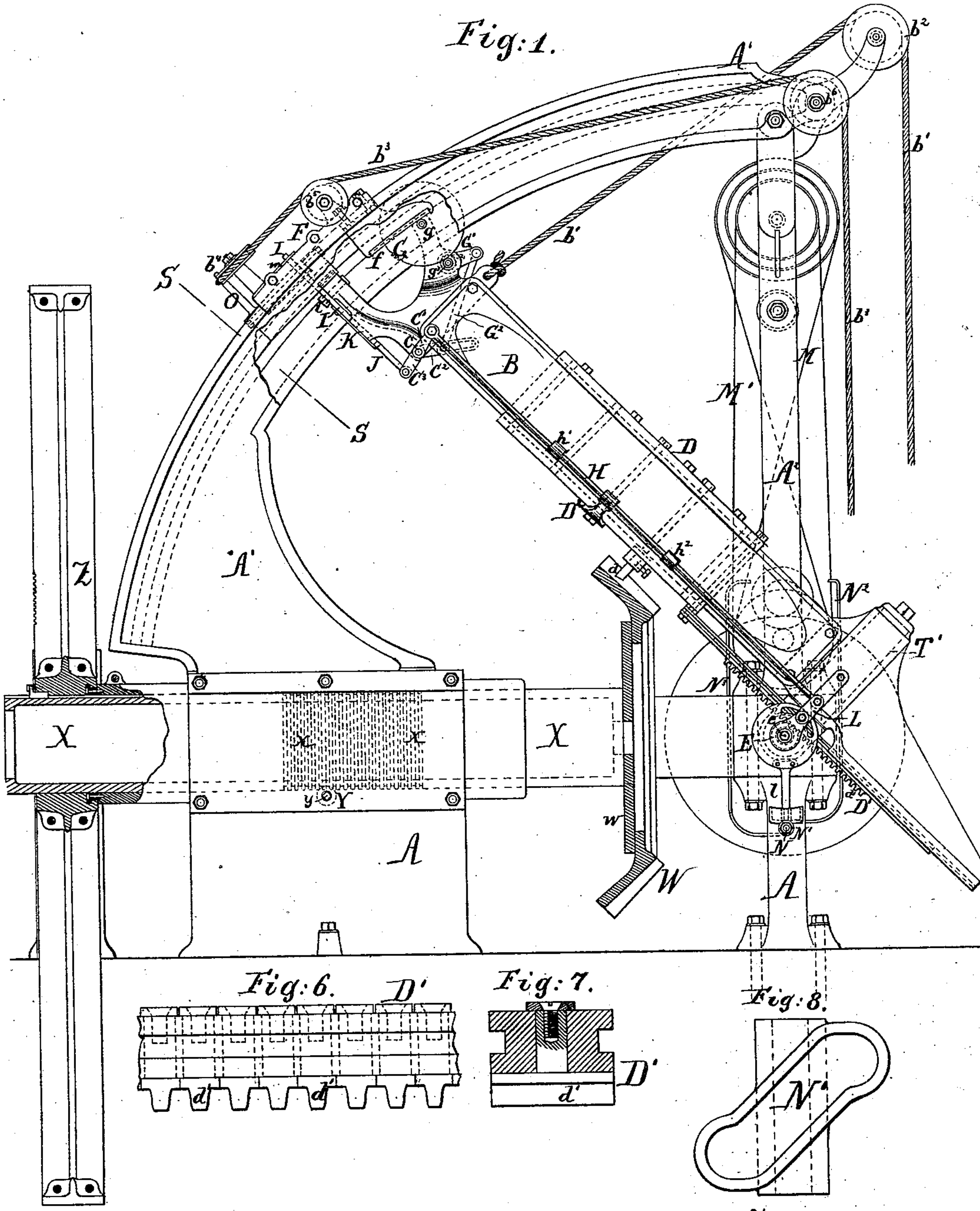
4 Sheets—Sheet 1.

G. H. CORLISS.

GEAR-CUTTING MACHINE.

No. 190,470. Patented May 8, 1877.



Witnesses:
M. A. Cayfilers
A. Henry Gennner Jr.

Inventor:
Geo. H. Corliss.
by his attorney
T. D. Stetson.

