F. BURGESS.

GEAR CUTTING MACHINE.

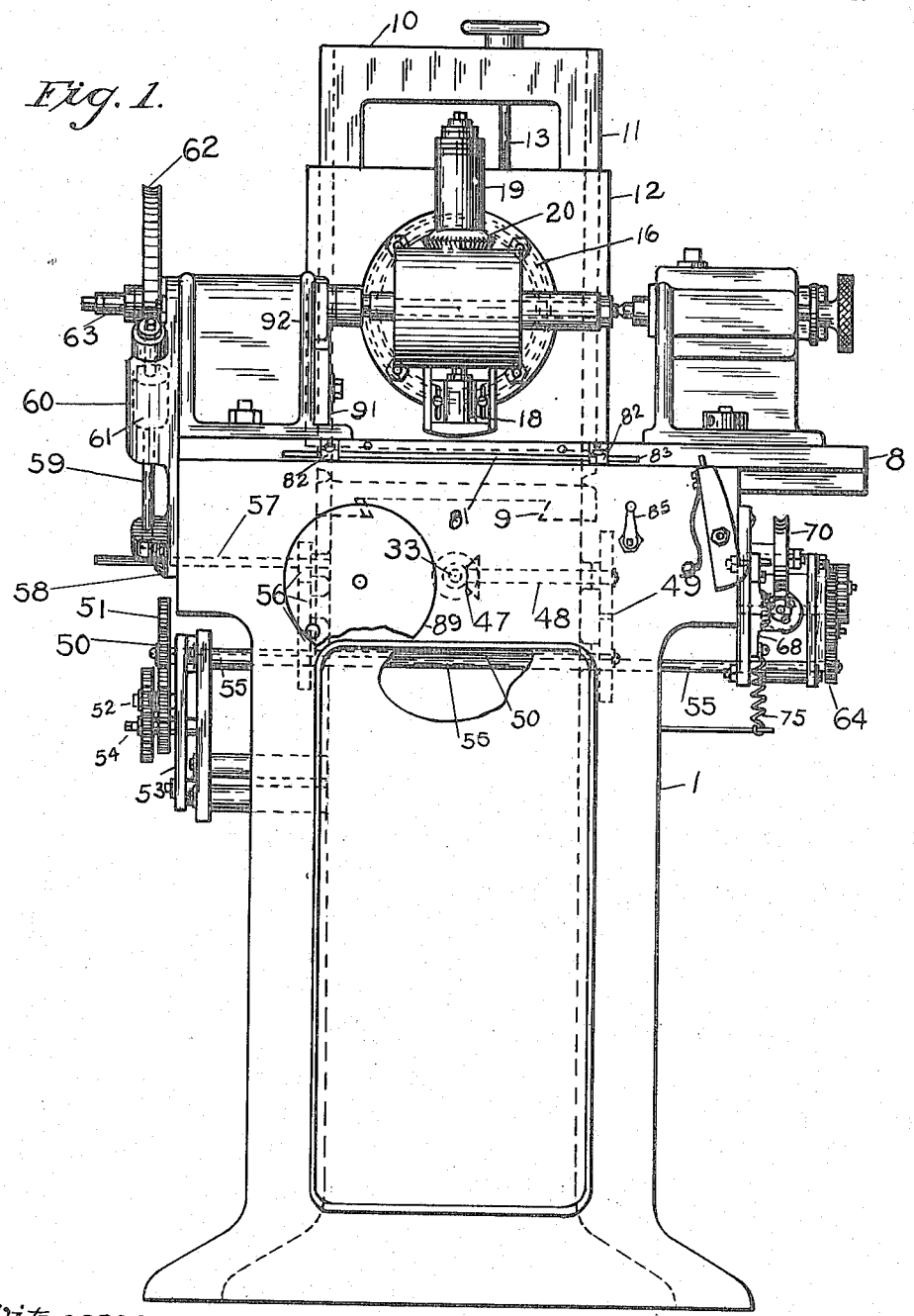
APPLICATION FILED APR. 2, 1913.

1,143,570.

Patented June 15, 1915.

6 SHEETS—SHEET 1.

Fig. 1.



Witnesses.

George L. Colburn

Louise A. Jordan

Inventor.

Frank Burgess

by Clyde L. Rogers

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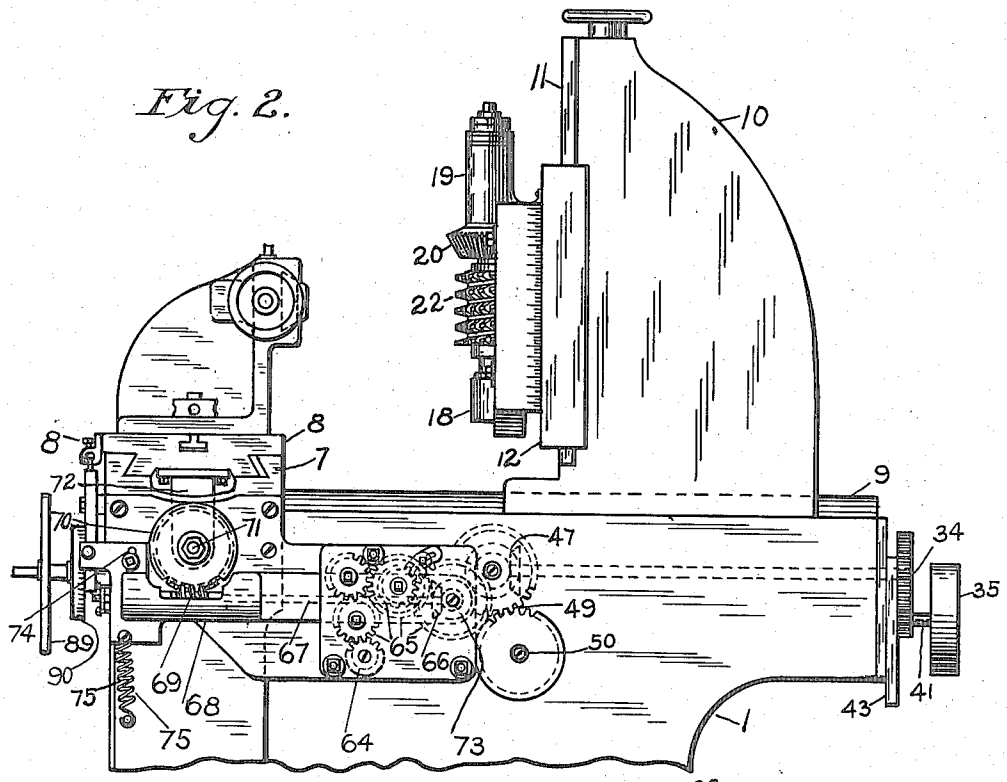
6 SHEETS—SHEET 2.

