No. 892,442. PATENTED JULY 7, 1908.

J. F. A. MILL.

GEAR CUTTING APPARATUS.

APPLICATION FILED JAN. 4, 1907.

4 SHEETS—SHEET 1.

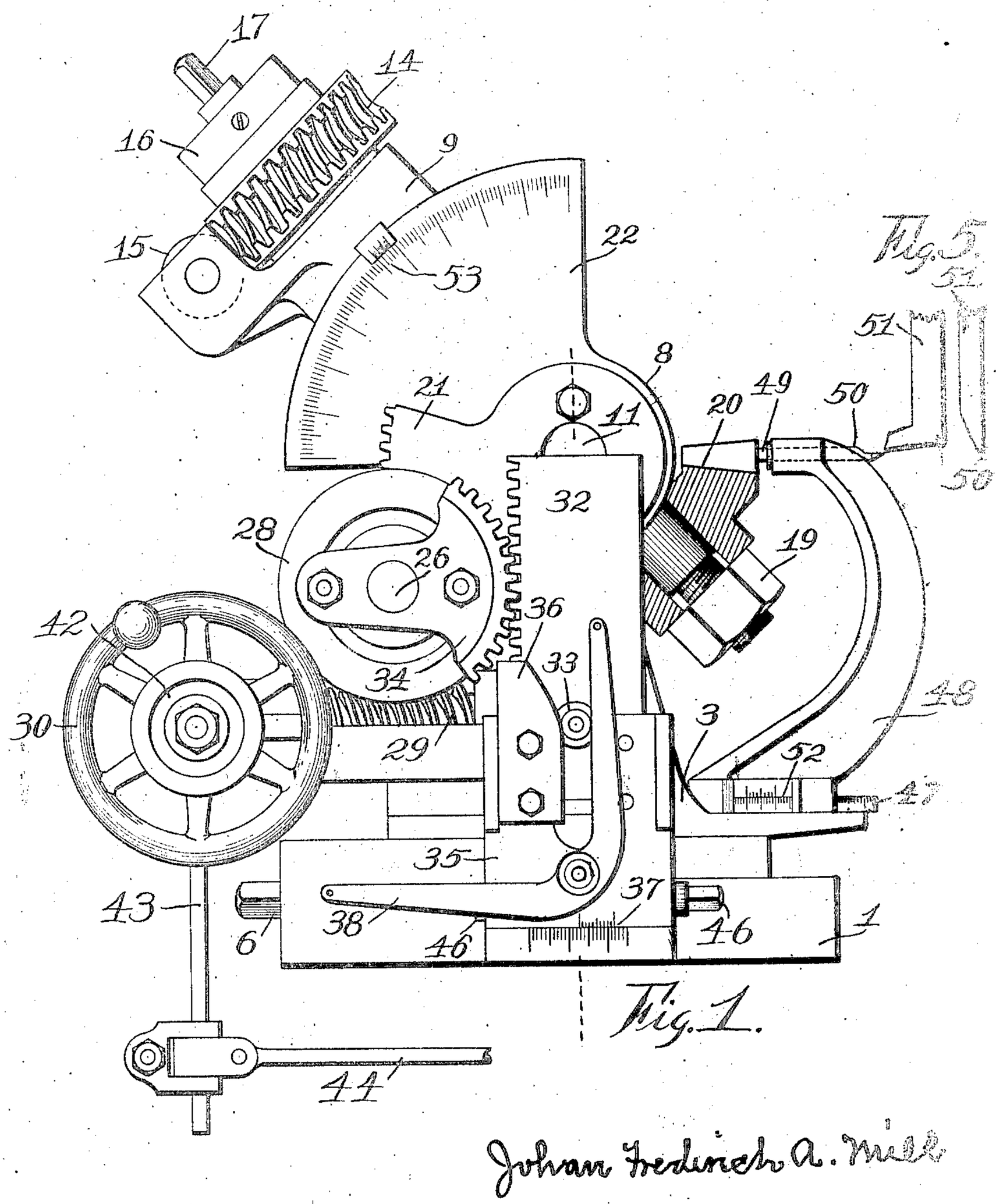

Fig. 1.

