The purpose of this invention is to provide improved means for cutting or planing gears and especially bevel gears.

In the drawings, Figure 1 is a perspective of my improved machine set for cutting a gear of moderate bevel and medium size. Fig. 2 is a side elevation of the same machine partly sectional, section being made at a longitudinal vertical plane through the axis of the gear-holding mandrel, the machine being set for a larger gear which is very nearly a crown gear being slightly bevel. Fig. 3 is a detail side elevation of the portion of the machine containing the gear-holding mandrel and devices for adjusting it, the same being shown in position for cutting a pinion adapted to mesh with the large gear shown in the figure, such pinion being shown in section on the mandrel. Fig. 4 is a detail plan of the bracket which holds the bearing of the feed screw, the latter being shown in horizontal section as at the line 4—4 on Fig. 2. Fig. 5 is a section at the line 5—5 on Fig. 2. Fig. 6 is a section at the line 6—6 on Fig. 5. Fig. 7 is an elevation of the tool-holder and carriage. Fig. 8 is a section at the line 7—7 on Fig. 7. Fig. 9 is a perspective of a gage-block for setting the cutter. Fig. 10 is a detail perspective illustrating the mode of use of the gage-block. Fig. 11 is an elevation of the templet which controls the cutter in shaping the tooth. Fig. 12 is a plan or elevation of the subdividing wheel as seen looking in the direction of the arrows on Fig. 3, the shaft or mandrel on which it is mounted being shown in section at the line 11—11 on that figure. Fig. 13 is a detail section at the line 13—13 on Fig. 2. Fig. 14 is a detail section at the line 14—14 on Fig. 2.

A is a rigid horizontal bed which supports the several parts of my machine.

B is an upright head supported and adapted to be adjusted longitudinally on the bed A and designed to hold the templet C, which corresponds to and determines the shape of the tooth produced by the action of the tool.

D is a post also mounted on the bed A and opposite the head B.

E is a small bracket also mounted on the bed, located between the head B and post D.

F and G are two bars pivoted to the brackets E and D respectively and located in the same vertical plane longitudinal with respect to the bed and adapted to oscillate or be adjusted in that plane and having journal bearings F′ and G′ for the mandrel H which is intended to hold the gear to be cut. In order to permit the adjustment of these two bars F and G so that their two bearings shall be in line, or, in other words, in order to permit the setting of the mandrel which extends through the two bearings at any inclination while it is held by such bearings, the bar F has a long slot *f′* adapting it to be adjusted on its pivot to the bracket E, and the bracket D has a vertical slot *d* permitting some range of adjustment of the pivot-bolt *d′* in said bracket, and the bar G has a plurality of holes *g* through any one of which the pivot-bolt may be passed, thus permitting it to occupy several positions, and the bar G has also several bearings G′ from which the most suitable may be selected. Practically all possible angles of adjustment may be obtained by these three means.

K is the subdividing wheel which will be hereinafter explained in detail. It is mounted on the mandrel H above the bar G and is provided with the clamp more particularly described in detail hereinafter for making it rigid with the mandrel.

M is a beam which is square in cross-section and is set with its diagonal planes respectively vertical and horizontal, being supported at the end nearest the head B by a link M′ adapted to suspend it from the ceiling of the room by a spring or with a counter-balance weight over a pulley, or in any equivalent manner, so that it shall be substantially free to be raised and lowered and swung laterally at that end without requiring any considerable power to give it such movement. At the other end the beam is provided with a bracket M^2 which is bifurcated at the lower end and with the fork arms

M[20] bent at right angles to the rest of the bracket and pivoted to a collar O which fits accurately but loosely enough to turn freely on the mandrel H above the gear which is mounted thereon for the purpose of being cut. This gives a swivel connection and support to this end of the beam M. The other end of the beam is provided with a bracket N, at the lower end of which there is a stud and roll N′ N[2] set off horizontally from the bracket longitudinally with respect to the beam.