Fig. 2.



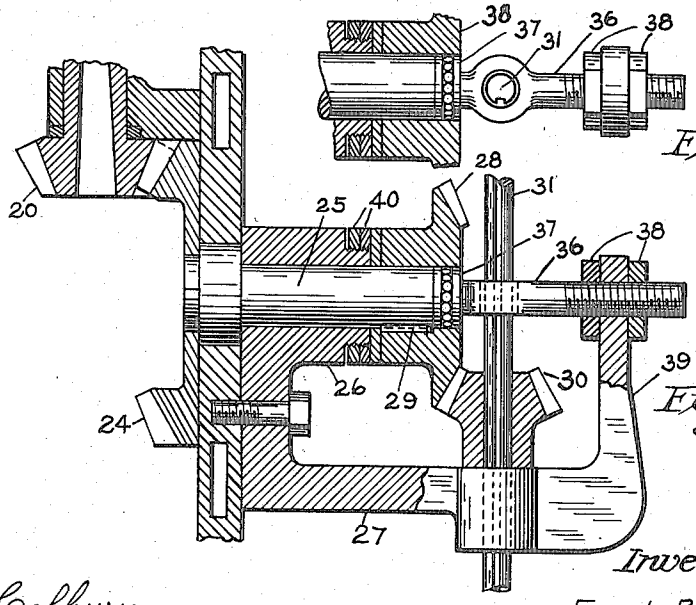


Fig. 14.

Fig. 13.

Witnesses.

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6 SHEETS—SHEET 3.

Fig. 3.

