Feb. 4, 1936.

W. E. SYKES

2,029,398

GEAR GENERATING MACHINE

Filed Dec. 12, 1932

5 Sheets-Sheet 1

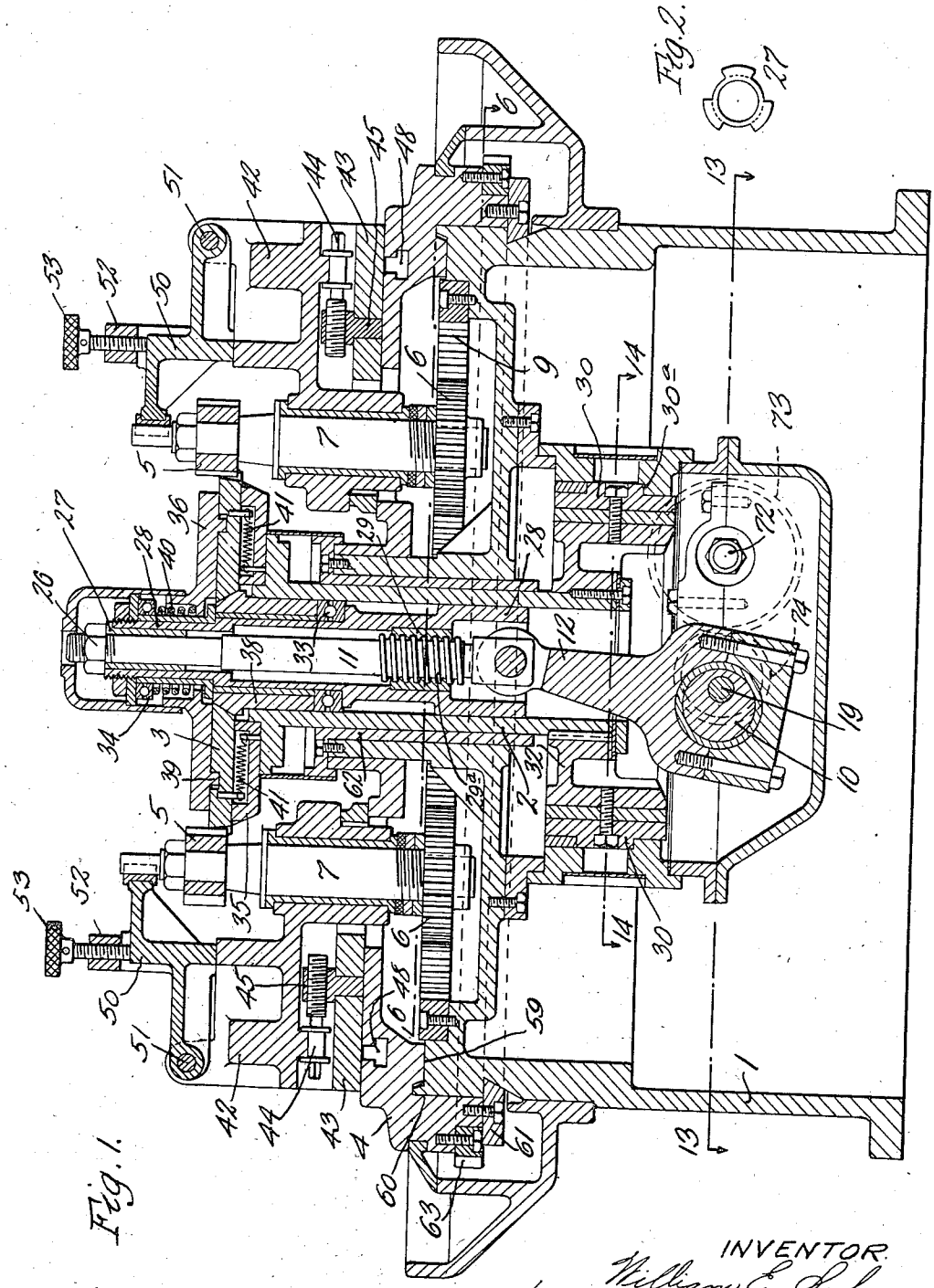


Fig. 1.