P P′ is a bell-crank lever for which a fulcrum is provided at either side of the bed by a pin or bolt *p* through eye-bolts *p′* which are inserted in the holes *a* in the side bars of the bed. The vertical arm P of this bell crank lever is forked and both branches of the fork provided with a number of holes *p*[10] at which the link P[2] may be pivotally connected to that arm of the lever, and this link has its end hollowed or slightly forked adapting it to bear against the wrist of the stud *n′* between the bracket N and the roll N[2], and the horizontal arm P′ of the bell-crank lever carries a weight P[3] tending to cause the vertical arm through the medium of the link or push-bar P[2] to swing the end of the beam M as far over in the direction in which the lever arm P′ extends as may be permitted by the contact of the roll N[2] with the guiding edge of the templet C; for the roll projects within the opening C′ of the templet and stands in the plane of the templet so that it bears upon the edge of the latter. The templet C is a thin plate of metal having the opening C′, which corresponds in shape to the shape of each tooth of the gear which is to be cut, in such manner that the roll N[2] rolling on the edge of the opening of the templet will trace by its axis the magnified shape of the tooth. The dotted outline in Fig. 11 indicates the shape of a tooth, for example, the dotted circle being the roll N[2] and the dotted outline being the path of its axis as it rolls on the margin of the opening C′ in the templet. The pivot selected for the thrust link P[2] on the vertical arm P of the bell-crank-lever is designed to be as nearly as may be at the center of an arc approximating the guiding edge of the templet which corresponds to the magnified outline of the tooth. This causes the pressure of the roll against this guiding outline to be substantially at right angles to said outline at the point of contact, whereby there is prevented any tendency to glance in either direction under the pressure.

Q is the tool carriage which is mounted on the beam and adapted to slide thereon carrying the tool-holder Q′ while it holds the tool S suspended below the beam M as seen in the drawings.

R is a gearing frame which is adapted to be secured rigidly in adjusted position on the beam M. The shaft R′ journaled vertically in this gearing frame carries at the lower end a pinion R[2] which meshes with and drives a gear R[3] which is journaled on the stud *r*[3] rooted in the gearing frame below the beam M. The gear R[3] is connected by the pitman R[4] to the carriage Q so that the rotation of the gear reciprocates the carriage on the beam. The upper end of the shaft R′ is connected by a universal joint R[5] with the telescoping shaft R[6] or by any other flexible means with the source of power. Not shown.

The central features of my invention may now be understood. The working point of the cutter S is located in a line from the intersection of the axis of the roll N[2] with the plane of the templet to the intersection of the pivot of the beam M with the axis of the mandrel H, for since the axis of the roll, as the latter follows the templet, traces in the plane of the templet the outline of the tooth, every point in the line from the path thus traced within the mandrel to the pivot about which the roll travels in tracing that path necessarily traces a precisely similar path upon a smaller scale and the intersection of the two pivots of the beam to the mandrel, to wit: its horizontal pivot on the collar O and the axis of the collar O itself, which is the axis of the mandrel, being the pivotal point of the movement of the roll and the point of the cutter being in the line indicated and making its reciprocations to plane the tooth at all successive positions occupied while the roll axis traces the outline in question the cutter will produce the desired outline in the tooth which it cuts and will taper that tooth properly toward the axis of the mandrel. If now the wheel to be cut is located on the mandrel so that the pitch cone apex is at the pivot of the beam to the mandrel the cutter will give it its proper bevel while producing the desired form of each tooth. The gear to be cut will be mounted on the mandrel and the mandrel set at the proper angle and the wheel located with its cone apex coinciding with the pivot of the beam as described by utilizing the several adjustments hereinabove mentioned of the bars F and G and the selection of a bearing in the latter bar for the mandrel.