Witnesses:
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Inventor:
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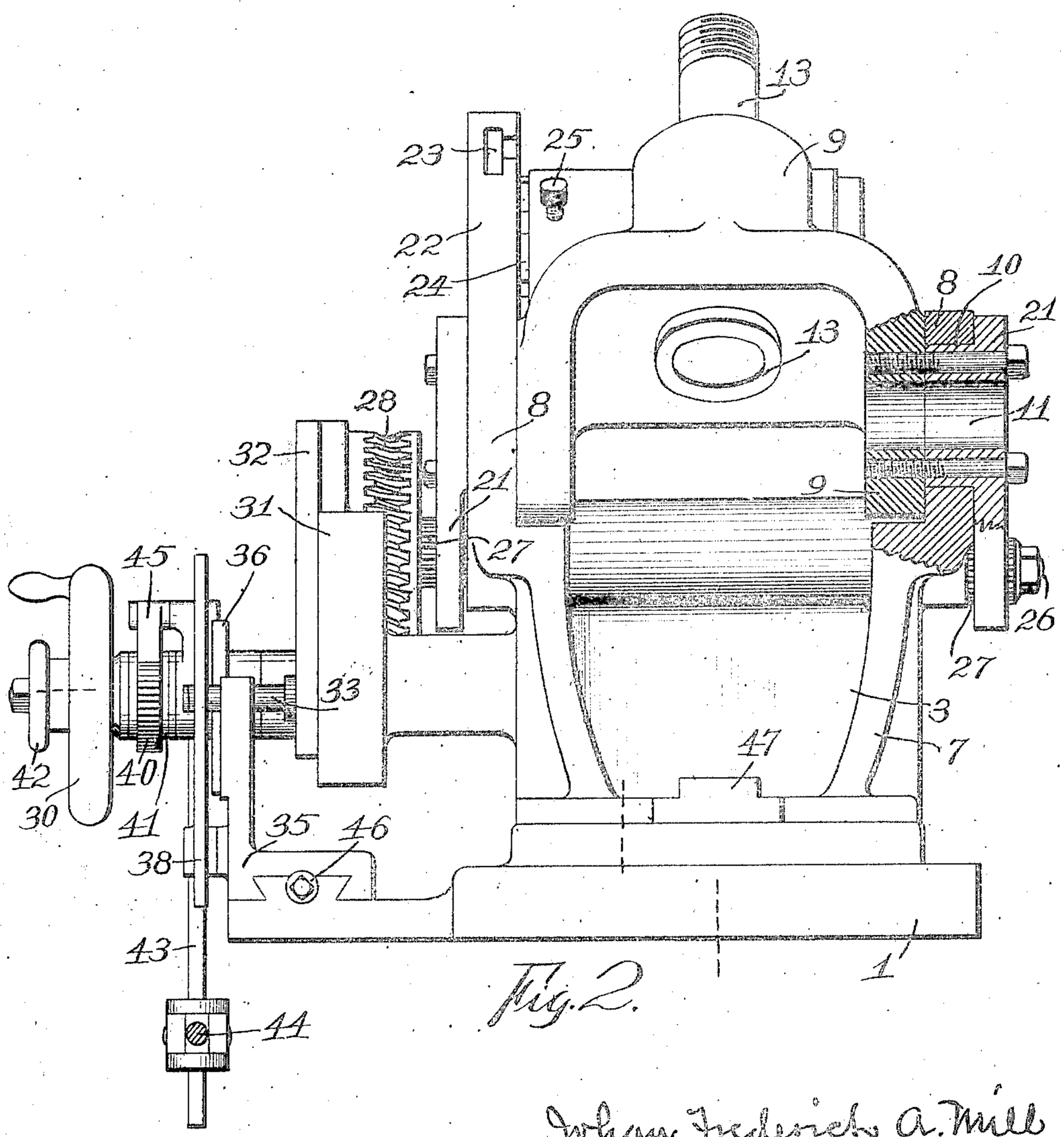

Fig. 2.

Witnesses:
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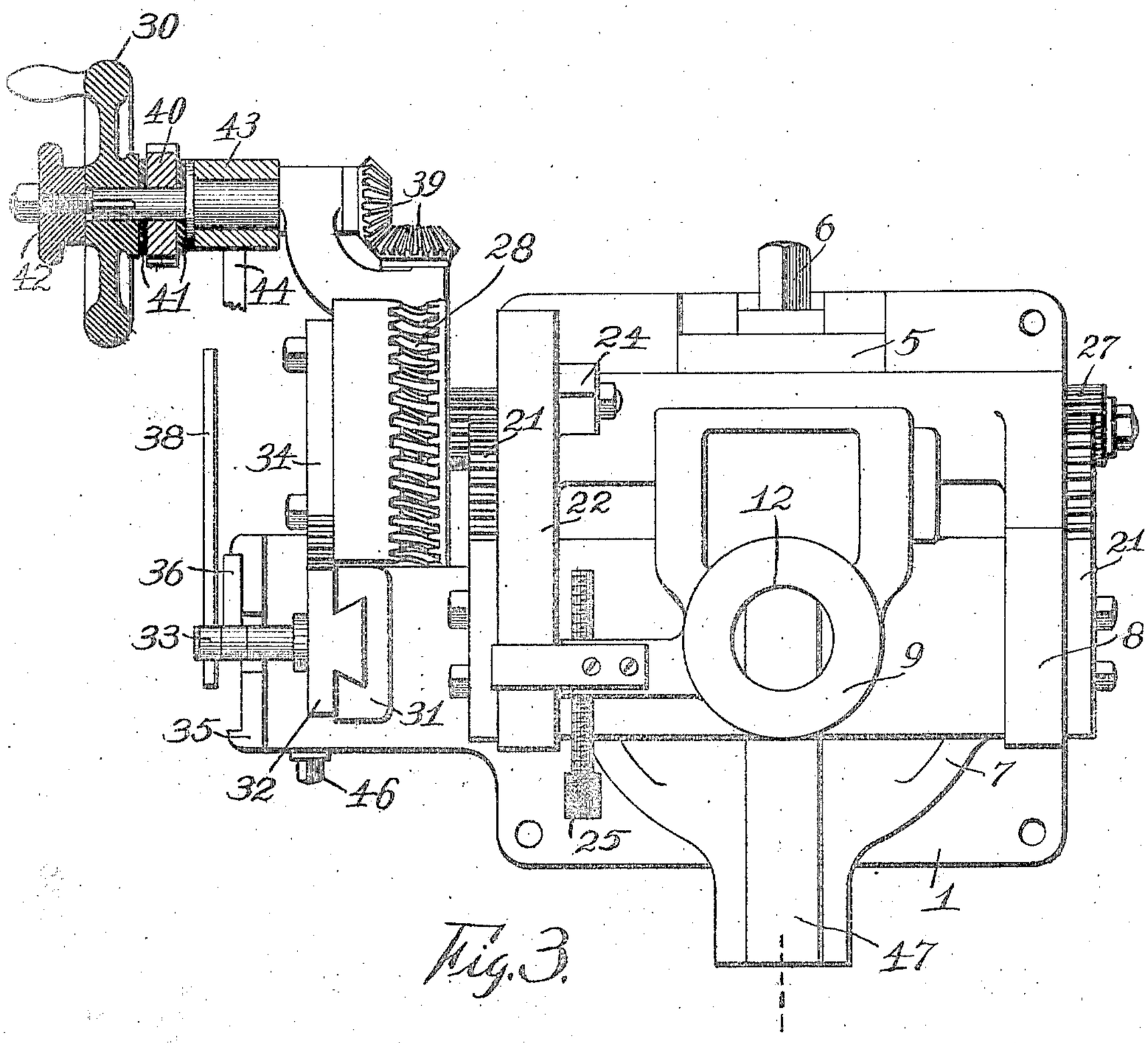

