T. GREENWOOD.

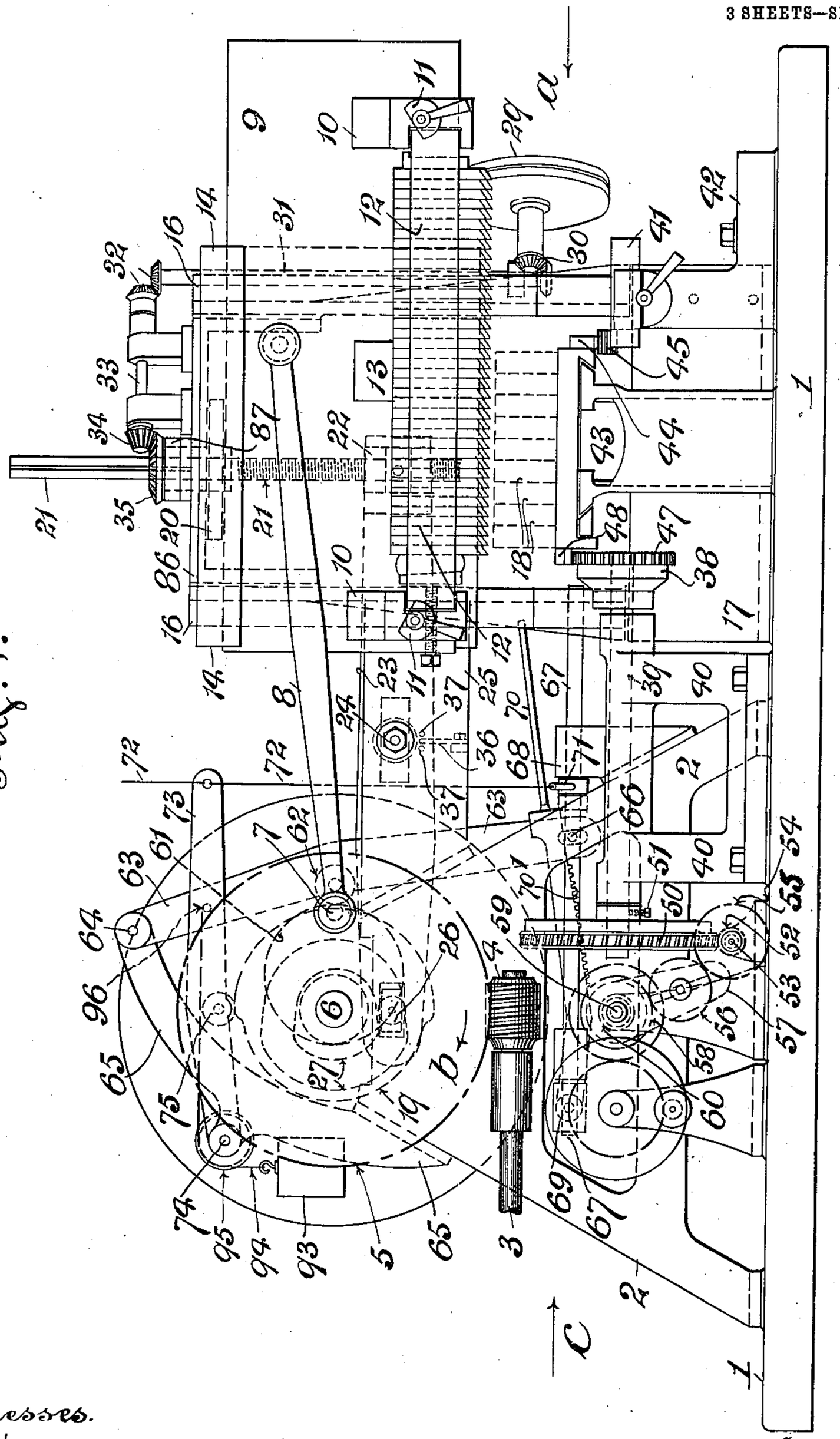
GEAR CUTTING MACHINE AND CUTTERS.

APPLICATION FILED JULY 15, 1907.

966,683.

Patented Aug. 9, 1910.