N. PETERS, PHOTO-LITHOGRAPHER, WASHINGTON, D. C.

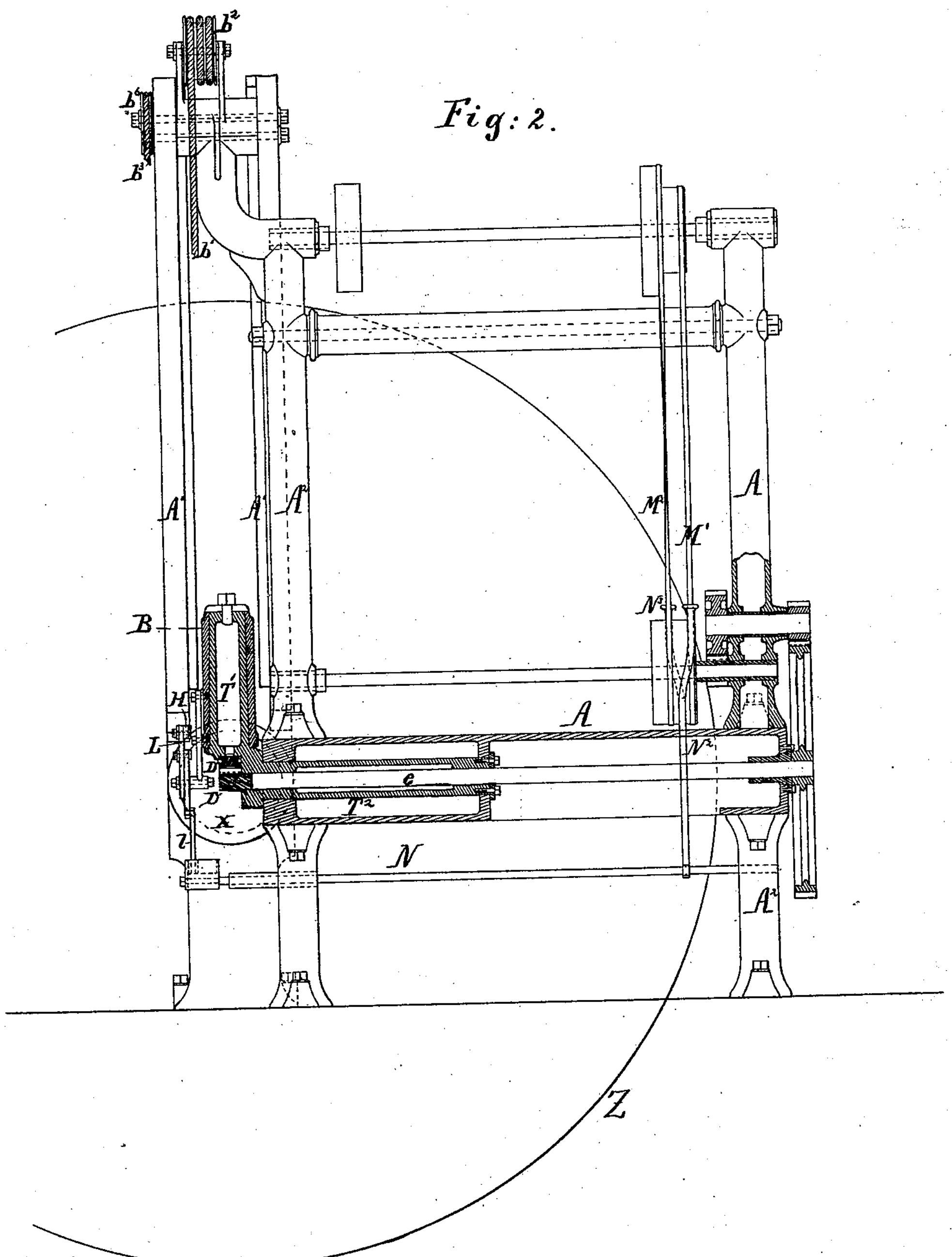
4 Sheets—Sheet 2.

G. H. CORLISS.

GEAR-CUTTING MACHINE.

No. 190,470. Patented May 8, 1877.

Fig: 2.



