J. G. RIMMER.

GEAR CUTTING MACHINE.

APPLICATION FILED FEB. 11, 1913.

**1,218,210.**

Patented Mar. 6, 1917.

4 SHEETS—SHEET 1.

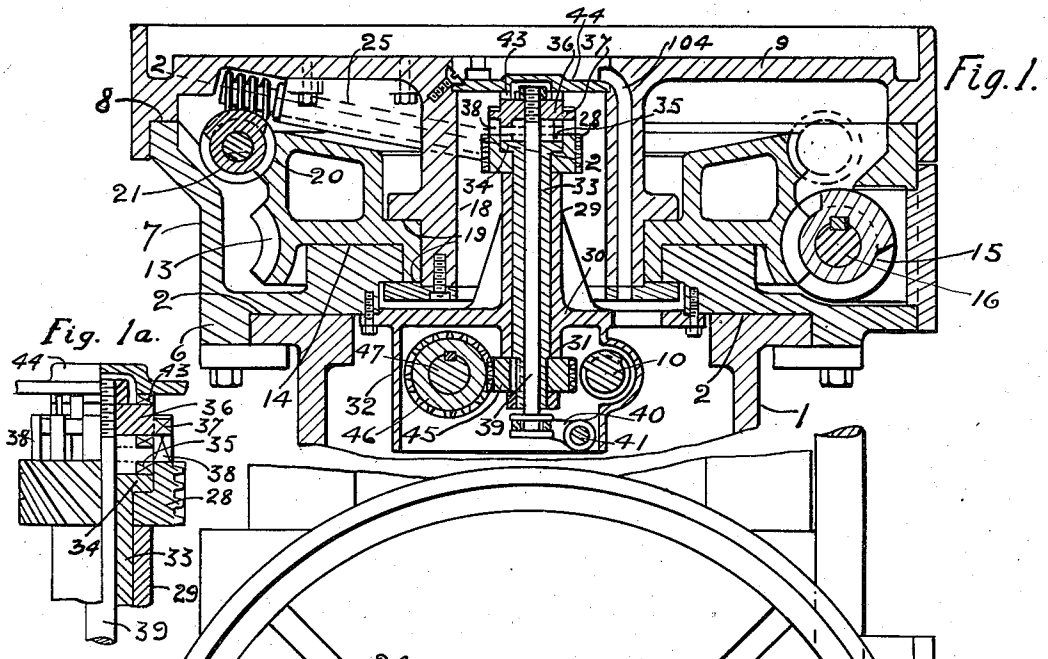



Fig. 1.

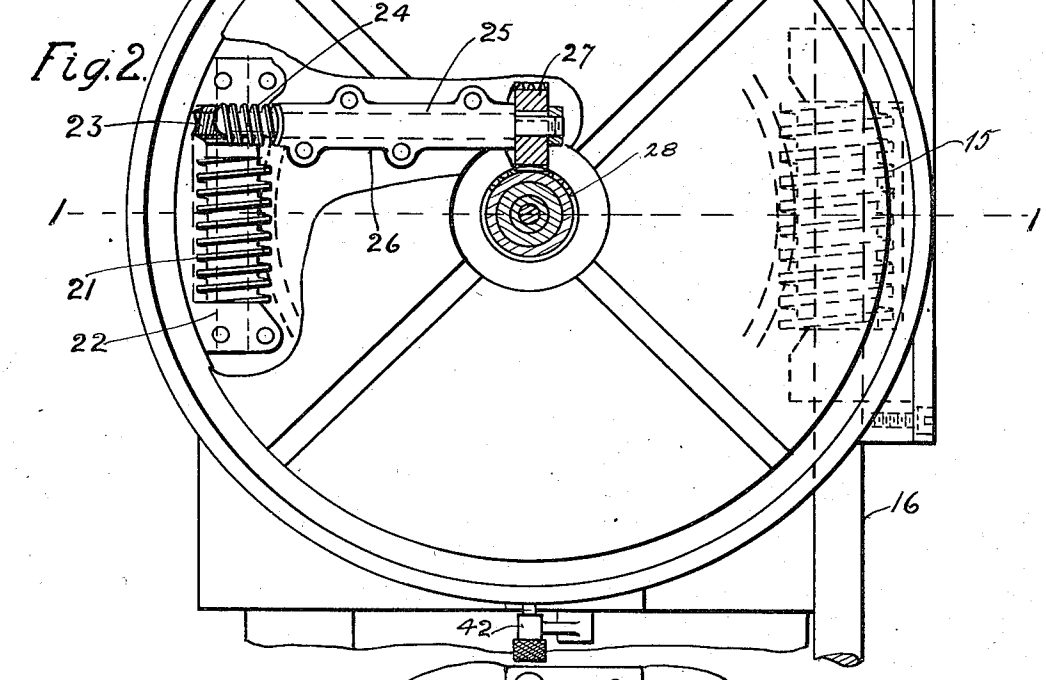



Fig. 2.

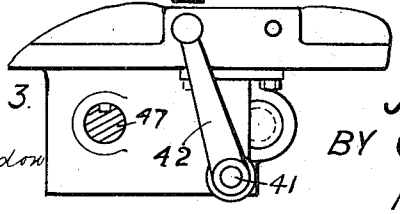



Fig. 3.