3 SHEETS—SHEET 1.



Witnesses.

A. Wagner.

L. B. Middleton

Inventor.

Thomas Greenwood

by Herbert W. Jenner.

Attorney.

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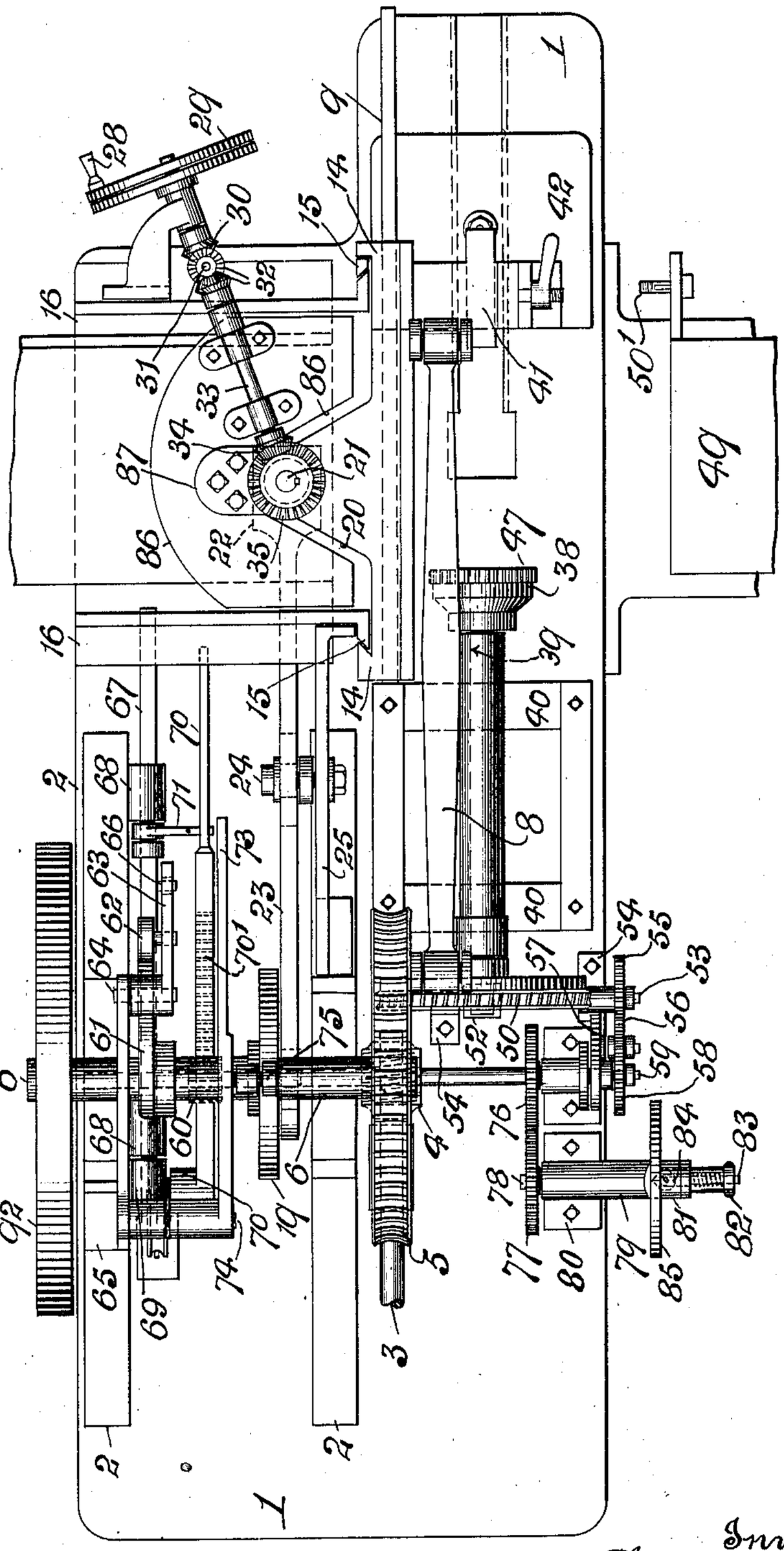
3 SHEETS—SHEET 2.