Witnesses:

M. A. Cayless,

A. Henry Gentner

Inventor:

Geo. H. Corliss,

by his attorney

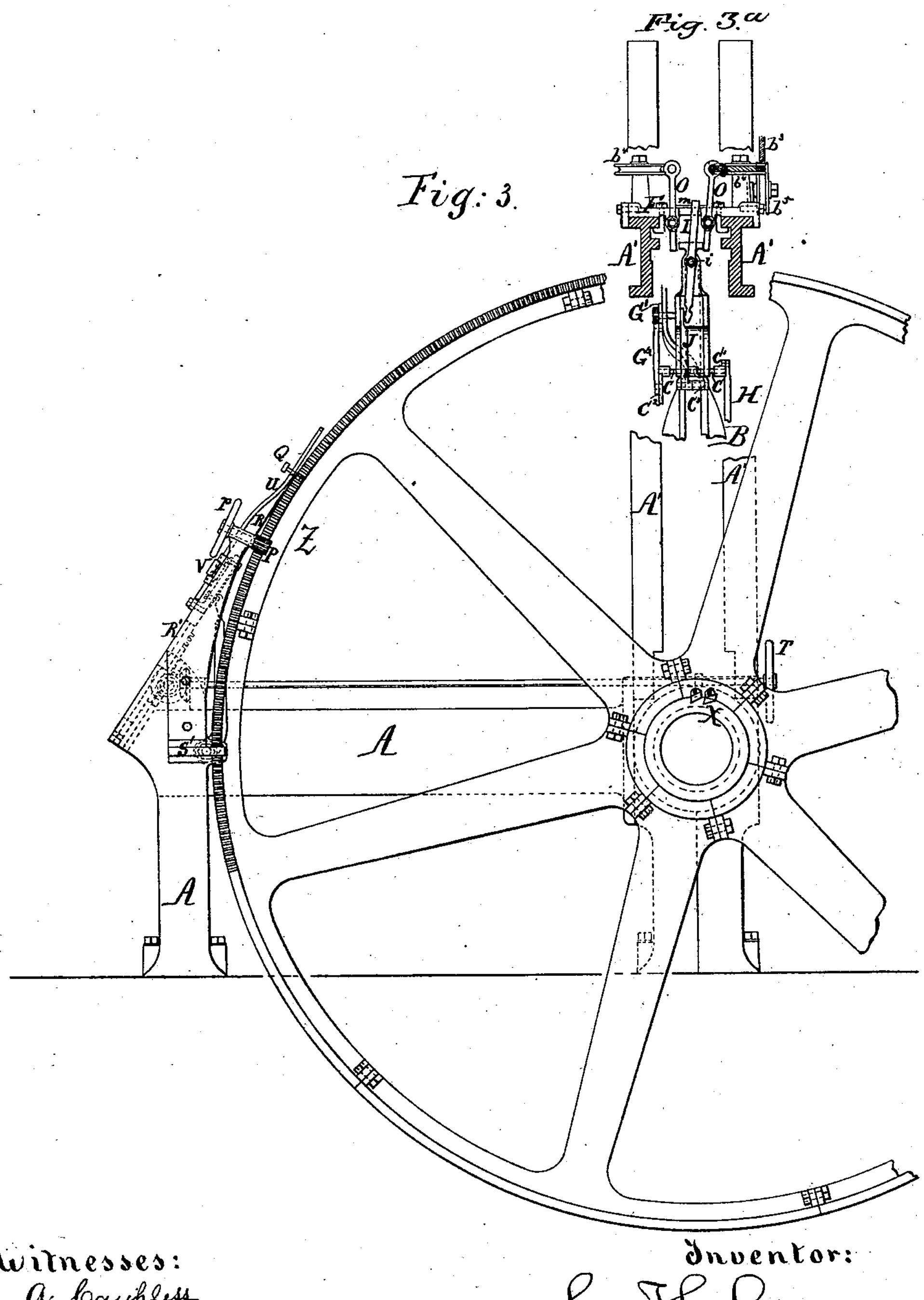
T. D. Stetson.

N. PETERS, PHOTO-LITHOGRAPHER, WASHINGTON, D. C.

G. H. CORLISS.

GEAR-CUTTING MACHINE.

No. 190,470. Patented May 8, 1877.



Witnesses:

M. A. Cayhless

A. Henry Gentner

Inventor:

Geo. H. Corliss.

by his attorney

T. D. Stetson

4 Sheets—Sheet 4.

G. H. CORLISS.

GEAR-CUTTING MACHINE.

No. 190,470. Patented May 8, 1877.

Fig: 4.