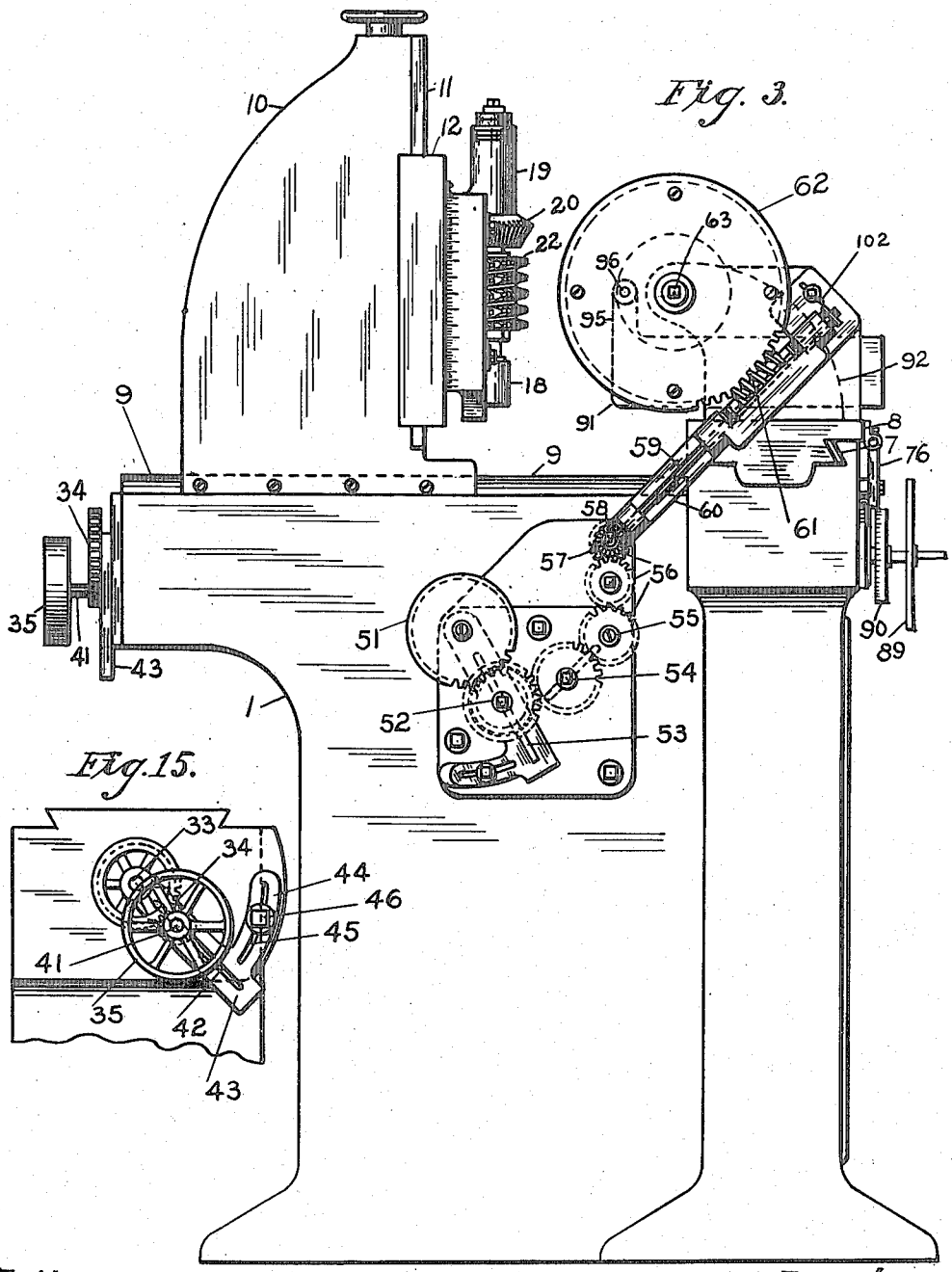

Fig. 15.

Witnesses.

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6 SHEETS—SHEET 4.

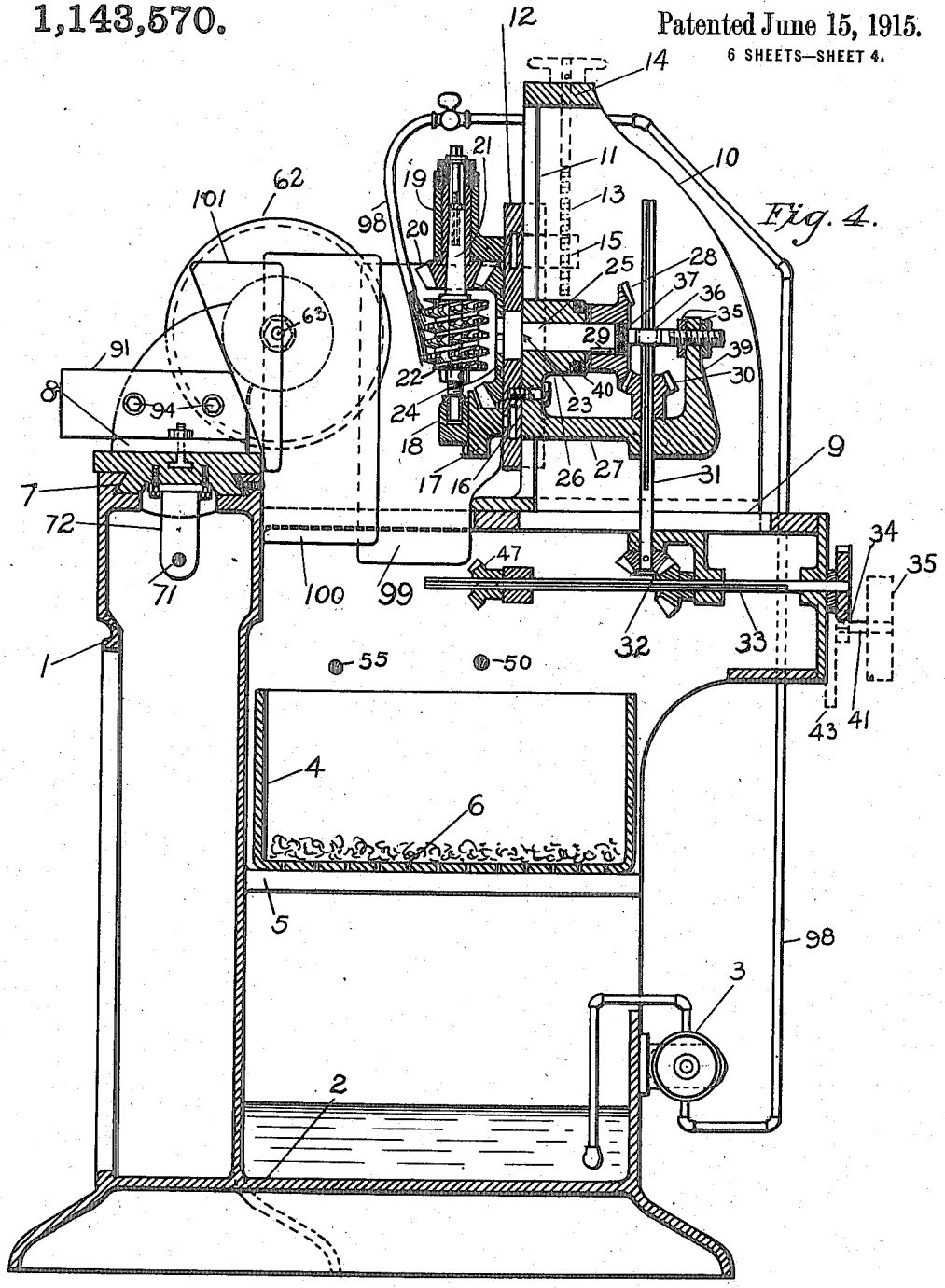

Fig. 4.

Witnesses.