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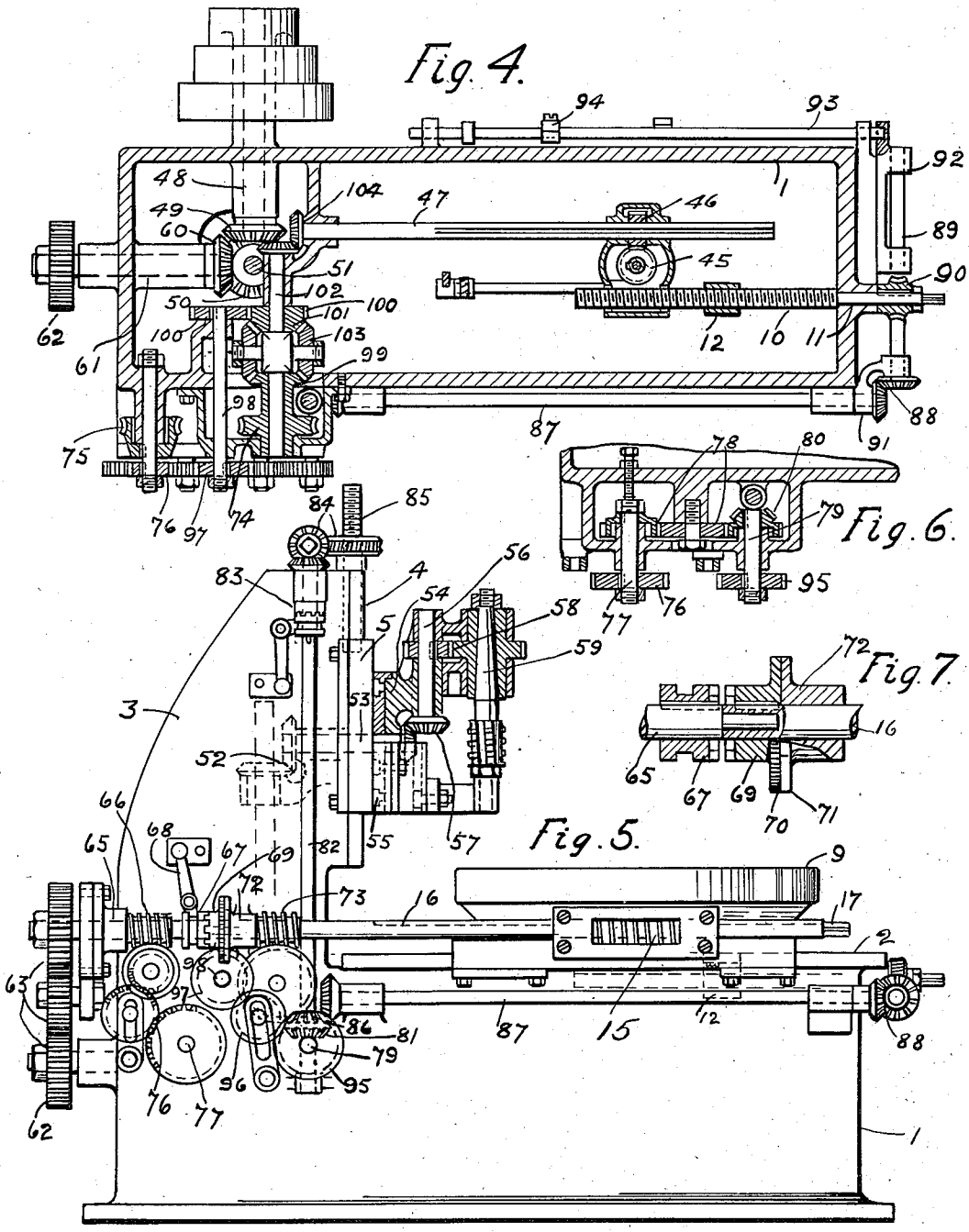
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4 SHEETS—SHEET 2.

Fig. 4.




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4 SHEETS—SHEET 3.

Fig. 9.