Before proceeding with the description in detail of the method of adjusting the gear on the machine and adjusting the machine to cut it, I will describe in detail the subdividing wheel and its connections. The subdividing wheel K is a disk with a marginal flange K′, having an overhanging flange K[10] producing a recess K″.

k k are small hardened steel rolls having each an axial aperture *k′*, for the purpose of accurate subdivision. The recess K[11] is designed to contain some predetermined number of these precisely equal hardened rolls, the rolls being of such length as to enter under the overhanging flange K[10]. It will be impossible, practically, to make the rolls, which must necessarily be dressed to their proper diameter, of such diameter as to exactly fill and fit tightly in the recess K[11], if the diameter of that recess were first fixed absolutely; but the wheel being cast with the

diameter measuring within the recess to the inner face of the flange K′, something less than necessary to make the recess accommodate some selected number of rolls of chosen diameter, the recess may be gradually enlarged by mounting the wheel in a lathe, and dressing away the metal from the back of the recess until, by repeated trials, the last roll,—for which, at first, there was not quite room in the recess,—may be forced thereinto completing the circle of rolls which tightly fill, and being equal accurately subdivide, the circle. The number of rolls will be such as to adapt the wheel to make a variety of subdivisions, or in case of special gears having large prime number of teeth, a special subdividing wheel may be made for the purpose.

To secure the subdividing wheel in position on the mandrel, and so that the mandrel may be adjusted thereby to bring the teeth of the gear which is being cut successively into position within range of the cutter, I employ clamping bars L L, adapted to be clamped by the bolts *l l* onto the mandrel, and on the inner or upper face of the wheel K, I secure a little bracket K^3, the end of which stands up between the ends of the clamp bars L L, and adjusting screws L′ L′ are set through the ends of the bars L L against the opposite sides of the upstanding arm of the bracket by which the latter may be set and held at any point between the ends of the clamp bars, the range of adjustment being sufficient to correct any slight inaccuracy in the first adjustment of the subdividing wheel on the mandrel, that first adjustment being made as accurately as possible by eye to bring the point of commencement of work on the tooth under the tool. A very slight range of adjustment, therefore, is all that is necessary to effect the correction which would in any event be required.

I will now describe the mode of adjusting the gear and the machine to cut it.

The drawings for the construction of the gear to be cut will give the angle of the pitch cone and also the distance of the apex of that cone from the opposite end of the hub, and the gear will have been turned up true as to the face of the wheel. The first step in adjusting the gear and the machine to dress it will be to drive the gear onto the mandrel, leaving enough of the length of the latter projecting below it to obtain sufficient bearing in the bar F. A sleeve made for the purpose of proper length, or successive bushings of proper aggregate length will next be placed upon the mandrel at the other side of the gear to hold the collar O at a distance from the gear necessary to locate the pivot of the beam at the apex of the pitch cone of the gear. The bar F will now be adjusted on the bracket E, so that the mandrel shall make to the horizontal plane half the apex angle of the pitch cone of the gear, thus bringing the pitch line of the tooth, which is on the side toward the cutter, horizontal. Any slight inaccuracy in this adjustment may be corrected at a later stage, but it can be made with substantial accuracy in the first instance. The bracket E, having been in the first instance placed approximately on the bed A, will now be adjusted as may be necessary to bring the pivot of the beam on the mandrel a certain distance from the plane of the templet C, or from the plane of the head B, this distance being that which is known to be the measurement from the pivot to the templet or the beam respectively when the roll N^2 rests properly against the edge of the templet. This adjustment need not be absolutely exact at this stage, provision for complete rectification at a later stage being made in the adjustability of the head B on the bed. The bar G will now be placed upon the mandrel H, the latter being inserted through such one of the bearings G′, as necessary in view of the size and bevel of the gear to permit the bar to be properly secured to the post D, and the bar being then so secured to the post at such one of the holes *g* as necessary, and the bolt *d′* being suitably tightened, the angle of inclination of the mandrel may be tested, and if in any degree inaccurate, may be corrected by slacking the bolts *d′* and *e* sufficiently to permit whatever change of position is necessary, and then tightening them to secure the mandrel finally at the proper angle. The subdividing wheel K will now be placed upon the mandrel above the bar G, and the gear being placed so that the tooth to be first cut stands as nearly as can be determined by the eye with the corner upon which the cutting is to commence in line with the proper path of the cutter, the pin will be inserted in the central opening of one of the rolls and the clamp L will be tightened on the mandrel so that subsequent rotation of the subdividing wheel will carry the mandrel and the gear with it. Any slight inaccuracy in the adjustment of the gear to bring the proper point for the commencement of the dressing in line with the tool may be made by means of the screws L′ and L′, turning the mandrel slightly around in either direction as will be readily understood. The tool carriage will be now moved on the beam until the cutter holder overhangs the proximate side of the gear, and the gage block Q, hereinafter described being placed upon the face of the gear tooth under the cutter-holder, the beam M will be lowered at the oscillating end, having first been lifted high enough to admit the gage block under it, until the gage block fits accurately both on the turned-up face of the gear and against the under side of the tool-holder. It will be seen that the position of the parts thus obtained will be that which will cause the cutter to commence cutting at the very point of the tooth. The templet C will therefore be adjusted vertically on the head B to bring the roll N^2 into the upper corner of the templet opening which corresponds to the upper corner of that side of the tooth which is to be