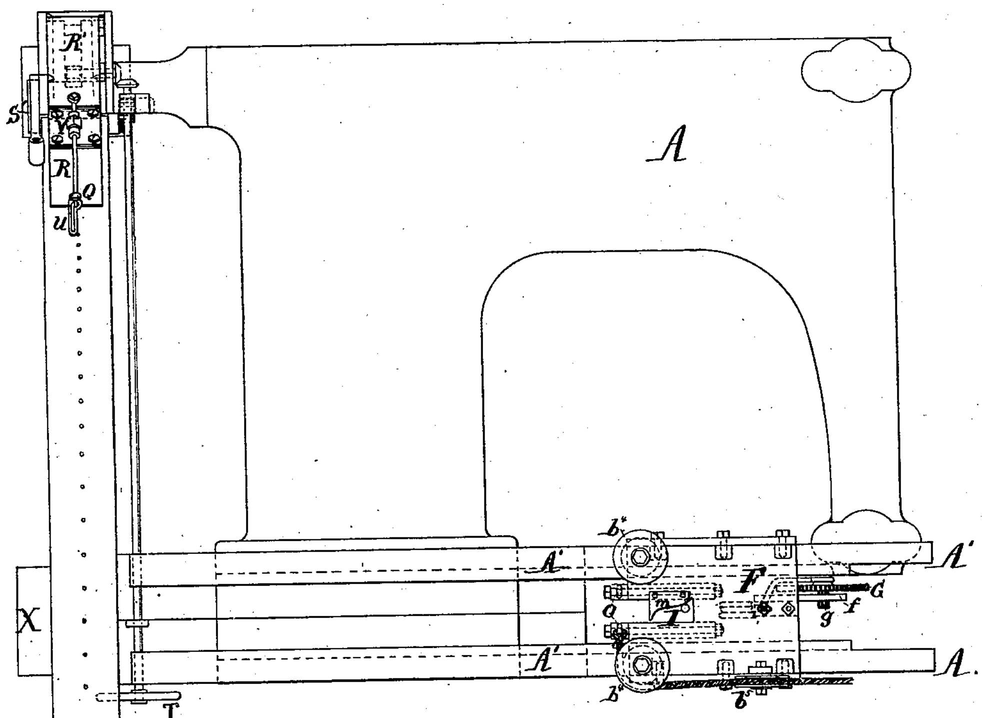
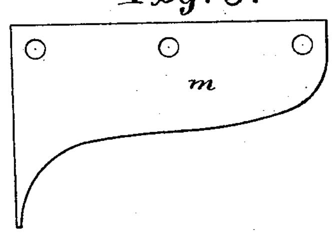


Fig: 5.



Witnesses:
M. W. Bayless
A. Henry Gentner

Inventor:
Geo. H. Corliss,
by his attorney
T. D. Stetson
New York

N. PETERS, PHOTO-LITHOGRAPHER, WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

GEORGE H. CORLISS, OF PROVIDENCE, RHODE ISLAND.

IMPROVEMENT IN GEAR-CUTTING MACHINES.

Specification forming part of Letters Patent No. **190,470**, dated May 8, 1877; application filed March 27, 1877.

To all whom it may concern:

Be it known that I, GEORGE H. CORLISS, of Providence, in the State of Rhode Island, have invented certain new and useful Improvements relating to Gear-Cutting Machines, of which the following is a specification:

The mode of operation of my improved machine is analogous to that of the machine set forth in the patent to me, dated March 10, 1849. The machine is adapted to cut bevel-gears of large size, with any required bevel, and gives the proper forms to each tooth, with the same contour of the tooth throughout. The required outline is produced, not by a milling but by a planing operation.

The planing-tool is guided by a templet of sheet-steel or analogous material, previously carefully wrought to the proper form. The cutting-tool, as it is fed or intermittently moved during the planing operation, is guided by the edge of that templet. The planing-tool is carried on a slide, which is guided on a rigid trunk, which is adjustable at various inclinations, according to the bevel of the wheel required; but, instead of holding that adjustable bar or trunk by the end nearest to the large side of the wheel, I hold it at the center, or the point where the converging lines of the several teeth would meet. The improved machine also differs from that described in my former patent in the provisions for holding the cutting-tool, the provisions for operating it, the provisions for holding and adjusting the position of the wheel the teeth of which are to be cut, and in various other points, including provisions for more exactly adjusting and confining the wheel as it is successively turned and held for the several teeth to be cut.

My machine cuts, like its predecessor, one side of each tooth first; it is then readjusted, and various parts, including the templet, are reversed in position to dress or cut the other side of each tooth.