Fig. 2.



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3 SHEETS—SHEET 3.

Fig. 3.

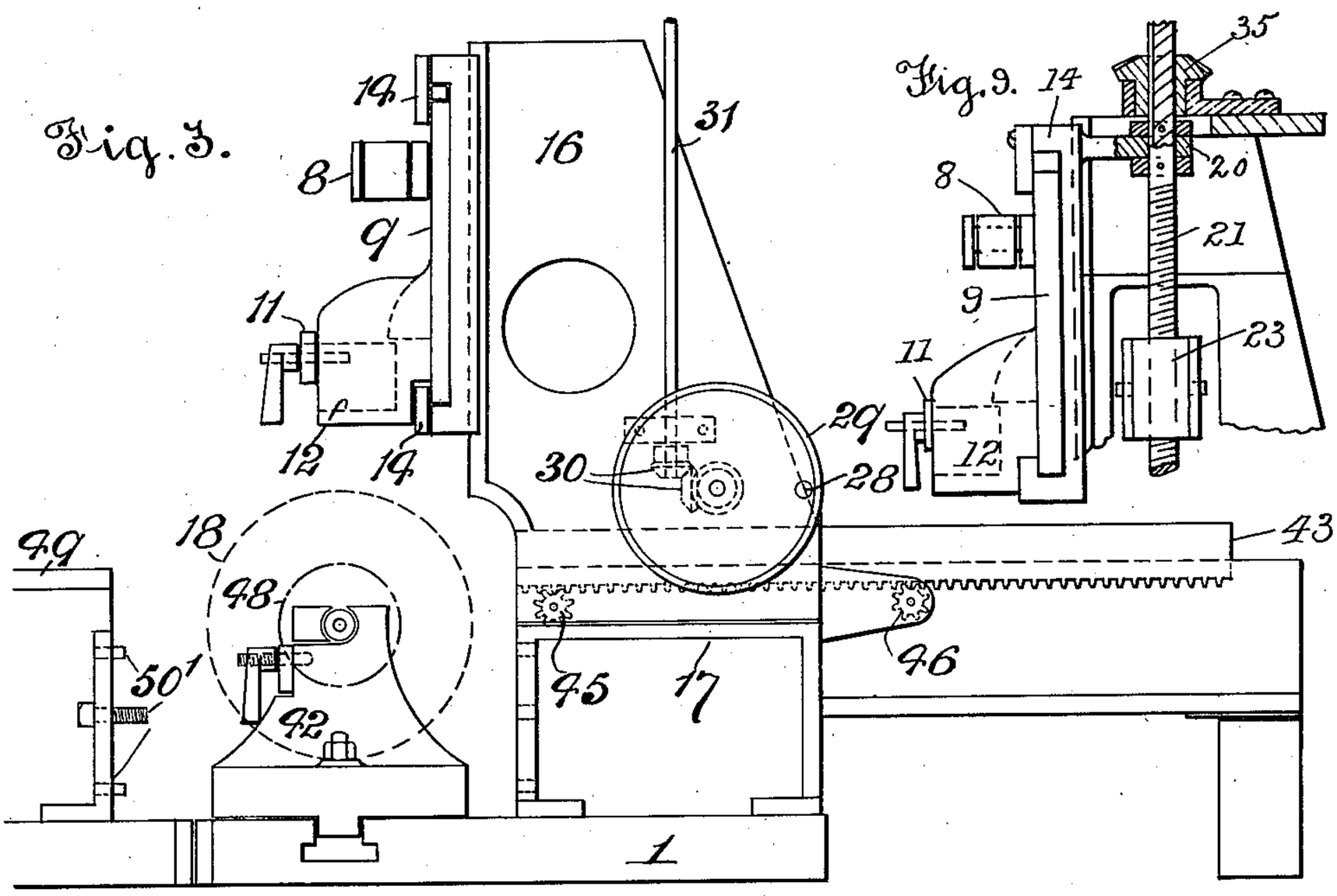

Fig. 9.

Fig. 4.