Fig. 3.

Witnesses:
Elmer R. Shipley.
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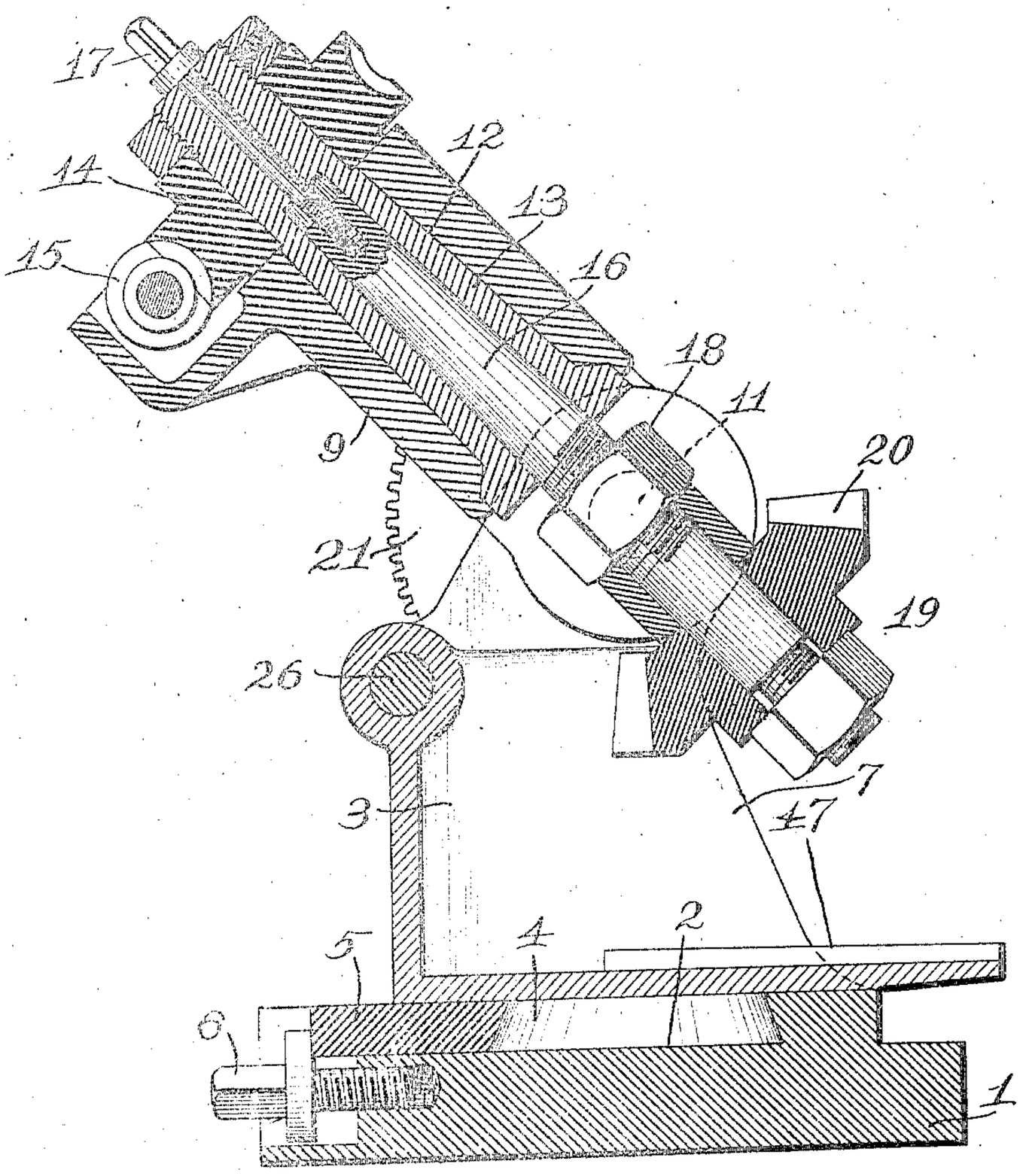

Fig. 4.

Witnesses:
Elmer R. Shipley.
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UNITED STATES PATENT OFFICE.

JOHAN FREDERICH A. MILL, OF HAMILTON, OHIO, ASSIGNOR OF ONE-HALF TO MAUD ESTELLA MILL, OF HAMILTON, OHIO.