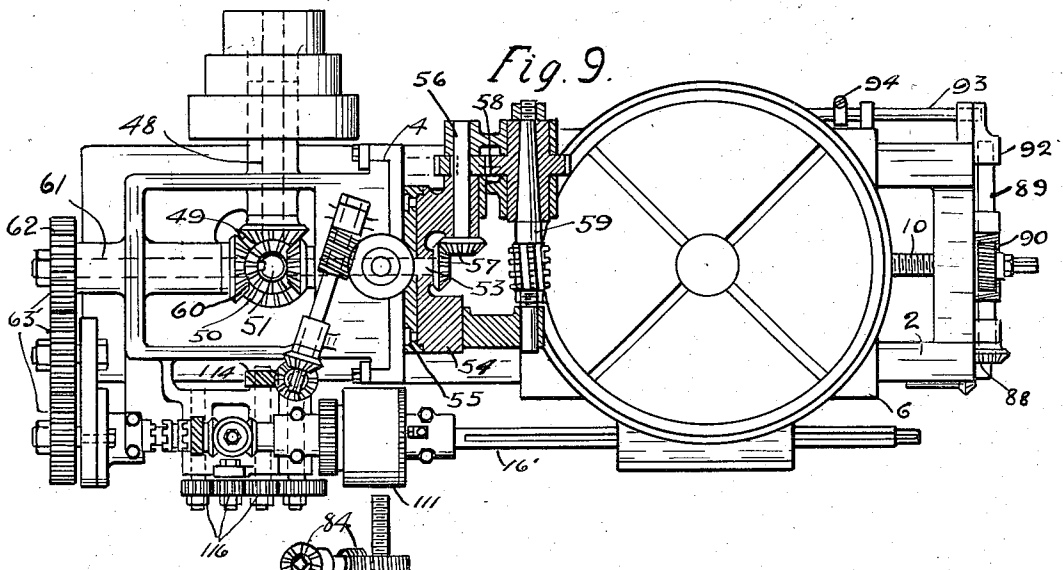
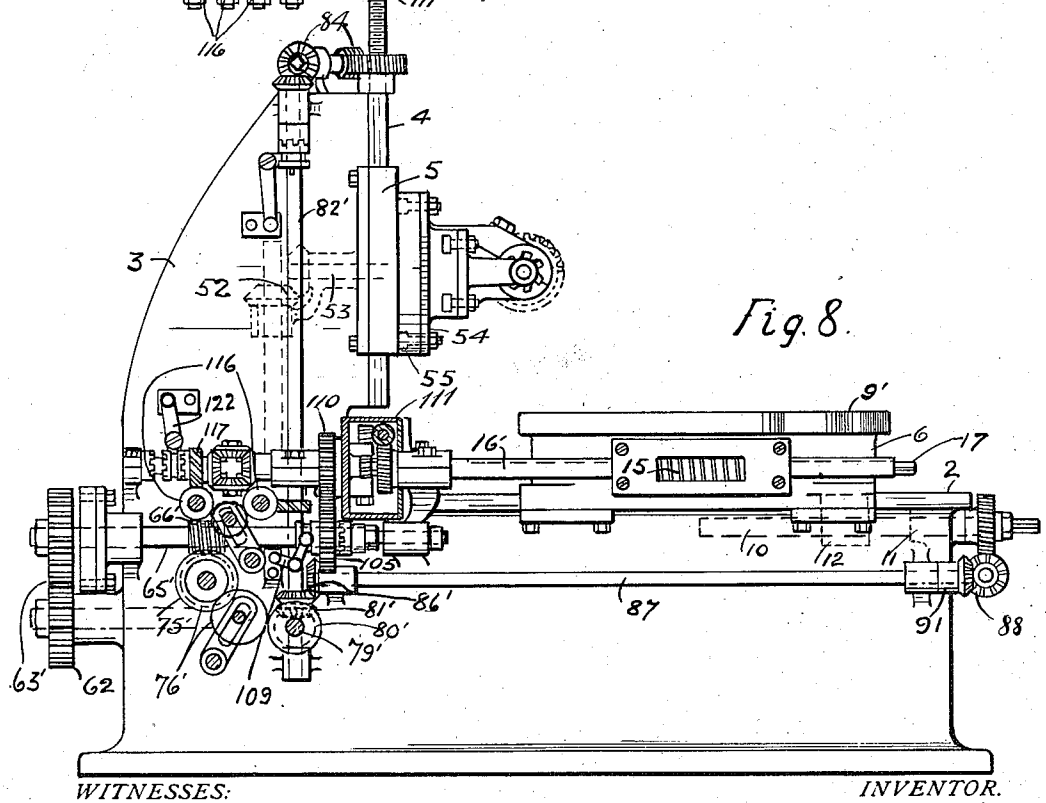



Fig. 8.




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4 SHEETS—SHEET 4.

Fig. 10.

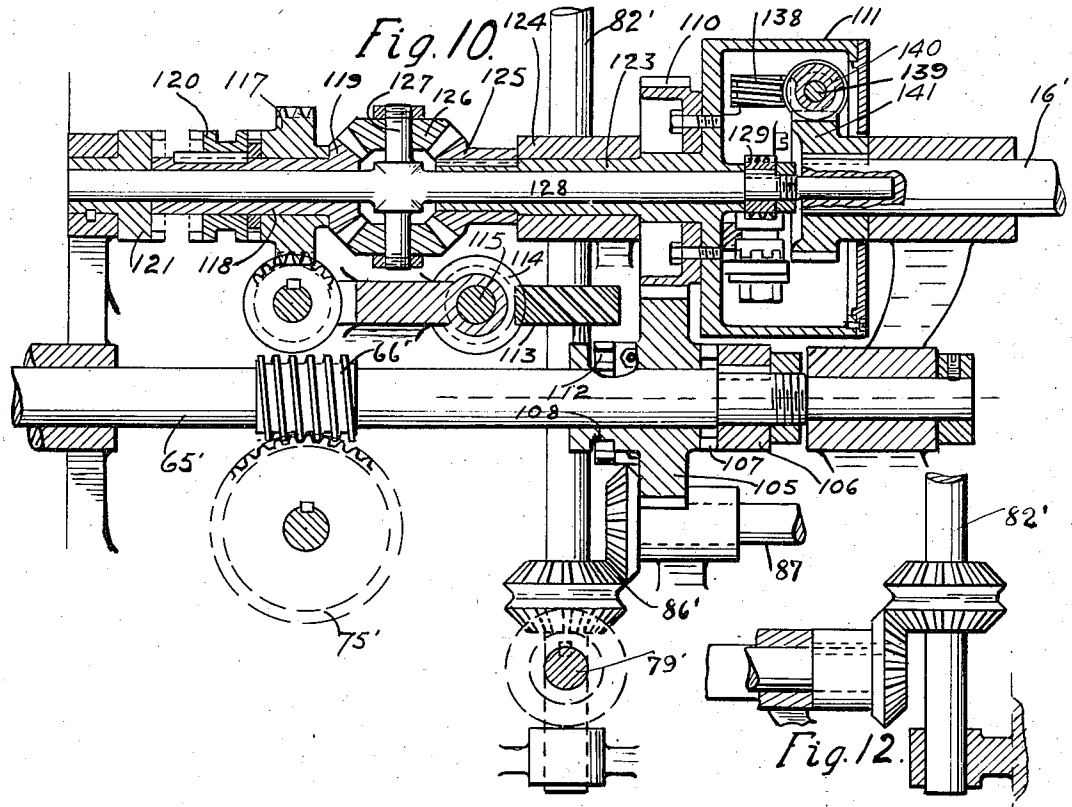



Fig. 12.