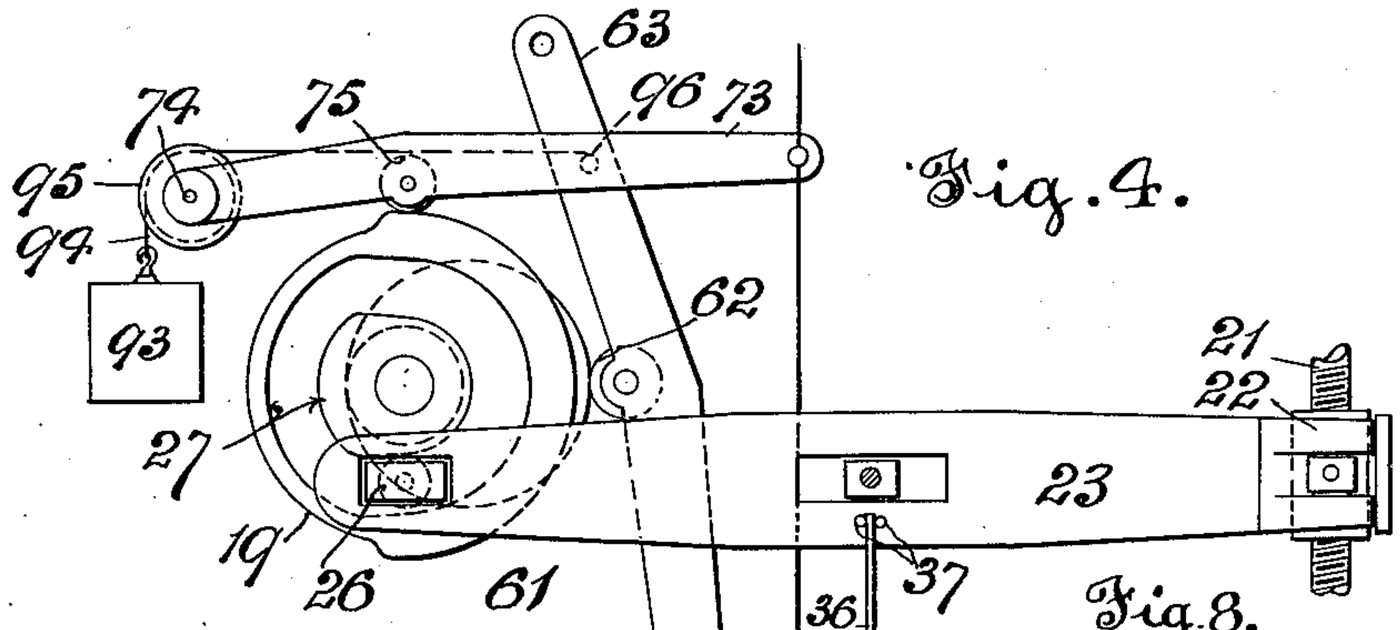

Fig. 8.

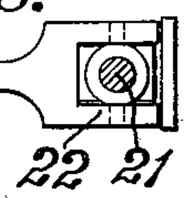

Fig. 7.

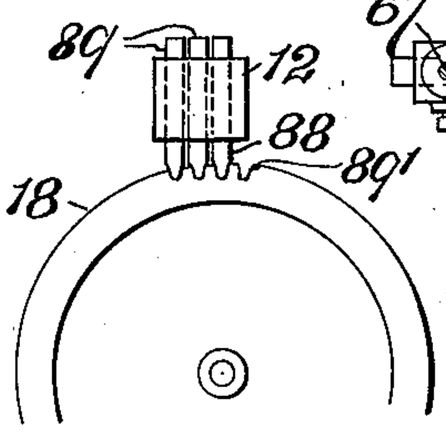

Fig. 5.