GEAR-CUTTING APPARATUS.

No. 892,442. Specification of Letters Patent. Patented July 7, 1908.

Application filed January 4, 1907. Serial No. 350,741.

To all whom it may concern:

Be it known that I, JOHAN FREDERICH A. MILL, a citizen of the United States, residing at Hamilton, Butler county, Ohio, have invented certain new and useful Improvements in Gear-Cutting Apparatus, of which the following is a specification.

This invention pertains to apparatus for cutting bevel gears by the method of focal planing, and the exemplifying embodiment herein set forth takes the form of a portable self-contained appliance adapted to be secured to the table of any ordinary metal shaping machine, the general system of construction, however, lending itself for use with most any kind of reciprocating metal paring machine.

The invention will be readily understood from the following description taken in connection with the accompanying drawings in which:—

Figure 1 is a side elevation of a gear cutting apparatus exemplifying my invention: Fig. 2 a front elevation of the same, part vertical section, the mandrel being omitted: Fig. 3 a plan, part horizontal section, the arbor, mandrel and indexing mechanism being omitted: Fig. 4 a vertical section in the plane of the vertical axis of the apparatus at right angles to the horizontal axis: and Fig. 5 a face view of the cutting tool in conjunction with its setting gage.

In the drawings:—1, indicates a base plate adapted to be rigidly secured to the table of a shaping machine: 2, a dovetailed recess in the upper surface of the base plate, semi-circular at one end and open at the other end: 3, a housing resting on the base-plate: 4, a circular dovetailed boss rigidly formed with the base of the housing and engaging the dovetailed recess in the base-plate: 5, a gib snugly fitting the open end of the dovetailed recess in the base-plate and having its inner end engaging the boss 4: 6, a screw engaging the base-plate and gib and serving to adjust the latter inwardly so that the housing becomes clamped with satisfactory firmness to the base-plate while at liberty to rotate upon the axis of the dovetailed parts, which axis constitutes what will be hereinafter referred to as the vertical axis of the apparatus: 7, upwardly projecting side-arms on the housing, one at each side of the vertical axis: 8, a horizontal bearing in each of these arms, their common axis constituting what will hereinafter be referred to as the horizontal axis of the apparatus, this horizontal axis intersecting the vertical axis, the point of intersection constituting the focus of the system or the apex of the cones represented by the bevel-gears to be cut: 9, an arbor-bearing having at its lower end a fork trunnioned to the bearings 8 so that the arbor-bearing may move angularly upon the horizontal axis of the apparatus, the axis of the arbor-bearing cutting the intersection of the vertical and horizontal axes of the apparatus, or, in other words, cutting the focus of the system, the lower end of the arbor-bearing being at some distance from the horizontal axis: 10, the trunnions of the arbor-bearing: 11, a bore, of accurately known diameter, axially through the fork-arms of the arbor-bearing and through the trunnions: 12, the tapering bore of the arbor-bearing: 13, the arbor accurately fitted for rotation therein: 14, a worm-wheel fast on the upper end of the arbor: 15, a worm journaled at the upper end of the arbor-bearing and engaging the worm-wheel, the worm and worm-wheel being merely typical of well known indexing devices for rotating the arbor: 16, the mandrel, having its shank firmly fitted in the arbor, the lower end of the mandrel projecting out of the arbor and past the focus of the system and being adapted to receive and fit the gear-blank to be operated upon: 17, the usual screw for drawing the mandrel tightly into the arbor: 18, a nut threaded upon the mandrel, between the gear blank and the lower end of the arbor: 19, a nut threaded upon the mandrel below the gear blank: 20, the gear blank snugly fitting the mandrel and tightly clamped between the nuts thereon, the gear blank occupying such longitudinal position upon the mandrel that it will lie below the focus of the system and have the focus coincide with the apex of the cone of which the gear blank forms a frustum: 21, a toothed sector carried by each trunnion of the arbo-r-bearing, exterior to the trunnion bearing, the preferred construction being that the trunnions are formed integral upon the inner faces of the sectors, the sectors and trunnions being rigidly bolted to the fork-arms of the arbor-bearing, the bore 11, before referred to, extending also through the sectors so that a test bar may be passed through the bores and across the apparatus: 22, a section supported rigidly by one of the side arms of the housing and presenting its segmental edge rearwardly and upwardly: 23, a segmental bolt-slot in the sector 22: 24,