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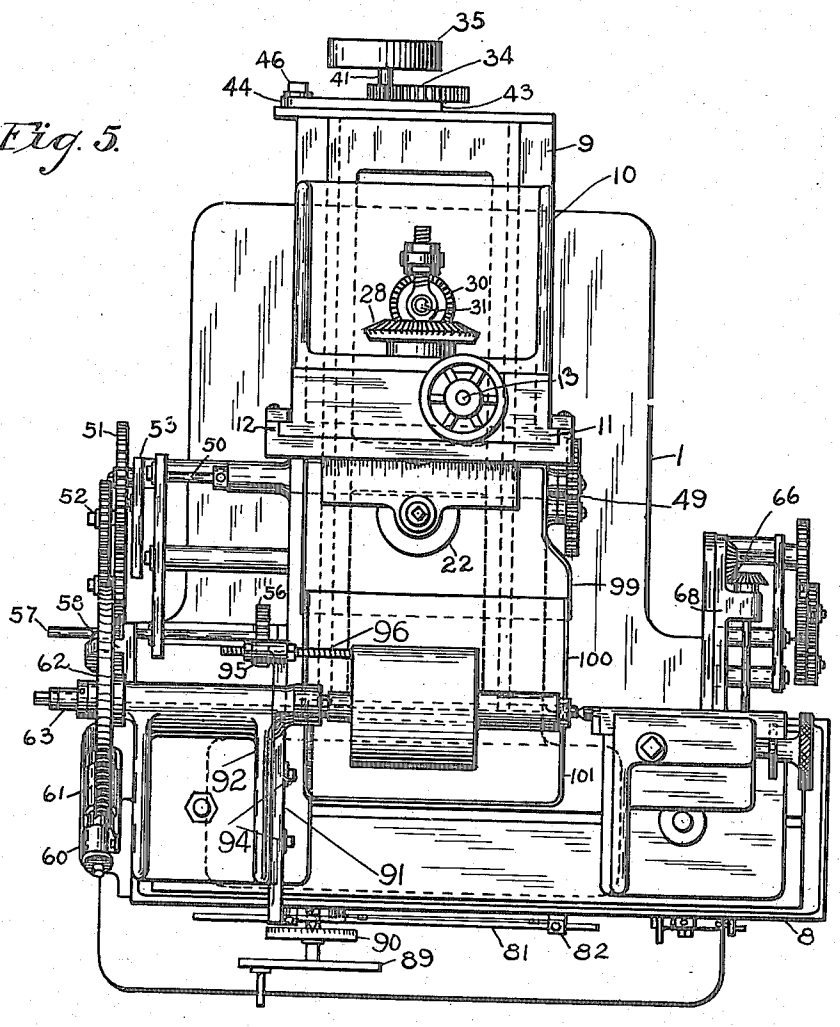
6 SHEETS—SHEET 5.

Fig. 5.



Witnesses.
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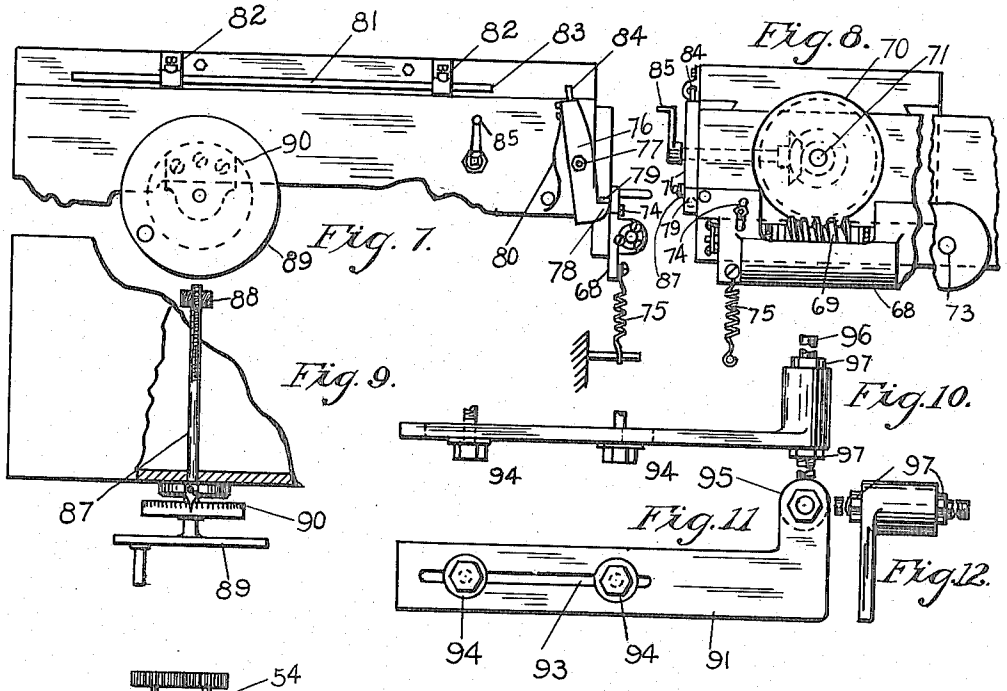
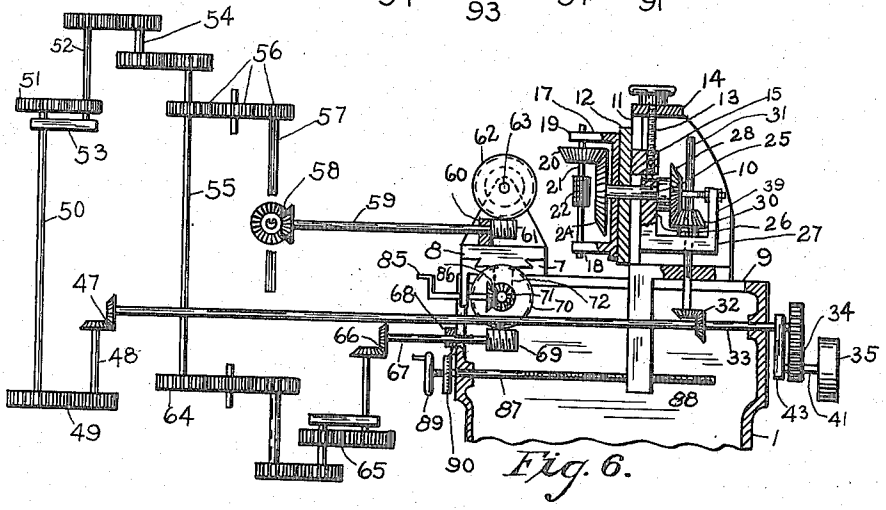
6 SHEETS—SHEET 6.