The following is a description of what I consider the best means of carrying out the invention.

The accompanying drawings form a part of this specification.

Figure 1 is a side elevation, partly in section. Fig. 2 is a front elevation, partly in section; and Fig. 3 is a rear view of some of the principal parts. Fig. 3^a is a cross-section of a portion on the line *s s* in Fig. 1. The wheel in Fig. 3 is broken away to allow the section Fig. 3^a, and the parts beyond the section, to be seen in an approximately correct position relatively thereto. Fig. 4 is a plan view of the machine with certain parts removed. Fig. 5 represents the templet detached. This is on a much larger scale than the figures previously referred to. The succeeding figures represent details detached, also on a large scale. Fig. 6 is a side elevation of the peculiar rack by which the slide carrying the cutting-tool receives motion. Fig. 7 is a cross-section of the same. Fig. 8 is a plan view of the device by which the proper end motion is communicated to the belt-shifter at the end of each movement of the cutting-tool.

Similar letters of reference indicate like parts in all the figures.

A is a fixed framing of cast-iron, forming an unyielding support for all the parts. Portions will be designated by further marks A^1 A^2, &c. The framing is firmly held down upon the ground or a suitable flooring by bolts, as represented. The flooring must allow the large index-wheel to extend below it, and also allow the gear-wheel which is to be cut to similarly extend below when required.

An important portion of the rigid framing I denominate a "quadrant." It is double, or formed in two parts, parallel to each other, (marked A^1 A^1.) An upright, A^2, stiffens the upper end of the quadrant.

The wheel to be cut, or rather the rim on which the principal work is to be bestowed, and which, in this case, is made separately from the center, is marked W. (See Fig. 1.) It is bolted upon a center piece, *w*, which is bolted firmly upon a large arbor, X, supported in a long bearing in the framing, and formed with a series of encircling grooves, *x*, which receive the gear-wheel Y, (shown in dotted outline,) mounted on a shaft, *y*, and adapted to be turned by a crank, (not represented,) to adjust the position of the arbor axially. Z is a large index-wheel, set adjustably but rigidly upon the arbor X, and by turning which the several teeth of the wheel W are successively presented to be treated, as will appear further.

The cutter is guided by a stout and rigidly straight trunk, B, which turns on an axis, T^2, which is at right angles with the axis of the arbor X. This trunk B is capable of being swung or turned up and down nearly the whole range of the quadrant A^1, according as the wheel is required to be beveled at different angles.

D, Fig. 1, is a slide, which embraces the trunk B and carries the tool *d*. D^1 is a rack, forming, practically, an extension of the slide D. The teeth *d'* of this rack D^1 are each capable of swiveling slightly, in order to accommodate themselves to a slight lateral swinging of the trunk B, which will be described farther on.

E is a spur-gear wheel, mounted on a shaft, *e*, Fig. 2, and engaging with the teeth *d'*, to operate the slide D, and consequently the cutter *d*. The shaft *e* is driven by gearing operated by reverse belts on fast and loose pulleys in a manner analogous to ordinary planing-machines. These parts are clearly shown in Fig. 2. The slide D, and consequently the cutter *d*, is moved backward and forward to dress the bevel-gear by a process analogous to planing, but guided to give the desired contour to the teeth.

The union of the trunk B with its axis is effected by a universal joint. It is stiff in the direction to prevent the trunk B from twisting, but allows it to swing up and down and laterally, as required.

Each cut of the planing-tool *d* is in a line directly to and from the center where the axis T^2 crosses the axis of the arbor X *x*.

The general position or inclination of the trunk B having been determined according to the inclination of the bevel of the teeth, the upper end must be raised and lowered in planing each tooth to an extent corresponding to the depth of the teeth, and it must be moved laterally to an extent corresponding to the width of the tooth, or half the tooth.

In practice I plane only one side or half of each tooth at one operation, and after planing the corresponding side of every tooth, I readjust the mechanism and plane the other side of each.

Mechanism is mounted adjustably on the quadrant to control the movement of the outer or upper end of the trunk B during the dressing of a tooth. A templet, *m*, is prepared, as indicated in Fig. 5, and the projection from the trunk B is caused to traverse slowly along its curved edge.