a stop-block bolted against the inner face of the sector 22 and angularly adjustable along the slot: 25, an adjustable stop-screw carried by the arbor-bearing in position to have its inner end abut against the stop-block 24: 26, a horizontal shaft journaled in the housing and extending across the same to the rear of the vertical axis and parallel with the horizontal axis of the apparatus: 27, two pinions fast on this shaft, one engaging each of the toothed sectors 21: 28, a worm gear fast on one end of this shaft: 29, a worm journaled in the housing and engaging this worm-gear: 30, a hand-wheel having operative connection with this worm: 31, a vertical guideway supported by the housing near the worm-wheel 28: 32, a rack sliding in this guideway: 33, a stud projecting rigidly from the rack, its axis being parallel with the horizontal axis of the apparatus, this stud being preferably provided with a plurality of rollers: 34, a toothed sector engaging rack 32 and mounted for angular adjustment on shaft 26, the preferred construction being to provide the outer face of worm-gear 28 with an annular bolt-slot and to bolt the sector thereat: 35, an upstanding bracket mounted for horizontal sliding adjustment on the base-plate in a direction tangential to a circle struck from the vertical axis of the apparatus, this bracket, hereinafter termed the templet-bracket having a pair of side-arms straddling the stud 33 but entirely free of the stud: 36, the templet, being in the form of a plate removably secured against one of the side arms of the templet bracket and presenting a properly contoured edge against the rack-stud 33, Fig. 1 illustrating the templet as being disposed at the left of the stud: 37, graduations, preferably verniered, at the sliding joint between the templet-bracket and the base-plate to facilitate the accurate adjustment of the templet in a horizontal direction: 38, a lever bearing against the side of the stud 33 opposite the templet and serving to hold the stud against the contour edge of the templet, this lever being adapted to have attached to it a weight or its equivalent to cause it to exert the proper pressure on the stud which pressure, by the way, may be very light: 39, gearing connecting the spindle of hand-wheel 30 with the spindle of worm 29: 40, a ratchet-wheel loose on the spindle of hand-wheel 30 between the hub of that hand-wheel and a collar on the spindle: 41, friction-washers at each side of the ratchet-wheel: 42, a nut on the spindle of hand-wheel 30 serving to clamp the ratchet-wheel between the friction-washers and produce the desired amount of driving capacity between the ratchet-wheel and worm 29: 43, a pawl carrying arm pivoted on the spindle of hand-wheel 30: 44, a rod connected with this arm and adapted to receive reciprocating motion from any suitable part of the shaper, say some part of the usual feed mechanism of the shaper: 45, a pawl carried by the pawl carrying arm and engaging the ratchet-wheel: 46, screws for adjusting the templet bracket 35 on the base-plate: 47, an accurately formed rib projecting up from the base of the housing and extending at right angles to the plane of the horizontal axis of the apparatus: 48, a gage-arm free to slide on the base of the housing and nicely fitting the rib 47, the upper end of this arm projecting up into the horizontal plane of the horizontal axis of the apparatus: 49, a gage-plug secured to and projecting inwardly from the upper end of the gage-bracket in the vertical and horizontal planes of the focus, the preferred construction for this gage plug being a cylindrical plug held rotarily in a cylindrical bore in the top of the gage bracket and projecting outwardly as well as inwardly from the gage-bracket: 50, the outer end of this gage-plug, this end being preferably brought to a point disposed accurately in the vertical and horizontal plane of the focus, the outer end of the plug being cut away down to its center: 51, the tool, to be reciprocated as usual, and having a cutting corner which is to do the work, this tool to reciprocate in a path at right angles to the vertical axis of the apparatus and at the level of the horizontal axis: 52, coöperating graduations, preferably verniered, at the joint of sliding engagement between the base of the housing and the base of gage-arm 48: 53, coöperating graduations, which are preferably verniered on sector 22 and a contiguous portion of the arbor-bearing.

By means of the mandrel-nuts the gear-blank may be adjusted to proper position relative to the focus; by means of the indexing mechanism the gear-blank may be turned upon its axis for the indexing adjustment; by means of the hand-wheel 30 the arbor-bearing and the parts carried by it, may be adjusted angularly into the general position desired and given proper angular motion for feeding purposes as the tool cuts down the side of the tooth; as the tooth feeds upward for the successive cuts the templet-stud descends along the edge of the templet and compels the gear-blank to move angularly on the vertical axis of the system; by means of the adjustable sector 34 the templet-stud can be set into proper relationship with the templet after the general adjustment has been made for the arbor-bearing to suit the bevel of the gear-blank in hand; by reversing the templet and securing it to the second arm of the templet bracket it may engage the other side of the templet-stud and provide for operations at the opposite side of the tooth spaces; by bringing the horizontal arm of lever 38 to the vertical it may be caused to act properly on the templet-stud under the new conditions of the templet, by means of screws 46 the templet in its new position may be shifted sidewise

to secure the proper width of tooth space; by means of the gage-arm the longitudinal position of the gear-blank upon the mandrel may be accurately determined through the medium of gage-point 49; by means of the outer end 50 of the gage-plug the cutting corner of the tool may be accurately adjusted to the focal line in which it is to always work; and by means of the rod 44 an automatic feeding motion may be transmitted to the spindle of hand-wheel 30.

Assume the gear-blank to have been produced of proper size for specified bevel, pitch and number of teeth and assume the templet to have its edge of proper contour and to be secured upon the lefthand arm of the templet-bracket. For simplicity of description let it be assumed that the teeth have been either cast or blocked out so that attention need be given only to the refined capacities of the apparatus. The specification for the gear to be produced, will involve a certain angle of a line cutting its focus and pitch line. By means of the hand-wheel 30 let the arbor-bearing and the parts carried by it be adjusted on the horizontal axis of the apparatus till the specified angle is read at graduations 53. Let the blank be placed upon the mandrel, at random position between the mandrel-nuts. By means of the mandrel nuts let the blank be adjusted and secured longitudinally on the mandrel till its outer pitch line is the specified distance from the horizontal axis of the apparatus, the exactness of this setting being determined by gage-plug 49 as referred to readings taken at graduations 52. Let the tool be adjusted to the surface or to the point of gage-plug 50, which will cause its path to cut the focus. Let the gage-arm then be removed. Let sector 34, assumed as heretofore free from worm-wheel 28, be now secured to the worm-wheel in such angular position that stud 33 coincides with the pitch-line point on the templet. Now, the arbor being locked by the index mechanism against rotation, by means of hand-wheel 30, tip the mandrel and its parts downwardly till the beveled face of the blank is below the cutting plane. The cutting at one side of the tooth-space may now proceed, hand-wheel 30 being advanced after each cut so as to raise the blank angularly till the face of the tooth is finished. While this angular raising of the blank to the cut progresses the stud 33 travels down the templet, and the housing and the parts carried by it are forced into angular movement on the vertical axis of the apparatus thus giving to the tooth-side a contour in correspondence with the templet. When the specified depth for the tooth has been reached by the tool the end of stop-screw 25 will strike against stop-block 24 and the feeding can proceed no further. These stops will have been adjusted for appropriate stopping position. In doing this the stop-block will be adjusted for the major range and the screw for the minor range, and the specified stopping angle for which the stops are to be adjusted can be accurately taken from the graduations 53.