Witnesses.

George L. Colburn

Louise A. Jordan

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UNITED STATES PATENT OFFICE.

FRANK BURGESS, OF NORFOLK DOWNS, MASSACHUSETTS.

GEAR-CUTTING MACHINE.

1,143,570. Specification of Letters Patent. Patented June 15, 1915.

Application filed April 2, 1913. Serial No. 758,387.

To all whom it may concern:

Be it known that I, FRANK BURGESS, a citizen of the United States, and resident of Norfolk Downs, county of Norfolk, State of Massachusetts, have invented an Improvement in Gear-Cutting Machines, of which the following description, in connection with the accompanying drawings, is a specification, like characters on the drawings representing like parts.

The present invention is a gear cutting machine adapted for the cutting of various kinds of gearing such as spiral, worm and helical gears, and screws, more particularly by what is known as the hobbing process, wherein the cutting hob is a hardened wheel or cylinder formed according to the shape and dimension of the gear element with which the blank when cut is to intermesh, this hob being gashed to form cutting teeth at suitable intervals.

One of the prime objects of the invention is to provide a construction wherein chattering and vibration is substantially eliminated, this being accomplished by mounting the cutter head so that the hob has a minimum of overhang and has an absolutely rigid backing directly against the supporting column, the work carrying arbor being also strongly and rigidly backed on its slide ways so that cutter and work are held in precise alinement and immovable relation producing a smoother finish on the work than has heretofore been possible, with a virtual elimination of the effects of jarring and chattering.

A further important object of the invention is to provide a construction wherein a complete and effective clearance of chips from cutter and work is insured, these together with the lubricant employed in the cutting, falling clear of the operating parts by reason of the vertical arrangement of the hob, and into a drain pan removably set in the supporting pedestal, the lubricant draining from this pan into a receptacle provided therefor in the base; the arrangement of the hob axis in a vertical plane also permitting the operator to keep the cutting action of the hob under close inspection.

A further object is to provide a simplified form of driving connections whereby cutter and work are properly and effectively driven and controlled with the smallest possible number of transmitting gears, the drive being arranged through ordinary gears and straight shafting without requiring universal joints or like expedients.

A further object of the invention is to provide a construction permitting the use of a special swivel cutter head of known type with a supporting backing therefor involving a very short overhang of the hob, while permitting the hob to be adjusted through a wide range of angles centrally of its axis of adjustment.

A further object is to provide an improved mounting of cutter head with a range of adjustments permitting the cutting of spur, spiral, helical, and worm gears, and screw threads, with a facility and easy capability of change from one use to another.

A further object is to provide an improved form of driving connections wherein the same mechanism is adapted to be employed for changing the gear ratios and also to serve as a belt tightener.

A further object is to provide improved power mechanism for feeding the work table, with an automatic disengaging device at the end of the table movement and provision for quick return by means of a hand operated device.

A still further object is to provide means for taking up all back-lash in the driving train to the hob, so that the driving impulse may be made positive and precise in any position of hob adjustment, this being effected by a simple screw manipulation.

The above and other objects and features of the invention will be better understood from the following detailed descriptions taken in connection with the accompanying drawings and will be thereafter pointed out in the appended claims.

Referring to the drawings, Figure 1 is a front elevation of a machine wherein my improvements are embodied; Fig. 2 is a side view of the operative portion of the machine, the supporting pedestal being broken away; Fig. 3 is a side view of the machine from the side opposite to that of Fig. 2; Fig. 4 is a central vertical section through the machine; Fig. 5 is a plan view of the machine; Fig. 6 is a diagrammatic view showing the lines of gearing for operating and controlling the various parts; Fig. 7 is a fragmentary elevation showing an end view of the throw-out mechanism for the table feed; Fig. 8 is a side elevation of the throw-out for the table feed; Fig. 9 is a

fragmentary view showing a micrometer adjuster for the hob carriage support; Figs. 10, 11, and 12 show a plan, side elevation and end view respectively, of an out-board or rim backing for the work piece; Fig. 13 is a sectional detail of the adjusting mechanism for taking up back-lash in the cutter drive; Fig. 14 is a fragmentary plan of parts shown in Fig. 13, and Fig. 15 is a fragmentary elevation showing the prime drive connections.