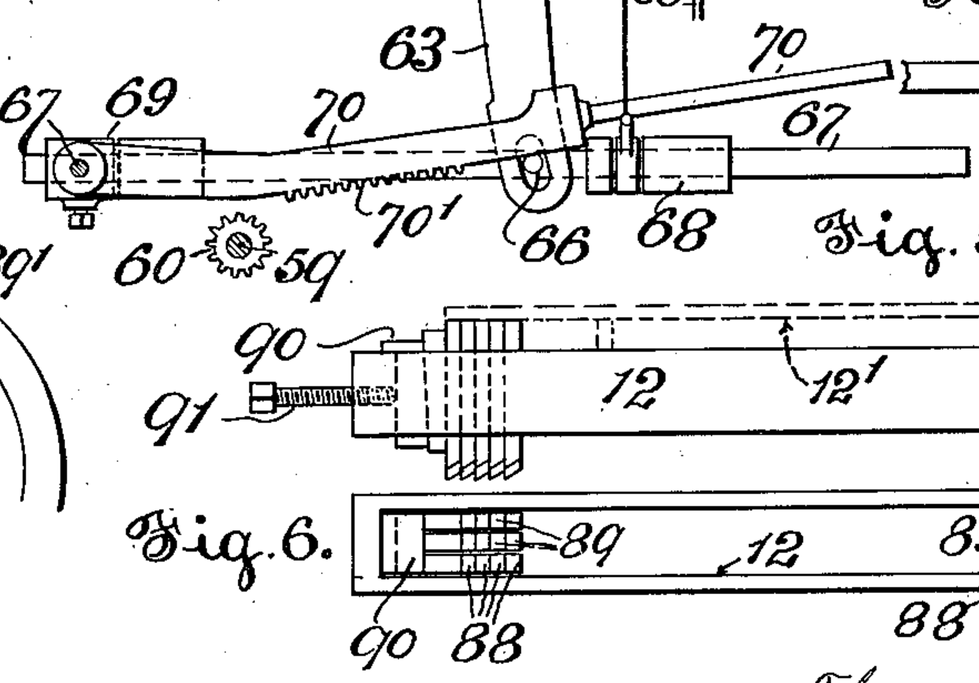

Fig. 6.

Witnesses.

A. Wagner.

L. B. Middleton

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UNITED STATES PATENT OFFICE.

THOMAS GREENWOOD, OF HALIFAX, ENGLAND.

GEAR-CUTTING MACHINE AND CUTTERS.

966,683. Specification of Letters Patent. Patented Aug. 9, 1910.

Application filed July 15, 1907. Serial No. 383,848.

To all whom it may concern:

Be it known that I, THOMAS GREENWOOD, a subject of the King of Great Britain, residing at Halifax, in the county of York, England, have invented certain new and useful Improvements in Gear-Cutting Machines and Cutters, of which the following is a specification.

This invention relates to machines for cutting gear teeth in metal blanks to form wheels or racks, the object of my improvements being to produce a novel machine by which gear teeth can be automatically and accurately cut at a rate considerably in advance of anything hitherto attained.

In carrying out my invention, I employ a special construction of metal box or holder in which are fixed one or more rows of single cutters, or each row of cutters may be in one piece. For wheels of small diameter one or two rows of cutters only are employed, but for wheels of large diameter and for cutting rack teeth, I may use three, four, and up to eight or more rows of single cutters. The cutters are, or may be, shaped to cut the points or tops of the teeth. In all cases one row of these cutters acts as master cutters, which both give the true pitch and the correct shape to the teeth. This row of cutters is always set central in the plane of the axis of the wheel. The other rows of cutters, which however only act as roughing or stock cutters may be the same shape as the master cutters. In rack cutting all the cutters are the same correct shape, and the last row of cutters act as master cutters, the preceding rows doing all the roughing out, and leaving only enough depth of cut for the master row to impart the true shape of tooth.

The box or holder containing the rows of cutters is mounted adjustably on a slide and is adapted to be reciprocated over or against the wheel or rack blanks, which are supported beneath or close to the path of the cutters. The construction of the machine and of the various motions it embodies for setting and feeding the work and the cutters, will be hereinafter clearly set forth.