As thus far referred to the feeding is assumed as having been done by hand. The power feed, derived from rod 44, may be employed if desired, nut 42 being tightened to sufficiently clamp the ratchet between the friction disks, a slipping of this clamping taking place and the feeding ceasing when the depth-stops engage.

By means of the indexing mechanism, employed in the usual manner, one side of all the tooth-spaces of the blank are to be successively finished. The new tool is then to be set, suited for cutting the other side of the tooth-space, and in setting this tool the gage-arm will again be brought into play. The templet is now to be reversed and secured to the second arm of the templet-bracket and the lever 38 to be properly adjusted. Now, having regard for the mathematical proportion existing between the specified apex distance of the blank and at the distance from the vertical axis of the apparatus to the vertical plane of the templet the templet-bracket 35 is by means of screws 46 to be shifted till the housing is moved angularly a distance corresponding with the specified width of tooth-space, the accuracy of this adjustment being determined from graduations 37. The parts are now in condition for the finishing of the second of the sides of the tooth-space and the completion of the gear.

It will have been noted that while the housing has an angular motion that motion is impressed upon it by the stud bearing against the edge of the templet under conditions which would cause the stud to assume varying angular relationship to the face of the edge of the templet, with a possible detrimental effect on the accuracy of transfer of contours from the templet to the gear tooth. But the error thus produced is of immaterial character and may be entirely neglected if the edge of the templet be thin or given a slightly convex cross-section, a construction dictated by nice working and durability regardless of accuracy of transfer. It will be obvious that with the positive form of templet shown the stud-thrust would be against the lever, and that with a reverse or negative form of templet the thrust would be against the templet. The stud is preferably in roller form, for obvious anti-friction reasons, and as the dragging effects of the templet and lever are opposed to each other, as regards the direction of turning of the roller, I provide the stud with two rollers, one for the templet and one for the lever, these two members being in dissimilar planes.

The accuracy of gage plug 49 with refer-

ence to graduations 52 is important and may be tested by inserting a test bar of known diameter in and at the horizontal axis of the apparatus, the mandrel being, of course, absent. With a test bar, say, two inches in diameter, and with gage-plug 49 in contact therewith, the reading of graduations 52 should show that the face of the gage-plug is one inch from the focus, or, in case of discrepancy, the needed correction will be indicated.

It is to be understood that the particular construction illustrated is a single exemplification only. I have merely described the principle of my invention and have set forth the best form in which I at present contemplate embodying it. Such terms as horizontal, vertical, etc., as employed in the claims, are to be taken in their relative sense only.

I claim:—

1. In gear cutting apparatus, the combination of a base, a housing mounted thereon to turn on a vertical axis, an arbor carrier mounted in the housing to turn on a horizontal axis intersecting the vertical axis mentioned, an arbor mounted in the carrier, a templet on the base and a templet follower carried by the housing, and means intermediate the carrier and templet follower serving to move the follower upon the templet in accordance with the movement of the carrier; the movement of the follower upon the templet causing movement of the housing on its vertical axis.

2. In gear cutting apparatus, the combination of a base, a housing mounted thereon to turn on a vertical axis, an arbor carrier mounted in the housing to turn on a horizontal axis intersecting the vertical axis mentioned, an arbor mounted in the carrier, a templet and an adjustable mounting therefor on the base serving to carry the templet in two different positions, corresponding to the two sides of the gear teeth being cut, a templet follower carried by the housing, and a connection intermediate the carrier and templet follower serving to move the follower upon the templet by the movement of the carrier upon its horizontal axis and thereby serving to move the housing on its vertical axis.

3. In gear cutting apparatus, the combination, substantially as set forth, of a base-plate, a housing vertically pivoted thereto, an arbor-bearing horizontally pivoted to the housing, a rotary arbor mounted in the arbor-bearing, the axes of the arbor and the vertical and horizontal pivoting intersecting at a focus, locking and indexing mechanism for the arbor, feeding means for progressively moving the arbor-bearing upon its horizontal axes, a templet rigidly supported by the base-plate in a plane tangential to a circle struck from the vertical axis of the housing, a vertically movable horizontal stud coöperating with the templet, connections between the stud and said feeding means to move the stud vertically along the templet, and adjusting devices for shifting the templet in said tangent plane.