Fig. 13.

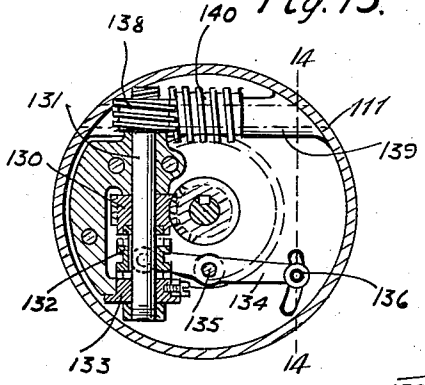



Fig. 11.

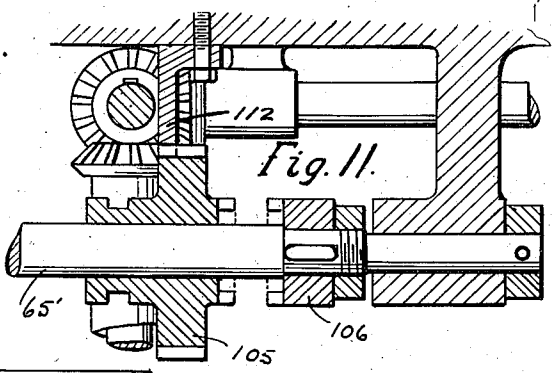
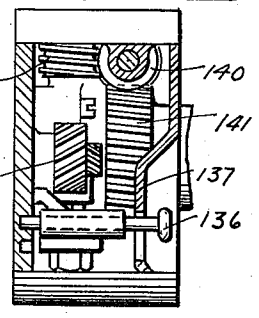



Fig. 14.




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# UNITED STATES PATENT OFFICE.

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## GEAR-CUTTING MACHINE.

1,218,210. Specification of Letters Patent. Patented Mar. 6, 1917.

Application filed February 11, 1913. Serial No. 747,757.

*To all whom it may concern:*

Be it known that I, JAMES G. RIMMER, a subject of the King of Great Britain and Ireland, and resident of Norfolk Downs, Quincy, 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 relates to gear cutting apparatus of a type adaptable to the cutting of most of the different forms of gearing in common use, either by a generating or milling action at will. A prime object of the invention is to provide an improved machine adapted for cutting spur or other gears by an ordinary intermeshing generating action or to produce gears such as spiral or worm gears, with a compound relative movement between the tool and work, requiring a special or "compensating" movement of a work table. It has heretofore been proposed to effect such a "compensating" movement by direct gearing which has required very elaborate tables and calculations, and it has also been proposed to avoid the necessity for complicated calculations by effecting the necessary compensation through a differential; in the latter type of machine however, so far as I am aware, the organization has been such that the main driving impulse has been imparted through such differential, imposing excessive strain thereon, thus making it show the results of wear in a short time and requiring the differential parts to be made large and bulky. In the present machine I avoid these objections by transmitting the main drive through a train, apart from, and as it were, in "shunt" relation to the differential, with connections so that the differential is only called upon to impart the small supplementary impulse required to modify the main driving movement to the extent necessary for the compensating needed. Further with my improved organization the differential can readily be wholly thrown out and rendered inoperative when the machine is to be employed for other gear cutting uses. A further object of the invention is to provide an improved machine of exceptionally simple, compact construction adapted for such a variety of uses as the cutting of worm gears by hobbing action, the milling of single thread or multiple thread worms, cutting spur gears by a hobbing action, cutting spirals by hobbing action, cutting worms by the equivalent of a hobbing action, and circular or flat milling. In one specific form the invention is herein shown as embodied in a construction of work table wherein a lower or base portion thereof is mounted for linear feed movement, and also for turning movement in timed relation to the other working parts, and there being mounted on said base portion a top portion or table proper having driving connections passing through the turning axis of the table for imparting an independent rotation to the table top which by a suitable differential is adapted to compensate for the feed movement between the cutter and blank by accelerating or retarding the normal rate of work table rotation to the requisite extent. In another illustrated form the invention is shown as embodied in a construction wherein while a standard or one part work table is employed, the action of a differential may be injected at will into its driving movement by gearing having the same general action as that of the two part table construction. Further features of the invention have to do with novel and improved driving gear connections which interconnect the driving and feed means of the work table and cutter head so that these may be shifted and varied to produce the desired result with the least possible effort or calculation. The above and other objects and features of the invention will be better understood from the following detailed description 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 central vertical section through a work table formed in accordance with one form of my invention, such section being taken on line 1—1 of Fig. 2;

Fig. 1ª is a fragmentary detail of a clutch connection shown in Fig. 1;

Fig. 2 is a plan view of the table with a

part broken away in section on line 2—2 of Fig. 1;

Fig. 3 is a fragmentary detail elevation showing the controlling means for the table clutch;

Fig. 4 is a horizontal section through the base portion of the machine;

Fig. 5 is a side elevation thereof;

Fig. 6 is a horizontal section showing details of the driving gearing;

Fig. 7 is a detail section of a driving clutch connection;

Fig. 8 is a side elevation showing another form of the invention;

Fig. 9 is a horizontal elevation of the form shown in Fig. 8 with parts in section;

Fig. 10 is a vertical sectional view showing essential parts of the driving gearing, of the form shown in Fig. 8;

Fig. 11 is a fragmentary detail of parts shown in Fig. 9 at right angles to said Fig.