In the accompanying drawings to which I will now refer, Figure 1 is a front elevation of the principal parts of a wheel or rack tooth cutting machine embodying my improvements, and being arranged to cut horizontally; Fig. 2 is a plan view of Fig. 1, the cutter box and cutters, and the cutter box supports, being omitted; Fig. 3 is an end view of some of the parts shown in Fig. 1, looking in the direction of arrow *a*, Fig. 1; Fig. 4 is a separate view showing in elevation some important motions hereinafter referred to, these being also shown in Figs. 1 and 2; Fig. 5 is a detached view of the cutter box with a few of the cutters in position; Fig. 6 is a plan view of Fig. 5; Fig. 7 is a face or end view of a wheel blank and cutter box with three rows of cutters; and Fig. 8 is a plan view of the end of the lever 8 in Fig. 4. Fig. 9 is an end view of the slides 9 and 14 showing the adjustable connection of the screw 21 with the lever 23, portions of the connecting devices being shown in section.

Referring to the drawings, Fig. 1 represents the foundation plate of the machine, and 2, 2 represent two **A** shaped frames mounted thereon.

3 is a driven shaft to which motion is imparted from any convenient source, and which has a worm 4 fast thereon, and gearing with a worm wheel 5 fast on a shaft 6, supported in bearings (not shown) from the frames 2.

92 is a fly-wheel of any approved construction secured on the shaft 6.

The worm wheel 5 has fast to it a crank pin 7 on which is mounted one end of a connecting rod 8, the other end of the said rod being mounted on a stud fast to the horizontal slide 9, which is provided with two suitable projecting parts 10, 10, having means such as locking plates 11, 11, by which the cutter box 12 can be quickly fixed in position. A central projection 13 on the slide 9 acts as a steady against which the top edge of the cutter box bears. The horizontal slide 9 is adapted to work in ways in the vertical slide 14 which is movable on the guides 15, 15, formed on the standards 16, 16, mounted on the horizontal casting 17 fast to the foundation plate 1.

The parts 18 shown in dotted lines in Fig. 1, may be taken as representing a number of rack or wheel blanks to be cut. It will thus be clear that if the shaft 6 be rotated in the direction of the arrow *b* (Fig. 1) the cutter box and cutters will, through the connecting rod 8, be moved across the work, half the cutters commencing to cut at once, and the remaining cutters coming into action as the forward stroke is completed.

A gradual down feed is given to the cut-

ter box as the forward or cutting stroke is being made, by means of the cam 19 fast on the shaft 6. The vertical slide 14 has a projection 20 forming a neck bearing on the vertical screw 21, which screw is connected by a swivel joint 22 with one end of the lever 23 pivoted adjustably on the stud 24 fast to the stay 25. The opposite end of the lever 23 carries a pulley 26 which works in the cam groove 27 of the cam 19. It will be evident that as the shaft 6 and with it the cam 19 revolves, the pulley 26 will, as the cutter box moves forward to cut, be lifted nearer to the center of the cam and that consequently the opposite end will be depressed, giving a suitable and gradual down feed to all the cutters. As the cutter box completes its forward stroke and commences to move backward, the cam slot 27 causes the vertical slide 14 to be raised so that as the cutters move back they are clear of the work.

36 is a spring blade having its lower end fixed to the stay 25 and its free upper end working between two pins 37 on the lever 23 to normally hold said lever in a central position.

I may dispense with the gradual feeding of the cutters during the cutting stroke by canting or tilting the cutter box containing the cutters, or by so setting the cutters in the box, that the rear ends of the cutters are lower than the front ends by an amount equal to the depth of one of the teeth to be cut, when one or two rows of cutters are employed. When three or more rows of cutters are employed the rear ends of the cutters will need to project less than the depth of the tooth according to the number of rows of cutters in use, since each row of cutters cuts a part of the tooth. This arrangement necessitates a stroke of such increased length being given to the cutter box, that all the cutters slide clear of the blanks being cut at each end of the stroke. No downward or central feed of the cutters during the stroke is required, but only one half of the work can be done in a given time as compared with the previously described feeding arrangement.

When starting the machine the operative feeds down the vertical slide 14 to set the cutters down to their work by means of the crank handle 28 attached to the index wheel 29. This index wheel operates through bevel wheels 30, vertical shaft 31, bevels 32, and shaft 33 to a bevel 34 meshing with a bevel 35 connected with the upper plain and keyed portion of the vertical screw 21 by a feather, so that operation of the said index wheel causes the screw to be rotated and the slide 14 raised or lowered as the case may be. The exact depth of the cutters would of course be set while the cutter box is taking the cutting stroke.