Two ropes are employed, which, by means of weights, (not shown,) exert constant force on the trunk. The rope b^1, running over a pulley, b^2, as shown, tends to balance the weight of the trunk B and its connections. The rope b^3, running around three pulleys, b^4 b^5 b^6, and carrying a weight, (not represented,) exerts, through the lever O, pivoted on a center fast on the quadrant A^1 A^1, a constant lateral force on the trunk B, tending to move it sidewise and hold it firmly against the edge of the templet.

The slide D may be required to traverse to various extents, according as the gear-wheel to be cut is wide or narrow, and the tool *d* may be required to be set in different parts of the slide D, according as the wheel is large or small. I provide a series of holes with suitable holding means adapted to receive the cutter *d* at different points in the slide D. I can furthermore adjust the operating of the slide D, itself, further up and down or out and in on the trunk B, the rack D^1 being sufficiently long to allow of such adjustment within wide limits.

The reversing of the motion of the slide is effected by means analogous to that by which ordinary planing-machines are reversed. An arm, D^2, Fig. 1, extending from the slide D, embraces a rod, H, lying parallel to the direction of the motion, and carrying adjustable stops h^1 h^2. This rod is connected to an arm, L, Figs. 1 and 2, turning loosely on the extended end of the shaft *e*, or, preferably, as shown, on a center otherwise firmly held in the same line, equipped with the usual adjustments, and with means for changing the driving-belts M^1 M^2, respectively, from the fast and loose pulleys, as the arm *l* is thrown in one direction or the other. The means by which this is effected is shown with tolerable clearness in Figs. 1 and 2. The arm *l* extends from the lever L beyond the center or pivot of its motion, and works, as a lever of the second order, in a peculiar slot, N^1, Fig. 8. This gives an end motion to the rod N, and thus moves the arms N^2 N^3, which embrace the belts M^1 M^2. There is, preferably, a roller on the end of the arm *l* to work in the slot N^1.

The end movement of the rod H at each termination of the movement of the slide D not only ships the belts and reverses the motion of the slide, and induces the proper feeding downward of the trunk B to put it in position for the next cut, but also swings the trunk B and its connections, so as to hold the tool slightly out of contact during the return motion.

Both these movements are effected from the single rocking shaft C, which is rocked by means of the arm C^1, pivoted to the rod H. There are two other arms, C^2 C^3, on this rocking shaft. The arm C^2 operates the feeding down, and the arm C^3 operates the holding off of the tool during the return motion. I will describe these motions separately, and first the feeding down.

F is a stout piece of framing adjustable in any required position on the quadrant A^1, and held by hooked bolts, Fig. 3^a. A rack, *f*, thereon, Fig. 1, receives the teeth of a pinion, *g*, which is operated by a large gear-wheel, G, which receives motion from a pinion, *g'*, turned intermittently through the action of a ratchet-wheel on the same shaft turned by a click on the lever G^1. This lever is actuated by a link, G^2, which gets a reciprocating motion from the arm C^2.

Next, the holding away of the tool. I is an arm smoothly rounded and hardened, and adapted to bear delicately but firmly against the edge of the templet *m*. This arm I turns on a pivot, *i*, in the end of the trunk B. The other end of the arm I is beveled, as shown in Fig. 3^a, and is controlled in position by a slide, J, (see Figs. 1 and 3^a,) which is pivoted to the arm C^3. A spring, K, Fig. 1, holds these parts I and J in intimate contact in a recess provided, so that the rocking of the shaft C alternately in one direction and the other, when the tool *d* reverses its motion, also by the end movement of the part J and its action upon the arm I, turns the arm I slightly upon the pivot *i*, and swings the entire trunk B sufficiently.

There are two of the pulleys b^4 adapted to allow the rope b^3 to be so reversed as to pull the trunk B either way, according as one side or the other of the teeth is being dressed.

It will be understood that the templet *m* must be turned over or shifted in position when the opposite sides of the teeth are to be dressed. This mechanism and its relation to the double quadrant is clearly shown in Fig. 4 and in Figs. 1 and 3^a.

Variations in the hardness of the metal, as well as in the depth of cut required in different portions of the wheel, make it important to provide means for not only turning the arbor X with exact mathematical accuracy in preparing to cut the next tooth, but also for holding it against any springing. I have provided for this as follows:

The edge of the wheel Z is toothed, and receives the teeth of a pinion, P, Fig. 3, supported in a bearing on the fixed framing and turned by a hand-wheel, *p*. There are series of equidistant holes around the periphery of the wheel Z. A pin, Q, is shifted by hand, as required, from one hole to the next, or to the alternate second or third or other hole, as may be previously determined, according to the number of teeth. Now, in order to turn and hold the wheel Z with the required accuracy and force, I turn until the pin Q is brought into contact with the upper edge of a thin, but sufficiently stout, stop-plate, R. When the wheel has been turned to bring the pin Q into firm contact with the upper edge of the stop R it is clamped by a strong clamp, S′.