Fig. 12 is a horizontal sectional detail of parts shown in Fig. 9;

Fig. 13 is a sectional view through the gear box of Fig. 9; and

Fig. 14 is a sectional detail on line 14—14 of Fig. 13.

Referring first to the construction of Figs. 1 to 7 the bed frame work of the machine designated 1 has longitudinal slide ways 2 formed thereon for the work table and an upright column 3 at one end equipped with vertical slide ways 4 for the cutter slide carriage 5. The work table has a slide carriage 6 fitted to the slide ways 2 and is equipped with a sleeve housing 7 extending up therefrom, a top flange 8 of which is formed as a circular journal bearing support for the table top 9 which is fitted thereon. The table carriage 6 is reciprocated along the ways 2 by the action of a feed screw 10 having a journal bearing at 11 in the frame work and engaging a nut 12 depending from the carriage, this screw having connections for power movement as later explained. The main driving gear for rotating the work table consists in a worm wheel 13 having a flanged formation fitting down upon an annular seat boss 14 provided therefor on the carriage, this worm wheel being driven by a worm 15 slidably splined on shaft 16 extending longitudinally of the machine at one side thereof, this shaft being power driven as later explained and also having its outer end squared as seen at 17 for turning by hand with its power drive disconnected. The table top or work table proper 9 is equipped with a central depending collar 18 which has a fixed and a removable flange interfitting with the hollow center of worm 13 for bearing engagement therewith as seen at 19. This engagement of worm 13 with the table instead of being a fixed one as usual, is one permitting relative turning movement between the table and its said driving worm wheel and this relative turning movement is controlled by a second worm wheel formation 20 shown as integral with the worm wheel 13 and engaged by a worm 21 which is shown as hollow and fitted on a shaft bearing 22 mounted in the table top 9 with provision to prevent endwise movement of said worm. On the end of worm 21 a worm wheel 23 is fixed, this also having bearing on shaft 22 and being in driving engagement with a worm 24 fixed on a shaft 25 journaled in a sleeve bearing 26 carried by the table top and extending obliquely downward to a point opposite the turning axis of the table where it carries a spiral gear 27 meshing with a coöperating spiral gear 28 mounted concentric with the table axis. The gear 28 rests on top of a sleeve bearing 29 extending up from a plate 30 fixed to the carriage 6, this plate also having a short depending sleeve 31 for placing a lower driving gear and said plate 30 carrying in a depending relation thereto a protector shroud 32 for the work parts. The gear 28 is loosely fitted to a driving sleeve 33 which has a flanged top 34 to hold said gear in position and it is also equipped with upstanding clutch teeth 35 by which it is adapted to be brought into driven engagement with said gear through a clutch block 36 having depending teeth adapted to engage the teeth 35 and other radially extending teeth 37 engaging long teeth 38 projecting up from said gear. The clutch block 36 is carried at the upper end of a slide rod 39 fitted in sleeve 33 and this rod receives actuation for moving the clutch block up and down through engagement by an arm 40 fixed on a rock shaft 41 with an operating handle 42 extending out to accessible position. The moving downward of the clutch block 36 thus brings the gear 28 into driven engagement with the sleeve 33 which is thus adapted to impart the proper compensating movement to the table top. The clutch block 36 has other clutch teeth 43 projecting up from its top which are adapted to engage downwardly projecting teeth on a plate 44 fixed to the center of the table top so that when the clutch block is in upper position the gear 28 is locked to the table top and hence it and the gearing moved thereby turn with the table top and without any separate driving movement. The sleeve 33 has keyed to its lower end a spiral gear 45 in driving engagement with a coöperating spiral 46 slidably keyed on a shaft 47 extending lengthwise within the bed.

The common prime mover for effecting the several table movements described, and for driving and feeding the cutter is shown as a shaft 48 journaled in the bed of the machine beneath the upright 3. This shaft through bevel gears 49, 50 drives a vertical

shaft 51 which through slidably keyed bevel geared connections 52 drives a short shaft 53 journaled in the slide carriage 5. The cutter head 54 which is mounted for adjustment around shaft 53 as an axis being held by T bolts fitting an under cut circular slot 55, has journaled therein a shaft 56 at right angles to the shaft 53 and driven thereby through bevel gears 57. The shaft 56 is connected by spur pinions 58 to the cutter spindle 59 on which a hob or milling cutter is mounted with a capability of having its axis set either vertical or horizontal or at any desired angle by the clamping of head 54 to the slide carriage in the necessary relation.