The operating parts are shown as mounted on a hollow pedestal base 1 which has a cavity or receptacle in its bottom as seen at 2 into which the lubricant drains and from which it is pumped by suitable pumping means 3. At an intermediate point in the height of the pedestal a chip pan 4 is removably mounted on slide rests 5, this pan having a perforated bottom 6 to permit draining of the lubricant while retaining the cuttings. The pedestal 1 has at its top on one side undercut slide ways 7 for the work carriage slide 8 and at its other side it is equipped with slide ways 9 at right angles to the slide ways 7 on which the column 10, which supports the cutter head, is adjustably mounted; the arrangement of these slide ways being such as to position the opposite operative portions of cutter and blank directly over the pan 4 as seen in Fig. 4. The spaced apart slide ways 7 and 9 are thus arranged with the chip receiving well beneath, therebetween in a horizontal direction. The column 10 is equipped with vertical slide ways 11 on its front face to which is fitted the cutter carriage slide 12 which is vertically adjustable on these ways by a manually operated screw rod 13 fitted to the top of the column as at 14 and having threaded engagement with a lug projecting back from the slide 12 as seen at 15. The cutter head slide 12 has on its front face an undercut annular groove 16 in which fit the heads of clamp bolts for holding the cutter head 17 in any desired angular position. The cutter head 17 has slidably fitted at one side thereof a dead center bearing 18 for one end of the cutter arbor, and at an opposite side it is equipped with a bearing 19 for the driving bevel gear 20 of the hob arbor, this gear being shown as having a sleeve extending through said bearing within which the hob arbor 21 is removably fixed, the hob 22 being thus mounted centrally and transversely with reference to its axis of adjustment about the center 23. The drive for the hob is imparted to the bevel pinion 20 from a bevel gear 24 mounted on shaft 25 arranged concentric with the axis of cutter adjustment in a bearing sleeve 26 provided therefor in a bracket member 27 bolted to the back of the slide 12. The shaft 25 is in driven engagement with a bevel gear 28, this driven engagement being effected by a slidable key connection 29 for a purpose to be presently explained. The driving impulse is imparted to the gear 28 from a pinion 30 slidably keyed on an upright shaft 31 journaled in the bracket 27 and having fixed at its lower end one of a pair of bevel gears 32, the other of which is slidably keyed to a horizontal shaft 33 journaled in the machine framework and having spur gear driving connections 34 to the prime driver 35 of the machine. The just described train of connections has provision for eliminating back-lash in the drive to the hob and to accomplish this purpose with reference to the gears 20, 24 I provide means for adjusting the shaft 25 which has the gear 24 fixed thereto inward or to the left in Fig. 4. For this purpose a screw bolt 36 has ball bearing thrust engagement 37 at its inner end with the outer end of shaft 25, and the outer end of this screw bolt has threaded thereon adjusting and clamping nuts 38 at each side of upstanding arm 39 on bracket 27 through which the outer end of screw bolt 36 passes, the intermediate portion of this bolt being yoked around the vertical shaft 31 as best seen in Fig. 14. Thus, by adjusting the nuts 38 the gears 24, 20 may be brought into precisely correct operative relation to a nicety, with the virtual elimination of back-lash, and the parts securely clamped in this adjusted position. A like result is attained with reference to the gears 28, 30, by adjusting screw rings 40 threaded on the end of sleeve bearing 26 and adapted to adjust the gear 28 outward by virtue of its slidably keyed engagement 29 with the shaft 25, the second of the nuts 40 serving as a lock nut as is usual in lock nut constructions. To permit driving the hob at any one of a variety of selective speeds the change gears 34 are provided, the driving one of these being mounted on a stud shaft 41 to which the driving pulley 35 is fixed. This stud shaft 41 is adjustable toward and from the shaft 33 being clamped in adjusted position in a long slot 42 of a radius arm 43 journaled concentric with the shaft 33. This radius arm is adapted to be swung angularly about the shaft 33 as a center for the purpose of properly tightening the belt which operates on belt pulley 35 and for this purpose it has a laterally extending lug or ear 44 with a long arcuate slot 45 therein, through which a clamp bolt 46 takes, to clamp the arm 43 in position with the driving belt properly tightened.

Driving impulse for rotating the work and also for feeding the work carriage endwise is transmitted through the shaft 33 and for this purpose it has fixed thereto at its inner end one of a pair of meshing bevel pinions 47, the other of which is fixed to a short countershaft 48 jornaled in the frame work which has fixed at its other end one of

a pair of spur gears 49, the other of which is fixed to a shaft 50 which is journaled in the frame work and extends out at the left side thereof as seen in Fig. 1. This projecting end of shaft 50 has fixed thereon a gear 51 which forms the driving member of a train of change gears, the intermediate ones of which are journaled on a stud shaft 52 adjustable on a radius arm 53 and these change gears on this radius arm driving other change gears on an adjustably mounted stud shaft 54 which transmit driving impulse to gears fixed on a shaft 55 which extends across the machine. One of the gears fixed on shaft 55 constitutes the driving member of a spur gear train 56 which drives countershaft 57 journaled in the frame work and having a projecting portion in squared or slidably keyed driving engagement with one of a pair of bevel pinions 58, the other of which is fixed to the end of a shaft 59 journaled in a bracket arm 60 to extend upward diagonally, and having at its outer portion a worm 61 fixed thereon which drives a worm wheel 62 fixed on the work arbor 63. The worm 61 is adapted to be disengaged from the worm wheel 62 at will and for this purpose the bracket arm 60 is journaled to swing about the shaft 57 as an axis and its other end is equipped with an arcuate slot to receive a clamping bolt, this slot being of sufficient length to permit the swinging of the bracket arm to engage or disengage the worm at will.