cut. A little care being taken in estimating in advance the approximate positions of the parts, the adjustments may be effected as described to the position at which the cutting is to commence, so that the feed screw shall at that stage be at its upper limit, or sufficiently near it that the range of movement downward will be sufficient to complete the cutting. Power being applied through the telescoping and jointed shaft from any source of power apart from the machine, motion is communicated from the pinion R^2, at the lower end of the shaft R, to the crank gear wheel R^3, which reciprocates the tool carriage, and causes the cutter to plane the tooth. The feeding of the beam and thereby the cutter down from the upper corner of the tooth to the root is effected by means of the feed screw V, which, at the lower end, is stepped in the upper side of the stud N', and at the upper end passes through the screw-block V', which is pivoted diametrically by means of the screws v^2 v^2 within the ring or collar V^2, which, in turn, is pivoted diametrically at right angles to the pivot of the screw block, to the ears X' X' of the bracket X, which is secured at x upon the head B. This construction gives the feed screw universal pivotal support in the feed block, so that its lower end may follow the changes of position of the stud and roll as the latter follows the outline of the templet. This feed screw may be operated by hand or by automatic pawl-and-ratchet mechanism which is shown in the drawings, and which comprises the rod W having yielding connection by means of the bracket Q^4 and bow spring Q^5 with the carriage Q. This rod W extends along above the beam and is pivotally connected to an arm W^{10} of a plate W', which is pivoted upon the feed screw and supported by a ratchet wheel which is rigid with that screw. The plate W' carries the ratchet pawl W^2, adapted to engage the ratchet wheel to rotate the feed screw when the rod W is pushed by the return travel of the carriage on the beam. All the connections of the rod W are sufficiently free to permit it to do its work as described, notwithstanding the change of height at which the plate W' stands at different stages of the work.

In order automatically to stop the downward feeding when the proper point is reached, the crank handle v at the upper end of the feed screw (which may be utilized to feed by hand) encounters the adjustable stop V^3, which is secured upon one of the ears X' of the bracket X, being adjusted vertically thereon to arrest the handle as it rotates when the screw has descended far enough. It will be understood that the bow-spring Q^5, which, bearing against the stop q^5 on the rod W, is the means of transmitting the pushing movement of the returning carriage to the rod W, prevents the further feeding action by yielding, while the crank handle V, having collided with the stop V^3, makes it impossible for the screw to rotate farther.