The bevel gear 50 is also in driving engagement with a bevel pinion 60 fixed on a shaft 61 mounted in the bed and extending out at the end of the machine where it has fixed thereon the driving gear 62 of a change gear train 63 the driven gear of which is fixed on a shaft 65, which extends lengthwise at one side of the bed. The shaft 65 has fixed thereon a worm 66 which drives the feed gear train and it is adapted to be clutched to the shaft 16 with which it is in axial alinement by a clutch collar 67 slidably keyed thereon and operated by a handle 68, this collar having teeth engaging with cooperating teeth on a flanged collar 69 keyed on the end of shaft 16. As best seen in Fig. 7 the flange 70 of collar 69 fits up against a similar flange 71 on the fixed journal bearing 72, and these two flanges have calibrations which may be used to determine the angular adjustment of shaft 16 when it is disconnected from shaft 65. When the clutch collar 67 connects the shafts 65 and 16 to move as one, driving impulse is imparted not only to turn the main table worm 15 but also to turn a worm 73 fixed on shaft 16 which drives a worm wheel 74 governing one element of a jack-in-the-box device to be presently explained. The connection for operating the feeding elements from the worm 66 consists in a worm wheel 75 engaged therewith which operates through change speed gearing 76 to drive the short shaft 77 journaled in a frame work housing and the shaft 77 through spur gearing 78 drives a shaft 79 on which is fixed a bevel pinion 80 that meshes with a bevel pinion 81 on a vertical shaft 82. The shaft 82 through a disconnecting clutch 83 and bevel and worm gearing 84 turns a nut formed as a part of the driven element thereof and threaded on the non-rotating feed screw 85 which raises and lowers the cutter carriage 5. The shaft 82 through bevel gearing 86 also drives horizontal shaft 87 which through bevel gearing 88 and cross shaft 89 operates worm gearing 90, the worm wheel member of which is keyed to feed screw 10. The shaft 89 has bearing at one end in a bracket 91 adapted to turn on the shaft 87 as an axis and its other end is journaled in a bracket 92 having a vertical range of movement and normally held up so that the worm on shaft 89 meshes with the worm wheel 90, by the engagement of the end of trip rod 93 thereunder, but it is adapted to drop down and disconnect the worm from the worm wheel when the trip rod is moved from under the same or to the left in Fig. 4. The trip rod 93 is mounted in bearings alongside the machine and has an adjustable stop 94 thereon adapted to be engaged by a finger depending from the work table carriage as it is fed forward, to move said rod and disconnect the feed. The shaft 79 has fixed on its outer end a pinion 95 connecting through a change gear intermediate 96 with a gear 97 fixed on shaft 98 which extends alongside of worm wheel 74 in a suitable frame-work mounting. The worm wheel 74 has an inwardly extending neck, bearing at its end a bevel pinion 99, and the shaft 98 which extends alongside thereof has spur pinion connection 100 for driving a bevel pinion 101 loosely mounted on shaft 102 and opposite pinion 99. The shaft 102 whose extremity has bearing in a hollow bore of gear 74, has radial bearing pins on which are journaled bevel pinions 103 meshing with bevel pinions 99, 101 and constituting therewith a jack-in-the-box differential device. The shaft 102 is connected by bevel pinions 104 to drive shaft 47. The shaft 47 as before explained is connected to effect the separate turning movement of the table top relative to the main drive thereof and the jack-in-the-box device consisting of the pinions 99, 103 is driven at such a speed by the worm wheel 74, that this differential device modifies the drive imparted through spur pinion 97 and shaft 98 just enough to compensate for the rotation of the work table around the central spiral drive gears thereof; this compensating acceleration or retarding of the table movement permitting the necessary selection of change gears for any particular grade of spiral to be made in a simple manner and without any elaborate calculations. The significance of this system of gearing connections will be better understood when it is considered that the shaft 16 has fixed thereon both the main table rotating worm 15 and the worm 73, and the latter through its driving engagement with the worm wheel 74 controlling the jack-in-the-box differential action, thus at all times exerts the proper modification on the drive through shaft 102 for separately rotating the table top so that whatever speed of turning movement is imparted to the main table drive through worm 15, the jack-in-the-box differential modifies the drive imparted through shaft 102 to the table top just enough to compensate for the

turning movement of the gears carried by the table in their movement with the table around the table axis. Thus when it is desired to set the machine for cutting gears of different sizes and pitches, the selection of the requisite change gearing, for the change gear trains 63, 76 and 96 becomes a simple matter of selecting gears to drive in the proper simple arithmetical ratio instead of a complicated calculation or formula which would otherwise be required.

Thus for cutting spirals the machine is geared as shown with the swivel cutter head 54 turned to the proper angle, and the linear work table feed stationary with the worm drive at 90 disconnected. In this operation the proper change gears at 63 are selected with reference to the size of the gear blank being operated on, these being set up in a simple ratio determined by the relative dimensions of the hob, and the worm wheel being cut. In this operation the change gears at 76 are selected for the proper vertical feed of the hob which is imparted to vertical feed shaft 82 from the train of gearing including the bevel gears 80, 81, and the differential operated through worm 73 taking care of the relative timing of the work table rotation. To cut spur gears the central clutch in the work table is thrown upward, the table top then revolving as though solid with its main driving gear, and the cutter head in correct angular position is fed downward. To cut worm gears the clutch 83 is thrown out, the table turns solid with its driving gear and the end feed worm for the table slide is thrown in; the hob being of course set at the correct angle. To cut single worms the clutch 67 is disconnected, and suitable change gears interposed in the feed gear trains. This will feed down the head which will be set with the hob spindle at the correct angle to the worm to be cut, *i. e.*, nearly vertical as shown, and the table top will be slowly rotated at the correct speed. In this operation the internal clutch at the table center should be down, and the table slide fixed. For multiple thread worm gear cutting the setting is the same as in the last example but the main table worm may be used for indexing purposes in connection with the graduated flanges on the drive shaft thereto described; it will be understood that the squared end of the table driving shaft at the side of the machine may be used to rotate the worm for the indexing.