4. In gear cutting apparatus, the combination, substantially as set forth, of a base-plate, a housing vertically pivoted thereto, an arbor-bearing horizontally pivoted to the housing, a rotary arbor mounted in the arbor-bearing, the axes of the arbor and the vertical and horizontal pivoting intersecting at a focus, locking and indexing mechanism for the arbor, feeding means for progressively moving the arbor-bearing upon its horizontal axes, a vertically movable stud connected with the housing, operative connections between said feeding means and stud to move the stud vertically, a templet-bracket rigidly supported by the base-plate, and a templet removably secured to said bracket with its edge in engagement with one side of said stud and adapted to be secured in reverse position upon said bracket so as to engage the opposite side of said stud.

5. In gear cutting apparatus, the combination, substantially as set forth, of a base-plate, a housing vertically pivoted thereto, an arbor-bearing horizontally pivoted to the housing, a rotary arbor mounted in the arbor-bearing, the axes of the arbor and the vertical and horizontal pivoting intersecting at a focus, locking and indexing mechanism for the arbor, feeding means for progressively moving the arbor-bearing upon its horizontal axes, a templet rigidly carried by the base-plate, a vertically movable stud carried by the housing and engaging the templet, operative connections between said feeding means and stud, and a pivoted lever mounted on the housing and bearing against the stud on the side opposite the templet and adapted to yieldingly hold the stud against the templet.

6. In gear cutting apparatus, the combination, substantially as set forth, of a base-plate, a housing vertically pivoted thereto, an arbor-bearing horizontally pivoted to the housing, a rotary arbor mounted in the arbor-bearing, the axes of the arbor and the vertical and horizontal pivoting intersecting at a focus, locking and indexing mechanism for the arbor, feeding means for progressively moving the arbor-bearing upon its horizontal axis, a vertically movable stud carried by the housing, operative connections between said feeding means and stud, a templet rigidly supported by the base-plate and engaging one side of the stud and adapted for reversal so as to engage the opposite side of the stud, and a lever pivoted on the base-plate and adapted to hold the stud against the templet and to be adjusted to engage the opposite side of the stud when the templet is reversed.

7. In gear cutting apparatus, the combination, substantially as set forth, of a base-plate, a housing vertically pivoted thereto, an arbor-bearing horizontally pivoted to the housing, a rotary arbor mounted in the arbor-bearing, the axes of the arbor and the vertical and horizontal pivoting intersecting at a focus, locking and indexing mechanism for the arbor, feeding means for progressively moving the arbor-bearing upon its horizontal axis, a templet rigidly carried by the base-plate, a vertically movable stud carried by the housing and engaging the templet, operative connections between said feeding means and stud, and adjusting devices between said stud and feeding means to permit the position of the stud along the templet to be adjusted independent of the angular position of the arbor-bearing.

8. In gear cutting apparatus, the combination, substantially as set forth, of a base-plate, a housing vertically pivoted thereto, an arbor-bearing horizontally pivoted to the housing, a rotary arbor mounted in the arbor-bearing, the axes of the arbor and the vertical and horizontal pivoting intersecting at a focus, a gage-arm fitted to slide in the housing in a plane of movement at right angles to said horizontal pivot axis, and a gage-plug carried by the gage-arm in the intersection of the planes of the focus.

9. In gear cutting apparatus, the combination, substantially as set forth, of a base-plate, a housing vertically pivoted thereto, an arbor-bearing horizontally pivoted to the housing, a rotary arbor mounted in the arbor-bearing, the axes of the arbor and the vertical and horizontal pivoting intersecting at a focus, a gage-arm fitted to slide in the housing in a plane of movement at right angles to said horizontal pivot axis, and a gage carried by the arm having a member presenting toward the gear-blank in the horizontal plane of the focus, and a member presenting away from the blank, terminating in a sharp setting point in the intersection of the focal planes.

10. In gear cutting apparatus, the combination, substantially as set forth, of a base-plate, a housing vertically pivoted thereto, an arbor-bearing horizontally pivoted to the housing, a rotary arbor mounted in the arbor-bearing, the axes of the arbor and the vertical and horizontal pivoting intersecting at a focus, a gage-arm fitted to slide in the housing in a plane of movement at right angles to said horizontal pivot axis, and a gage-plug secured in said gage-arm in the vertical and horizontal plane of said focus and having a measuring surface upon its inner end and a setting-surface upon its outer end.

11. In gear cutting apparatus, the combination, substantially as set forth, of a base-plate, a housing vertically pivoted thereto, an arbor-bearing horizontally pivoted to the housing, a rotary arbor mounted in the arbor-bearing, the axes of the arbor and the vertical and horizontal pivoting intersecting at a focus, locking and indexing mechanism for the arbor, feeding means for progressively moving the arbor-bearing upon its horizontal axes through the tooth-depth angle, a segmental bolt-slot in a part rigidly carried by the housing, a stop-block adjustable in said slot, and an adjustable stop-screw carried by the arbor-bearing and adapted to engage said stop-block.

12. In gear cutting apparatus, the combination, substantially as set forth, of a base-plate, a housing vertically pivoted thereto, an arbor-bearing horizontally pivoted to the housing, a rotary arbor mounted in the arbor-bearing, the axes of the arbor and the vertical and horizontal pivoting intersecting at a focus, locking and indexing mechanism for the arbor, and trunnions carried by the arbor-bearing and engaging the housing and forming the horizontal pivot uniting the arbor-bearing and housing, said trunnions having an axial bore for the reception of a test-bar.