It will be understood that after dressing one side of the tooth, the roll N^2, bearing against one side of the templet, the weighted lever being shifted to shift the bearing of the roll to the other side of the templet, the point of the cutter is brought to position to dress the opposite side of the tooth, and that, in order that it may operate on that opposite side, the cutter must be made in reversed form,—that is, two tools,—a right hand and a left hand tool,—must be used, one adapted to stand facing one side of the tooth, and the other to stand facing the opposite side; but in both instances the cutting point must be set to travel exactly in the line from the pivot of the beam at one end to the center of the guiding roll at the other end, in order that both sides of the tooth may be shaped exactly alike or reciprocally. In order to accomplish this result invariably, notwithstanding the wear of the tool and the necessity of dressing it which would change the exact position of the cutting point on the tool itself, and to permit the tool to be adjusted in the holder in a manner to compensate for any change in the position of the cutting point due to wear and dressing of the tool, it is made from a cylindrical blank, the upper portion of which constitutes the stem, the lower portion constituting the bit, cut away at one side a little past a diametrical plane, leaving that operating end or bit a little less than half the original cylinder. The end is then beveled back from the one corner of the segment which is to constitute the cutting point to afford clearance underneath, and the cutter is set in the tool holder so that that cutting point is in the plane of the path of reciprocation of the axis of the cutter stem. In order to thus set the tool, I provide the gage block Z, which has the plane face Z', and is in height just equal to the necessary projection of the tool from the lower side of the holder,—that is, the distance necessary to bring the point of the cutter down to the line of the axis of the roll and pivot of the beam. The face Z' is rabbeted back at the upper edge at Z^2 a distance equal to half the width of the two gage pins which are set in the lower end of the holder in the plane of the path of reciprocation of the axis of the cutter. The gage block is hollowed at Z^3 to accommodate the stem at the upper part, so that it can be placed against the lower end of the holder and brought up to the gage pins which will rest in the rabbet Z^2, and whichever side of the pins the block is placed being stopped by the pins in the rabbet whose depth is half the diameter of the pins, the face Z' will be in the plane of the path of reciprocation of the axis of the cutter stem. The cutter being now pushed up in its socket in the holder until the cutting point is exactly even with the lower side of the gage block, and turned

in its socket until that point rests against the face Z′, the cutting point is accurately located in the desired plane. It will be evident that however much the tool may be dressed, its point can always be brought to this plane by means of the gage block, and that changes of tool in case of breakage or dullness during the process of shaping any tooth can be readily made, because the point of a new tool can be brought exactly to the line occupied by the point of the old one when the accident which necessitated the removal of the latter occurred.

It will be noticed by reference to the drawings that the pitman R^4 which drives the cutter carriage is attached thereto in the line of travel produced of the cutting point of the tool. This entirely prevents any possibility of cramping the carriage on the beam by reason of the resistance of the work, and of course prevents any bending strain on the beam from the same cause, and so makes the accuracy and ease of the work as little as possible dependent upon the stiffness of the beam. It will also be observed that the general plan and method of the machine is such that the work puts no strain whatever upon the bed between the head B and the bracket E, and that the remainder of the frame and supports for the gear experience scarcely any strain from the work, that strain being confined practically to the gear itself and to so much of the mandrel which supports it as may intervene between the hub of the gear and the collar which affords the pivoted connection of the beam. These statements relate to the strain due to the push of the tool in its working movement. As to the torsional strain on the mandrel which is due to the sideward crowding of the tool against the work, its effect is reduced to the minimum by the construction which makes the portion of the length of the mandrel which may in any event be subject to such strain, the shortest possible; and in the case of large gear which would afford long leverage for such torsional strain on the mandrel, the bed is provided with holes for the purpose of fastening at any necessary position suitable clamps to take hold of the periphery of the gear near the point of work, and thus resist the sideward crowding and prevent the torsional strain. Such clamping devices are familiar for like purposes and are not shown.

The construction shown, in that the beam on which the tool carrier reciprocates is attached to the mandrel on which the gear is fixed, so that it will be virtually attached to the gear itself at the center, and that the working movement of the tool is toward the center, is especially advantageous because from it it results that the resistance of the work to the tool tends to pull the collar toward the gear on which it is in the first instance stopped, so that the relative position of the parts which receive the immediate strain of the work is preserved instead of disturbed by that strain, no stop being necessary on the mandrel, therefore, above the pivot collar nor below the bearing F′.