When a wheel is bolted on the arbor it is not easy to set it with its teeth in exact relation to the holes in the periphery of the wheel Z. I can accommodate that by moving the stop R up or down a little after the wheel has been fixed to the arbor. This is effected by mounting the stop R on a slide, R′, carried in guides on the framing, and operated by gearing from the hand-wheel T, as indicated in Figs. 3 and 4.

In order to easily and certainly insure uniform and just sufficiently forcible contact of the pin Q with the upper edge of the stop R, I have further provided a slotted hooked piece, U, operated by a nut, V, to which a wrench may be applied. On finishing the treatment of one side of a tooth the wheel Z may be turned backward a little to bring the pin Q out of its previous firm contact with the stop R and allow its removal. This pin is then removed and shifted to another hole, still within the slot in the piece U, which slot must be made long enough to accommodate the greatest pitch which the machine will ever be required to cut. On turning the wheel Z by the hand-wheel *p*, acting through the pinion P, until the pin Q is brought down into a loose contact, or an approximate contact, with the stop R, I swing the slotted hooked piece a little, after engaging the pin Q in the hooked end of the slot, operate the nut V, and draw Q into very firm contact. This is done before the tightening of the clamp S′. Of course, on liberating the parts to turn the wheel again, the nut V must be slackened, to allow the slotted hooked piece U to be disengaged again.

Aside from the facilities which this form of the framing and general arrangement gives for using a large wheel, Z, and the several improved details of the mechanism, I esteem this construction intrinsically superior to my former machine, in the fact that the trunk B, which carries the slide, is firmly held at the apex of the cone, to which the lines converge. The old construction held the wheel to be cut in a horizontal plane, and held the guide or trunk (corresponding to my trunk B) only at the lower end. The upper end, toward which the lines converge, was left unsupported and liable to spring. The present machine is very firmly held at that point by a universal joint.

The construction of that joint is shown quite clearly in Figs. 1 and 2, but additional description may be of service. A casting, T^1 T^2, Fig. 2, is employed having two parts standing at right angles. The lower or horizontal arm T^2 is adapted to turn in the framing A, and supports the shaft *e* in its central line, with liberty to turn freely in one direction, and the other to operate the tool *d*. The other arm, T^1, (represented in Fig. 2 as upright,) is smoothly turned on its exterior, and stands within a corresponding cylindrical or slightly-tapered hole bored in the trunk B. The work forms a universal joint by the turning of the casting T^1 T^2 in the horizontal bearings, to allow the trunk to be raised and lowered, and by the turning of the trunk B itself in its bearing on the upright arm T^1 of the part T^1 T^2, to allow the trunk to move laterally.

I claim as my improvement in gear-cutting machines—

1. The guiding bar or trunk B, jointed to the framing in line with the axis of the arbor

X, in combination with mechanism for taking hold of and guiding said bar at its opposite extremity, as herein specified.

2. The bar or trunk B and cross-shaft *e*, crossing each other at the center of the universal joint T^1 T^2, in combination with the quadrant A^1 A^1, as herein specified.

3. The rack D^1, having the swivel-teeth *d'*, in combination with the operating-shaft, tool-carrier D, and its guiding mechanism, with the arbor X, supporting the wheel to be cut, as herein specified.

4. The grooved arbor X, supporting the index-wheel Z, and adapted to hold the wheel to be cut, in combination with the operating-pinion Y, and with the reciprocating tool *d* and its operating means, guided by the adjustable bar or trunk B, as herein specified.

5. The adjustable stop R, in combination with the pin Q on the index-wheel Z, and with means for turning the latter, as herein specified.

6. The hooked piece U, in combination with the stop R, wheel Z, and with suitable gear-cutting mechanism, as herein specified.

In testimony whereof I have hereunto set my hand this 28th day of September, 1876, in the presence of two subscribing witnesses.

GEO. H. CORLISS. [L. S.]

Witnesses:

GEO. A. DODGE,
GEO. W. KENNEDY.