For the purpose of feeding the work carriage endwise, the shaft 55 is extended across the machine and projects at its right side as seen in Fig. 1 where it has fixed thereon a pinion 64, which through a train of change gears 65 and bevel gears 66 drives a shaft 67 journaled in a bracket arm 68. The shaft 67 has fixed at its outer end a worm 69 adapted to drive a worm wheel 70 fixed on the feed shaft 71 which is journaled in the frame work beneath and in parallelism with the work carriage slide 8, said slide having a depending nut 72 in threaded engagement with said feed shaft. To permit disengagement of the worm 69 from the worm wheel 70, the bracket arm 68 is swingingly mounted about the axis 73 of the bevel gear by which the shaft 67 is driven and its outer end has an arcuate slot and clamp bolt device 74 for controlling the position of the bracket arm at will. I preferably utilize this swinging mounting of the bracket arm 68 to constitute an automatic throw out of the work feed at the end of operative movement, and for this purpose the clamping connection 74 is loosened and a spring 75 is fixed at one end to the frame work and connected at its other end to said arm to normally draw the arm downward. The bracket arm and worm 69 are held up to operative position while the machine is in operation by a latch 76, pivoted at 77, and having a toe 78 at its lower end adapted to catch under the pin 79 projecting from the end of arm 68; there being preferably a spring device 80 tending to move the latch to engaging position. To trip this latch at the end of work carriage movement, I provide a rod 81 adjustably carried in lugs or ears 82 at the side of the work carriage, and in use this rod is positioned and clamped in the lugs 82 so that its end 83 will engage a projection 84 at the top of the latch 76 to trip said latch when the work is completed, and permit the worm 69 to become disengaged from the worm wheel 70, thus stopping the feed. It will of course be understood that the latch 76 may also be tripped by hand to permit disengagement of the worm 69, thus stopping the feed manually. The work carriage may be conveniently returned quickly by hand when its driving gearing is thus disengaged, and for this purpose I show a hand operated crank shaft 85 having a bevel gear driving connection 86 to the carriage operating screw 71.

For the purpose of moving the column 10 with the cutter head-in-and out radially of the work, I provide a manually operable screw shaft 87 engaging in a nut 88 depending from said column and having an operating hand wheel 89 extending out at a convenient position for operation with a micrometer head 90 in position for convenient inspection.

I preferably provide means for furnishing a strong rigid backing to the outer edge or rim portion of the gear blank in the direction of the working thrusts and adjacent the point being operated on, and for this purpose I show a stout arm 91 clamped to the upright or post 92 which carries the live center of the work arbor, this clamping being of an adjustable character effected by means of a long slot 93 in the arm 91 through which the clamp bolts 94 pass into the upright post. This arm 91 has at its outer end an upstanding portion 95 of a height adapted to present a stout pin 96 passing through its upper end in position to engage the end of the gear blank substantially in the plane of cutting action. This pin 96 is adjustable in the upright portion 95 and for this purpose it is threaded and has fitted thereon nuts 97 adapted to hold it in fixed and definite relation to the arm by which it is carried. Thus by proper in and out adjustment of arm 91 and by adjustment of the pin 96 in said arm, the end of the pin may be brought to position to act as a stop and backing for any size or character of blank for the cutting of which the machine is adapted.

It will be understood that the lubricant from pump 3 is forced up to be discharged at the cutting point by a suitable piping 98

leading to a point adjacent and directly over the cutting point as best seen in Fig. 4. To conserve the lubricant as thus discharged and insure its return to the receptacle in the pedestal base and prevent its being scattered from the machine, I preferably provide shield or guard plates 99, 100, 101 at each side of the machine, these being adapted to slide over one another more or less, in telescoping fashion, when the column 10 is adjusted in and out. Thus it is insured that the lubricant and cuttings will drop into the pan 4 and not be scattered, since in the first place the vertical arrangement of the cutter permits the greatest freedom of chip discharge and clearance, and this is further facilitated by the flow of the lubricant from above, while the relative arrangement of the cutter with its backing, and the work with its backing support, along with the side guards makes a completely inclosed well with the receiving pan 4 at the bottom thereof. It is to be observed that these desirable features are combined with a construction wherein the cutter head is virtually swiveled to the rigid frame backing whereby very great stiffness with very little overhang is attained.

It is the construction and arrangement of the cutter head 17 with a mounting on a vertical slide way 11 of column 10 so that it rests and has backing immediately thereon over substantially its entire area and with nothing interposed except as shown the slide plate 12 to permit angular adjustment, that I refer to in the claims when I describe the cutter carrier as having a direct mounting on its backing support.

It is to be noted that my improved arrangement provides for a continuous close inspection of the cutting operation by a workman standing in front of the machine since the working point on the work is always in sight from this point; further that the throw-out control effected by the adjustable rod 81 is also mounted at the front of the machine for convenient access from this position, and that the out-board work prop or support carried by arm 91 is always conveniently controllable and adjustable from this position. My improved construction minimizes back-lash in two ways, first by largely reducing the number of gears in the driving train to the hob, and second in providing means whereby the bevel gear teeth mesh accurately and closely as by the adjusting device exemplified by threaded adjusting rod 36; it will be understood that this adjustment is merely illustrative of similar adjusting means that may be employed throughout in the driving train if desired.

It is, of course, to be understood that the several change gear trains described are selectively arranged and combined in various ways according to the character, size and pitch of the gears to be cut, the machine as described being capable of effecting rotations of the hob and work in any desired ratios within wide limits; this relative variation being distinctively effected in the present machine by arranging the several change gear trains, in the line of driving connection to the work arbor, leaving the drive to the hob a short, direct, and powerful one which need not be disturbed by the variations in driving ratio between the hob and work as effected by the change gear devices. The driving movements to the hob and work arbor may be combined with a continuous endwise feed of the work by movement of the work carriage slide 8 as effected by feed screw 71, there being of course in this case a suitable compensating element introduced in the ratio of rotation between the hob and work, or the work slide 8 may be held stationary by disconnection of the driving worm 69 from screw 71 at will, for types of work best performed in this way. I am aware that the various features of the invention can be embodied in other specific forms and in different relations from the illustrative embodiment shown and I therefore do not desire to be limited to the present form of the invention or to any particular form and refer to the appended claims rather than to the foregoing description to indicate the scope of protection intended to be secured.