If wheel blanks are to be cut they are threaded on an arbor, one end of which is clamped to the chuck or face plate 38 fast to a spindle 39 mounted in a bracket 40 fast to the foundation plate 1. The other end of the arbor carrying the blanks is supported in a portable bush 41 carried in an adjustable headstock 42. When cutting racks the blanks are supported on and clamped to a table or bed 43 adapted to be moved under the cutter box and provided with a rack 44 and rack pinions 45 and 46 for this purpose. The face plate 38 when cutting racks carries a rack wheel 47 which is adapted to gear with a rack 48 on the underside of the rack table.

49 is an auxiliary bed which may be coupled to the rack table 43 by steady pins and screw 50′. When the rack blanks have been clamped in position on the rack table 43 and auxiliary bed 49 the table is moved to a position to put the rack 48 into gear with the rack wheel 47.

Motion is transmitted to the spindle 39, to give the required feed to the work, in the following manner. The said spindle 39 has at the end opposite to the face plate 38, a worm wheel 50 adapted to be clamped to the spindle by a set screw 51. Meshing with the worm wheel 50 is a worm 52 mounted on a tangent or worm shaft 53 carried by brackets 54, 54. The shaft 53 has fast thereon a gear 55 meshing with a gear 56 on a stud fast to a swing plate 57. Meshing with the gear 56 is a change wheel 58 fast on the end of the shaft 59 on which is mounted a rack pinion 60. The worm wheel shaft 6 has fast on it an eccentric 61 which acts on a pulley 62 carried by a lever 63 pivoted at 64 to the bracket 65. The lower end of the lever 63 is slotted to receive a pin 66 on a shaft or bar 67 supported in bearings 68, 68. To a boss 69 fast on the shaft or bar 67 is pivoted a rack lever 70 having on its underside a rack 70′. The rotation of the eccentric 61 causes the shaft or bar 67 to be slid positively in the direction of the arrow *c* so that if the rack lever 70 be in its lowered position the rack pinion 60 will, as the cutter box is making its return or idle stroke, be rotated through one revolution. This rotation is transmitted through the intermediate gears to the spindle 39 and rotates the said spindle through a distance equal to the pitch of the teeth, this being determined by the change wheel 58. It would not, of course, do for the rack lever 70 to be constantly in gear with the rack wheel 60, as the spindle 39 must be at rest during the cutting stroke. I therefore mount loosely on the shaft or bar 67 an arm 71 projecting under an extension on the end of the rack lever 70. This arm is connected by wire 72 with the free end of a lever 73 pivoted at 74 on the bracket 65, and carrying a pulley 75 resting on the outer surface of the

cam 19. By the rotation of the cam the rack lever 70 is lifted out of gear with the rack pinion 60, that is to say it occupies the position shown in Fig. 1, while the cutter box is making its cutting stroke, and the said lever is lowered into a position to gear with the rack pinion when the cutter box commences its return or idle stroke. The wire or connection 72 is continued beyond the lever 73 to a position within reach of the operative, so that the rack can be put out, and if necessary held out, of gear at any time. When the rack lever has completed the rotation of the rack pinion 60 and has been lifted up clear of or out of gear therewith, it is returned to its original position by the weight 93, and cord 94 passing over the pulley 95 and connected at 96 with the lever 63.

The shaft 59 by which motion is transmitted from the rack pinion 60 to the change wheel 58 has fast on it a gear wheel 76 meshing with a gear wheel 77 of equal size. The gear 77 is fast on a spindle 78 journaled in the boss 79 of the bracket 80. Secured to the spindle 78 is the boss 81 of a crank handle 82 which handle is provided with a spring pressed spindle 83 carrying a small pulley 84. This pulley is adapted to be pressed, at every revolution of the shaft 59 into a V notch in the lower edge of the face of a division plate 85 formed on or integral with the boss 79. The crank handle affords a means of feeding the work by hand if desired.