The tool holder Q′ is pivoted to the carriage at the upper side of the beam M, and swings to a stop against it in the cutting movement and away from it in the return movement in a well known manner. The pivotal connection of the tool-holder is made by means of the pivot screws which are readily withdrawn to permit the tool holder to be removed from the carriage for the purpose of setting the cutter therein, for which purpose the holder can be taken to a bench or other convenient place affording ample light to make an accurate adjustment of the tool, and the mode of adjusting herein described is especially advantageous because the adjustment is complete as between the tool-holder and the cutter, and is made without any necessity of reference to other mechanism or to any line or point on the gear, but when the cutter is properly adjusted in the holder by means of the gage block it is inevitably in the right position with respect to the work.

To secure the subdividing wheel in adjusted position on the bar G, the bracket G^2 is mounted on the top of the bar, and has the split finger G^{20} overhanging the margin of the wheel, and a pin G^4, whose point is adapted to fit into the axial aperture of the roll, and having its upper part flattened upon both sides is inserted through the split finger which has the clamping screw G^{21}, through the ends, adapted to make the fork grasp the pin on its flat sides and hold it firmly after it has been put into the proper roll. The split or slotted finger and the flat-sided pin are used instead of a bearing which a full round pin would accurately fit, so that any slight inaccuracy in the direction of the axial opening in any of the rolls will not prevent the insertion of the pin or make its insertion or withdrawal too difficult. In order to prevent the rolls from slipping around in the subdividing wheel, in addition to making them fit very tightly by driving the last one into place as described, I employ as a key the bar K^4 whose ends k^4 bear respectively against two rolls sufficiently separated around the circumference of the wheel to permit such engagement of the bar against them, and the bar being secured to the wheel by a screw locks one roll against movement in one direction and the other against movement in the opposite direction, and thereby effectually locks the whole series against movement in either direction.

I claim—

1. In a gear cutting machine, in combination with the support for the gear to be cut, a reciprocating cutter and its carriage, and the bar, beam or bed on which it reciprocates, the latter being pivoted at one end to the gear support and suspended at the other end, the mechanism for reciprocating the carriage

mounted on the beam comprising a gear train in which the speed is reduced to the carriage operating crank wheel, the primal shaft in said train having the highest speed and having a flexible or jointed shaft connection through which power is communicated to the train from a source independent of the beam or gear support: substantially as set forth.

2. In a bevel gear cutting machine, in combination with the gear support, the cutter and the bar, beam or bed which carries it pivoted at one end to the gear support and suitably supported at the other end with capacity for oscillation, a templet adapted to be secured in a position fixed with respect to the gear support, the beam having an abutment which bears upon the templet to afford guidance to the beam, the feed screw centered on the beam and the screw block through which it operates universally pivoted upon a support rigid with the templet, and mechanism for driving the tool and operating the feed screw: substantially as set forh.

3. In a gear cutting machine, in combination with the cutter carrying beam pivoted at one end and adapted to oscillate at the other to vary the path of the cutter; a templet to control the path of the cutter suitably supported in fixed position with respect to the pivot of the beam; the beam having an abutment at its oscillating end adapted to bear against the templet; a thrust link pivoted at the center of an arc which approximates the guiding outline of the templet; and suitable means for yieldingly forcing the pivotal support of such link toward the templet: substantially as set forth.

4. In a bevel gear cutting machine, in combination with a horizontal bed, the support for the gear to be cut angularly adjustable in the bed to accommodate the bevel of the gear; a head bracket supported and adjustable on the horizontal bed remote from the gear support; the cutter and its carriage and operating mechanism, and the beam which carries them pivoted at one end at the apex of the pitch cone of the gear and suspended and counterbalanced at the other end; a templet adjustably secured to the head bracket, the beam having an abutment adapted to bear against the templet; a weighted lever to hold it laterally in contact therewith and the feed screw adapted to actuate vertically the suspended end of the beam: substantially as set forth.