Having described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A gear cutting machine, comprising a supporting frame work having spaced apart slide ways with an intermediate lubricant and chip receiving well beneath constituting a lubricant container at its bottom and with an intermediate receptacle for cuttings, a work carrier mounted for movement on one of said slide ways and a cutter carrier mounted for movement on the other slide way directly over said well said work carrier and cutter carrier being formed to hold the work and cutter projecting toward each other with the operative area substantially over said well.

2. A gear cutting machine, comprising a frame work having a cutter slide way and a work slide way at right angles to each other with an intermediate lubricant and chip receiving well beneath, there being a lubricant container at the bottom of said well and a receptacle for cuttings removably held thereabove, a cutter slide, and a work slide mounted for movement on their respective slide ways, said slides being formed and equipped to hold a cutter and a blank respectively with their operative areas over said well.

3. A gear cutting machine, comprising a

frame work having slide ways on its top at right angles to each other, a work carriage slide on one of said ways, a cutter support slide on the other of said ways, said frame work having an open chip and lubricant receiving well beneath said ways in chip receiving position, and a hob carrier mounted directly over said well, whereby clearance for chips and lubricant is provided.

4. A gear cutting machine, comprising a work carrier, a hob carrier, driving connections for imparting operative movements to said carriers for rotating the hob and work in timed relation, and a mounting for the hob carrier formed to swing in a vertical plane about an axis transversely central of the hob, there being a rigid column upstanding from the machine frame work affording a direct rigid backing for said hob mounting in all positions of its angular adjustment, and said driving connection to the hob carrier being a direct train from a prime driver in part concentric with the swinging axis of said mounting for the hob carrier.

5. A gear cutting machine, comprising a supporting frame work having slide ways at right angles to each other at its top, a work carrier slide fitted to one of said slide ways, an upright column fitted to the other slide way, a cutter slide vertically adjustable on said column, a hob carrier mounted for angular adjustment on said slide about an axis transversely central of the hob, said hob carrier and said cutter slide being formed and relatively arranged for the hob to have a relatively close, direct, and rigid backing on said column with a minimum of overhang, whereby vibration is minimized, and means for driving the hob carrier formed as a relatively direct train from a prime driver having a part concentric with the axis of angular adjustment of the hob carrier.

6. A gear cutting machine, comprising a frame work having slide ways at right angles to each other on its top with an intermediate lubricant and chip receiving well beneath the same, a work slide on one of said slide ways, a cutter support slide on the other slide way, cutter on said cutter support located directly over said well, the parts mounted on the cutter slide and the work slide constituting two sides of the well top, and relatively slidable guard plates mounted to inclose the remaining sides of the well top whereby scattering of lubricant and cuttings is prevented.

7. A gear cutting machine, comprising an upright frame work having a cutter slide way and a work slide way spaced apart with an intermediate well for lubricant and cuttings beneath the same, a cutter carrier and a work carrier coöperatively mounted on said slide ways respectively and forming two sides of the well top, and plates fixed to said carrier fitted to slide over each other for inclosing the remaining two sides of the well top whereby scattering of lubricant and cuttings is prevented.

8. A gear cutting machine, comprising a hob carrier and a work carrier mounted in coöperative relation, the work carrier being mounted for feed movement endwise of the work axis, and driving connections for rotating the hob and work in timed relation consisting in a direct and relatively short train of permanently mounted gears for driving the hob and series of selective change gears connected therewith for rotating the work and feeding it endwise in a predetermined and variable ratio to the hob rotation.

9. A gear cutting machine, comprising a hob carrier and a work carrier, one of said carriers being mounted for feed movement endwise of the work, and driving mechanism for said carriers consisting in a relatively short train of direct permanent gears for rotating the hob and series of change gears for rotating the work and effecting a relative feed thereof endwise, the connections for effecting such relative feed having provision for automatic disconnection at will, said connections also permitting manual disconnection.

10. A gear cutting machine, comprising a frame work support having slide ways at right angles to each other, a slide having a work carrier thereon fitted to one of said slide ways, hob carrying means fitted to the other of said slide ways with provision for swiveling adjustment about an axis transversely central of the hob, means for driving the hob in any position of its adjustment, and means for moving the work, said means having provision for rotating the work in any one of a series of ratios relative to the hob rotation, and other provision for feeding the work endwise of its axis at predetermined and variable rates.

11. A gear cutting machine, comprising a frame work support having slide ways at right angles to each other, a work carrier mounted on one of said slide ways and formed to present the work with its axis parallel to and overhanging said slide way and at right angles to the other slide way, and a hob carrier mounted on the other slide way with provision for angular adjustment of the hob in a vertical plane parallel to the work axis and about an axis transversely central of itself.

12. A gear cutting machine, comprising a frame work support having a slide way, a work carrier fitted and connected for feed movement along said slide way formed to hold a work piece with its axis horizontal and parallel with said slide way, and a rotary cutter carrier mounted to attack the work so held and having provision for adjustment about a vertical axis in a plane parallel to the work axis.

13. A gear cutting machine, comprising a base frame work having a slide way along the front of the top thereof, a work carrier mounted on said slide way, a hob mounted to attack the work carried thereby, means for feeding the work carrier along said slide way, having as a part thereof a worm and worm wheel driving connection, said worm being mounted to swing into and out of operative relation to said worm wheel, means for holding the worm normally in driving relation to the worm wheel, and means for tripping said last named means consisting in a trip rod adjustably held at the front of the machine for the purpose stated.

In testimony whereof, I have signed my name to this specification, in the presence of two subscribing witnesses.

FRANK BURGESS.

Witnesses:
HARRY H. KERR,
GEORGE L. COLBURN.