It will be understood from the above description that the blank, either wheel or rack, is automatically fed forward the distance of one tooth during each return or idle stroke of the cutter box. When setting the parts to the position for starting, the worm wheel 50 must be free on the end of the spindle 39 and the rack lever 70 must be kept out of gear with the rack pinion 60 until ready for starting, when the worm wheel is clutched to the spindle 39 by the set screw 51 and the rack lever dropped into position.

86 is a plate, secured between the upper ends of the standards or guides 16, 16. 87 shows a bracket secured on this plate and forming a bearing for the boss of the bevel wheel 35.

The screw feeding engagement of the screw 21 is effected by means of a feather-key or spline secured in the hub of the beveled toothed wheel 35 which engages with a longitudinal key-way in the upper part of the screw 21. The projection 20 on the slide 14 is arranged between collars on the screw 21, and consequently the rotation of the screw 21 causes the distance between the projection 20 and the end of the lever 23 beneath said projection to be increased or diminished, thus moving the slides 14 and 9 and the cutter-box, and setting the cutters nearer to or farther away from the work. When the cutters have been set in this manner, the machine is started, and the slides 14 and 9 together with the cutter-box and cutters are moved up and down periodically by the lever 23, the screw 21 sliding up and down with them in the hub of the wheel 35.

Fig. 7 shows a left hand end view of three rows of cutters in process of cutting the second cut at one or more blanks. The row of master cutters is shown at 88, and two rows of roughing cutters at 89, 89. The cutters are so shaped that they form, while cutting out the opening between two teeth, one half of the top of each tooth on either side, as indicated at 89′, so that on working right around a wheel blank, the last tooth will be properly cut and finished. The master row of cutters are or may be set a step lower than the preceding row of roughing cutters, and each row of roughing cutters is or may be set a step lower than the preceding row of such cutters in order to suitably divide the cutting. The cutters may be conveniently secured in the cutter box by cotters 90 and screw 91. The cutter box 12 may be provided with a lid or thrust plate 12′. The cutters are made the same shape at the back as at the front, so that as the cutters are sharpened, by grinding the faces, they always retain exactly the same shape.

What I claim is:

1. In an external gear cutting machine the combination, with a cutter holder 12 adapted to carry one or more longitudinal rows of cutters, and means for securing cutters therein, of slide 9, means for securing the cutter holder 12 to said slide, slide 14 movable transversely of and carrying the slide 9, means for reciprocating said slide 9, a work holder, means for adjusting the position of the slide 14 relatively to said work holder, and means for moving said slide gradually toward the work during movement of the slide 9 in one direction, and away therefrom during movement of said slide in the opposite direction.

2. In an external gear cutting machine, the combination, with a cutter holder adapted to hold one or more longitudinal rows of cutters, means for securing cutters in said holder, a slide 9, means for securing said holder to said slide, a slide 14 movable transversely of and carrying the slide 9, and means for reciprocating said slide 9, of screw 21, adjustably pivoted lever 23, a swivel joint 22 between one end of said lever and the screw 21, means for rocking said lever 23 and a projection 20 on the slide 14, embraced by collars fast on the screw 21 and forming a neck bearing so that vertical movements of the said screw are transmitted to the slide 14.

3. In a gear cutting machine, the combi-

nation, with a cutter-holder, of a slide, means for securing the cutter-holder to the slide, a second slide movable transversely of and carrying the cutter-holder slide, a work-holder, means for adjusting the relative positions of the said work-holder and the second said slide, means for reciprocating one of the slidable parts crosswise of the other, and means for moving one of the slidable parts gradually toward the other during the cutting stroke and away therefrom at the commencement of the return stroke.

4. In an external gear cutting machine the combination with a slide, means for reciprocating same, a work holder, and means for adjusting the position of said slide relatively to the said work holder, of a cutter holder secured to said slide and adapted to carry one or more longitudinal rows of cutters, one end of the said cutter holder being set nearer the work holder than the other end.

In witness whereof I have hereunto set my hand in presence of two witnesses.

THOMAS GREENWOOD.

Witnesses:
FRANK LEWIN,
FRED S. HAMMOND.