In the form of the invention shown in Figs. 8 to 14, I provide an organization adapted to employ a standard work table along with a standard or usual framework and cutter head arrangement. In this form I provide a differential compensating device with a combination of connecting gears having an action quite closely equivalent to that of the two-part table construction before described. In this form the drive shaft 48 actuates the vertical hob rotating shaft 51, and the shaft 61 which transmits impulse for the working feeds and table rotation in like manner as in the preceding form. The shaft 61 operates through change gear 63′ which are selected with reference to the size of gear to be cut in like manner as the change gears 63, and the shaft 65′ has fixed thereon a worm 66′ driving a worm wheel 75′, and this in turn is connected to actuate through change gears 76′ a shaft 79′ which by a bevel gear 80′ fixed thereon drives a bevel pinion 81′ on the vertical shaft 82′, the shaft 82′ also driving through bevel gearing 86′ the shaft 87. In this combination it will be observed that the change gear 76′ are the feed gears which are selected to give the required cutting feed to the cutter head and the work table, since through the described connections they control the turning movement of the shafts 82′ and 87 to the cutter head and the work table feeds respectively. Driving impulse for rotating the work table is transmitted from shaft 65′ through a gear 105 loose thereon but having clutch teeth at one side engageable with coöperating clutch teeth on a collar 106 keyed to shaft 65′, the interengaging clutch teeth being shown at 107. The gear 105 has a grooved collar 108 at one side thereof, the groove of which is engaged by a hand operated shifting lever 109. This gear meshes with a gear 110 fixed to a gear box 111 which is mounted concentric with and connected to turn shaft 16′ with an interposed differential at will, in a manner to be presently described. It will be understood that the shaft 16′ controls the turning of the table with a worm gear connection thereto as does the shaft 16, but since the differential is in this instance interposed back of this shaft instead of between it and the table top, its own movement is modified to the required extent by the differential to impart the necessary compensation to the table by a direct connection and without the separate table top movement of the first described form. The gear 105 is slidable along the shaft 65′ to an extent sufficient to disengage the clutch teeth 107, while its gear teeth still remain in mesh with those of 110, and in this latter position its teeth come into mesh at one side with a rack member 112 fixed to the frame work. In this position it will be observed that the gears 105, 110, and gear box 111 are held locked against rotation, so that the work table may be held against turning as required for certain gear cutting operations. In this embodiment of the invention I show the driving impulse for the differential compensating movement, as derived from a spiral gear 113 fixed on vertical shaft 82′, this gear meshing with a coöperating spiral 114 fixed on a shaft 115. The shaft 115 through a change gear train

116 drives a spiral 117 loosely mounted on a long sleeve 118 of a bevel pinion 119 which constitutes one element of a jack-in-the-box differential. The gear 117 has at a side thereof clutch teeth adapted to engage cooperating teeth on a clutch collar 120 slidably keyed to the sleeve 118, and this clutch sleeve has other clutch teeth at its other side engageable with clutch teeth on a flanged collar 121 fixed to the frame, so that by sliding clutch collar 120 in one direction the gear 117 is brought into driving connection with the pinion 119 and on sliding said collar in the opposite direction it is interlocked with the fixed collar 121, and the pinion 119 held against turning; a suitable actuator and controller for the collar 120 is indicated at 122. The gear box 111 has a long sleeve bearing arbor 123 carried at one side thereof which has a mounting in a bearing support 124 and has keyed at its extremity a bevel pinion 125 opposite the pinion 119. Between the pinions 119 and 125, and completing the jack-in-the-box device are bevel pinions 126 journaled on stud pins 127 extending radially from a shaft 128 which is journaled in the bore of sleeves 118 and 123, and extends into the gear box 111 where it has keyed thereto a spiral pinion 129. The pinion 129 is in mesh with a spiral pinion 130 loose on the shaft 131 journaled crosswise of the gear box 111 at one side of its center and this spiral pinion is adapted to be brought into driving engagement with its shaft by a clutch collar 132 slidably keyed on the shaft, this collar having also clutch teeth at its outer end engageable with clutch teeth on a collar block 133 fixed to the gear box, so that the shaft 131 may be either locked against turning or locked to turn with the pinion 130 at will; a suitable actuator for clutch collar 132 is shown as a lever 134 fulcrumed at 135 and having an operating knob 136 extending without the gear box at a dished-in part thereof as seen at 137. The shaft 131 has fixed thereon a worm 138 meshing with a worm wheel on a shaft 139 journaled at right angles thereto in the gear box and shaft 139 has fixed thereon a worm 140 meshing with a worm wheel 141 keyed to the end of shaft 16′.

With this organization it will be observed that when spiral gears are to be cut with the required turning movement of the work table, the primary impulse for effecting the turning, is through the direct train of gears 105, 110, gear box 111 and worm wheel 141 on to the table drive shaft 16′, this drive being separate from and as it were in shunt relation to the differential, and the differential control from the spiral 113, through the jack-in-the-box and shaft 128 only being required to transmit a relatively small increment of differential movement to modify the drive of shaft 16′ to the required extent; it will be understood that the whole gear train involved in the jack-in-the-box differential will therefore be geared down so that the amount of driving stress thereon is very small. Further it will be noted that my improved arrangement permits the differential to be wholly dispensed with or shunted out in a very easy convenient manner when required, by simply shifting the clutch collar 120, or clutch collar 132 whichever may be most convenient, to a position wherein the differential is inoperative, and the driving connections locked together to move as a unit without any compensating modification—as would ordinarily be the case for cutting spur gears or worm gears with a radial table feed.