5. In combination with the tool holder, the cutter having a cylindrical stem and its cutting point located eccentrically with respect thereto, a gage block having a plane vertical face, the upper end of the block and the lower end of the tool holder being provided with correlated devices, adapted to be engaged, those pertaining to the holder being symmetrical about the plane of the path of reciprocation of the cutter axis: substantially as set forth.

6. In combination with a tool-holder, the cutter having a cylindrical stem and its cutting point located eccentrically with respect thereto; gage pins set in the tool holder in the plane of the path of reciprocation of the axis of the tool stem, and projecting equally both sides of that plane; a gage block having a face Z' and a rabbet Z^2 to receive the gage pins, the depth of the rabbet being half the width of the pins; whereby the gage block placed against either side of the pins has its face set in the plane of the path of reciprocation of the axis of the tool, and constitutes a stop for setting the cutting point of the cutter in such plane: substantially as set forth.

7. A subdividing wheel consisting of a flanged or crown disk, and equal cylinders arranged in a complete circle within the flange and occupying such circle fully: substantially as set forth.

8. In a gear-cutting machine, a subdividing wheel consisting of a flanged or crown disk and equal axially apertured cylinders arranged in a complete circle within the flange and occupying such circle fully: substantially as set forth.

9. The subdividing wheel having the overhanging flange and the equal cylinders located in the recess under such flange and fully occupying the same circumferentially; the overhanging flange having an aperture for the admission of the last of the cylinders, whereby the same may be driven in and made to secure the entire series of cylinders rigidly: substantially as set forth.

10. In a gear cutting machine, in combination with the bed, the gear-supporting shaft or mandrel supported on the bed; the subdividing wheel on the mandrel and the cutter-carrying beam pivotally supported on the mandrel between the position of the gear and the subdividing wheel, and adapted to be oscillated at the other end to vary the path of the cutter: substantially as set forth.

11. In a gear cutting machine, in combination with the bed, the gear-supporting shaft or mandrel; two bearings for the same at opposite sides of the position of the gear, each supported on the bed; the cutter-carrying beam pivoted to the mandrel between such bearings, and adapted to be oscillated at the other end to vary the path of the cutter: substantially as set forth.

12. In a gear cutting machine, in combination with the bed; a gear-supporting mandrel; two bearings for the same at opposite sides of the position of the gear; the cutter carrying beam pivoted to the mandrel between the bearings and adapted to be oscillated at the other end; the subdividing wheel located at the opposite side of the pivot of the beam to the mandrel from the gear, and adjacent to the bearing at that side: substantially as set forth.

13. In a gear-cutting machine, in combination with the bed, the gear-supporting mandrel; two bearings which said mandrel enters

at opposite sides of the position provided for the gear, each being independently adjustable with respect to inclination and position relatively to the bed; the cutter-carrying beam pivoted at one end to the mandrel between said bearings, and adapted to be oscillated at the other end to vary the path of the cutter: substantially as set forth.

14. In a gear-cutting machine, in combination with the bed, posts E and D adjustable thereon; the bars F and G secured to the posts respectively, and adapted to be both longitudinally and pivotally adjusted with respect thereto; the gear-holding mandrel H, journaled in said bars and adapted to carry the gear between the same; the cutter-carrying beam M, pivoted to the mandrel at the pitch cone apex of the gear and between the same and that bearing of the mandrel which is located on the same side of the gear, and the subdividing wheel on the mandrel at the opposite side of the beam from the gear: substantially as set forth.

In testimony whereof I have hereunto set my hand, in the presence of two witnesses, at Chicago, Illinois, this 20th day of January, 1894.

THOMAS O. PERRY.

Witnesses:
CHAS. S. BURTON,
JEAN ELLIOTT.