13. In gear cutting apparatus, the combination, substantially as set forth, of a base-plate, a housing vertically pivoted thereto, an arbor-bearing horizontally pivoted to the housing, a rotary arbor mounted in the arbor-bearing, the axes of the arbor and the vertical and horizontal pivoting intersecting at a focus, locking and indexing mechanism for the arbor, a toothed sector at each side of the housing, and hubs formed on the sectors and engaging bearings in the housing and secured rigidly to the arbor-bearing and forming its horizontal pivot.

14. In gear cutting apparatus, the combination, substantially as set forth, of a base-plate, a housing vertically pivoted thereto, an arbor-bearing horizontally pivoted to the housing, a rotary arbor mounted in the arbor-bearing, the axes of the arbor and the vertical and horizontal pivoting intersecting at a focus, locking and indexing mechanism for the arbor, a rib carried by the housing at right angles to said vertical and horizontal pivoting, feeding means for progressively moving the arbor-bearing on its horizontal axes, and a gage-arm adapted for separable engagement with the rib of the housing.

15. In gear cutting apparatus, the combination, substantially as set forth, of a base-plate, a housing vertically pivoted thereto, an arbor-bearing horizontally pivoted to the housing, a rotary arbor mounted in the arbor-bearing, the axes of the arbor and the vertical and horizontal pivoting intersecting at a focus, locking and indexing mechanism for the arbor, feeding means for progressively moving the arbor-bearing upon its horizontal axis, a vertically movable stud carried by the housing and operatively connected with said feeding means, a templet-bracket engag-

ing a horizontal seat on the base-plate, a templet carried by the templet-bracket and engaged by said stud, and adjusting screws for adjusting the templet-bracket and templet in a direction substantially at right angles with said stud.

16. In gear cutting apparatus, the combination, substantially as set forth, of a base-plate, a housing vertically pivoted thereto, an arbor-bearing horizontally pivoted to the housing, a rotary arbor mounted in the arbor-bearing, the axes of the arbor and the vertical and horizontal pivoting intersecting at a focus, locking and indexing mechanism for the arbor, feeding means for progressively moving the arbor-bearing upon its horizontal axis, a vertically movable stud carried by the housing and operatively connected with said feeding means, a templet-bracket engaging a horizontal seat on the base-plate, a templet carried by the templet-bracket and engaged by said stud, adjusting screws for adjusting the templet-bracket and teimplet in a direction substantially at right angles with said stud, and a pair of arms carried by said templet-bracket and straddling said stud and adapted to receive the templet upon either side of the stud.

17. In gear cutting apparatus, the combination, substantially as set forth, of a base-plate, a housing vertically pivoted thereto, an arbor-bearing horizontally pivoted to the housing, a rotary arbor mounted in the arbor-bearing, the axes of the arbor and the vertical and horizontal pivoting intersecting at a focus, locking and indexing mechanism for the arbor, a shaft, gearing connecting the shaft with the arbor-bearing so that the turning of the shaft moves the arbor-bearing angularly, a rack-guide carried by the housing, a rack sliding vertically in the rack-guide, a toothed-member mounted on said shaft and engaging said rack, a stud carried by the rack, and a templet supported by the base-plate and adapted to be engaged by the stud.

18. In gear cutting apparatus, the combination, substantially as set forth, of a base-plate, a housing vertically pivoted thereto, an arbor-bearing horizontally pivoted to the housing, a rotary arbor mounted in the arbor-bearing, the axes of the arbor and the vertical and horizontal pivoting intersecting at a focus, locking and indexing mechanism for the arbor, a shaft, gearing connecting the shaft and arbor-bearing whereby the turning of the shaft adjusts the arbor-bearing angularly, a rack guide carried by the housing, a rack sliding in the rack-guide, a toothed-member engaging said rack and mounted for angular adjustment on said shaft, a stud carried by the rack, and a templet rigidly supported by the base-plate and engaged by the stud.

19. In gear-cutting apparatus, the combination of a vertically pivoted housing, an arbor-carrier horizontally pivoted to the housing, a gear-sector on the carrier, a pinion in fixed bearings engaging the sector, worm-gearing for driving the pinion, a toothed segment arranged to move with the pinion and angularly adjustable in relation thereto, a fixed templet, a templet follower, and a slide movably mounted in ways on the housing and engaging the toothed segment, and carrying the templet follower.

20. In gear-cutting mechanism, the combination of a housing having arms with apertures forming trunnion-bearings, an arbor-carrier having forked arms the ends of which have round bores and lie against the housing arms, gear-sectors having projecting hubs forming trunnions resting in said bearings, the hubs having bores alined with the bores of the carrier arms, and fastenings connecting the hubs to the carrier-arms.

21. In gear cutting apparatus, the combination of a blank-carrying arbor, means for carrying said arbor so that it may turn on intersecting horizontal and vertical axes, a stationary templet, a templet follower engaging the templet and regulating the angular position of the arbor with respect to its vertical axis, and means intermediate the arbor and follower serving to move the latter upon the templet in accordance with the movement of the arbor on its horizontal axis.

22. In gear cutting apparatus, the combination of a blank-carrying arbor, means for carrying said arbor so that it may turn on intersecting horizontal and vertical axes, a stationary templet, a templet follower engaging the templet and regulating the angular position of the arbor with respect to its vertical axis, means for holding the follower against the templet, and means intermediate the arbor and follower serving to move the latter upon the templet in accordance with the movement of the arbor on its horizontal axis.

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Witnesses:
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