It is thus to be observed that in both of the described forms of the invention the main drive to the work table is through a strong direct gear train, the differential movement being interjected, in the one case at the separately moving table top and in the other case at the gear box 111, in the proper amount to compensate for the rectilinear relative feed movement between the tool and work; further that in each case the jack-in-the-box device permits the interjection of the differential in a manner to permit easy and convenient calculation, since the jack-in-the-box device takes care of the rotation of the small spiral gears one around the other, this turning of one spiral gear around the other being in the one case at the vertical drive concentric with the table, and in the other case at the gears 129, 130 within the gear box 111. When cutting worm gears or spur gears where the differential mechanism is not needed it may be very easily disconnected from the feed gear train and allowed to run idle, in this respect presenting a very material improvement over those types of machine wherein it is necessary to take the differential mechanism into account when selecting the rotation gearing, with a corresponding greatly increased difficulty and complexity of calculation. In the present mchine since the influence of the differential movement inserting means is taken care of, *i. e.*, neutralized by the jack-in-the-box device, the differential may be ignored when selecting the rotation gearing, and for a given ratio between the hub and the gear blank, the rotation gears remain the same whether spur, spiral or worm gears are to be cut, the differential giving the necessary advance or retard to the work to compensate for the hob feed in cutting spirals and being cut out for the other forms of gears. Thus while in previous machines employing a jack-in-the-box device to interject the differential it has been necessary for a given ratio between the hob and the blank, to use

two different sets of gears for cutting spurs and spirals, in the present machine on the other hand the same set of driving connections are adapted for use for cutting all kinds of gears. In cutting spur gears or worm gears the differential gearing may merely act as a compensating device and it will be understood that it is always merely a compensating device when the feed gears are not rotated, or the clutches in fixed locked position.

While I have herein referred to the cutting of spiral gears as that distinctively accomplished with the differential compensating mechanism in operation, and to the cutting of spur and worm gearing as distinctive of the use of the machine with the differential disengaged, it will be understood that spur or worm gearing can also be produced with the differential in operation, *e. g.*, in the cutting of spur gears the compensating acceleration of the table movement would be made to bear such a relation to the rectilinear feed of the hob, and the relative turning of hob and work that any given point on the hob will travel in a line parallel with the work axis in passing through the work. I am aware that the invention can be embodied in other specific forms without departing from the spirit thereof and I therefore desire the present embodiment to be considered as illustrative and not restrictive and I refer to the appended claims rather than to the foregoing description to indicate the scope of protection intended to be had.

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

1. A gear cutting machine, comprising work holding and tool holding means mounted in coöperative relation and having direct gear connections for rotating in definitely timed relation, one of said means having provision for receiving feed movement in a direction lengthwise of the axis of the work holding means, and other means arranged in a shunt relation to said direct gear connections and arranged to be interjected therein at will to modify the action of said connections for compensation of said feed movement.

2. A gear cutting machine, comprising work holding means, tool holding means, a main driving set of gear connections therebetween for effecting the rotation of tool and work in definitely timed relation, one of said means having provision for receiving rectilinear feed movement in a line substantially parallel to the axis of the work piece, and other gear connections arranged in a shunt relation to said main drive connections, and arranged to be interjected therein at will to modify the action of said connections for compensation of said feed movement.

3. A gear cutting machine, comprising work holding means, tool holding means, a main driving set of gear connections therebetween for effecting the rotation of tool and work in definitely timed relation, one of said means having connections for imparting rectilinear feed movement thereto in a line substantially parallel to the axis of the work piece, and other gear connections arranged in a shunt relation to said main drive connections and consisting of a jack-in-the-box device arranged to be interjected in the driving train between the work holding means and the tool holding means at will, in a manner to modify the action of the main drive connections for compensating said feed movement.

4. A gear cutting machine, comprising a work table mounted for rotation, a hob spindle mounted for rotation and also for bodily movement across the periphery of the blank, means for effecting rotation of the table and hob spindle in definitely timed relation, and means normally occupying a shunt relation to the last named means and adapted to be interjected therein at will to effect compensation for the bodily movement of the hob spindle, said means consisting in a differential jack-in-the-box device adapted to be rendered inoperative or operative at will.

5. A gear cutting machine, comprising a hob spindle, a work table, a set of main gear connections for turning the hob spindle and the table in definitely timed relation, said connections having an assemblage composed of a central shaft, a gear carrier movable in an orbit therearound with connections from said central shaft to the orbital gears, and a differential device adapted to automatically neutralize the effect of such orbital movement around the central shaft in the transmission.

6. A gear cutting machine, comprising a work table mounted for rotation and for rectilinear movement at will, a cutter spindle mounted for rotation and for bodily movement across the edge of the work piece, geared connections for effecting the turning of the work table and of the cutter spindle, and the bodily feed of the cutter spindle or of the work table at will in definitely timed relation, said connections having a part thereof mounted for orbital movement about a central shaft, said shaft having provision to receive compensating movement, and a jack-in-the-box device for modifying the turning of said shaft for compensation to an extent adapted to neutralize the effect of said orbital movement in the transmission.

7. A gear cutting machine, comprising a work table and a cutter spindle mounted in

operative relation and with gear connections for rotation in definite ratios, one of said elements having provision to effect rectilinear feed of the cutter across the periphery of the work, said connections having a part thereof mounted for orbital movement about a central shaft, said shaft having provision to receive compensating movement according to the said rectilinear feed, and a jack-in-the-box device for modifying the compensating action of said shaft to an extent adapted to neutralize the effect of said orbital movement in the transmission.

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

JAMES G. RIMMER.

Witnesses:

CLYDE L. ROGERS,

W. E. BROWNELL.