Fig. 2.

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Fig. 3.

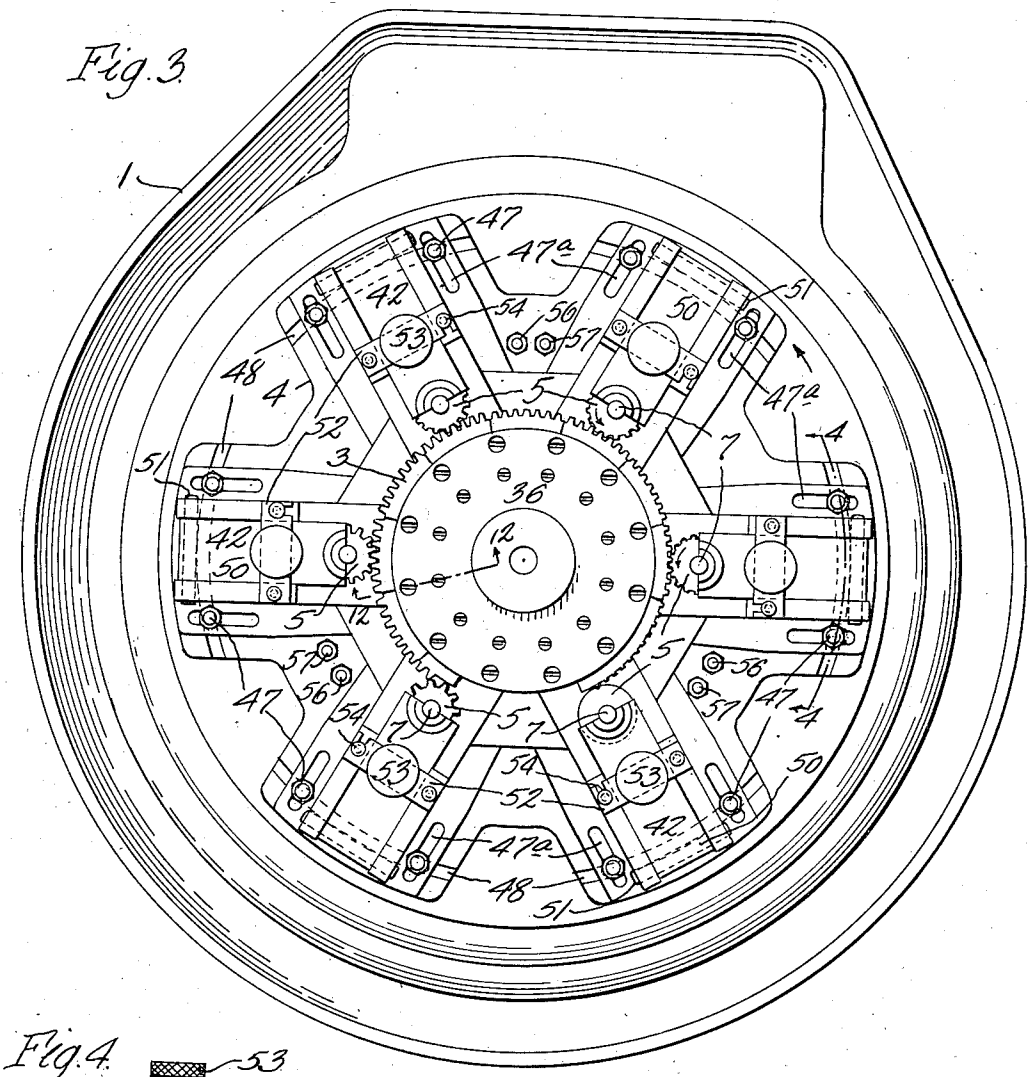
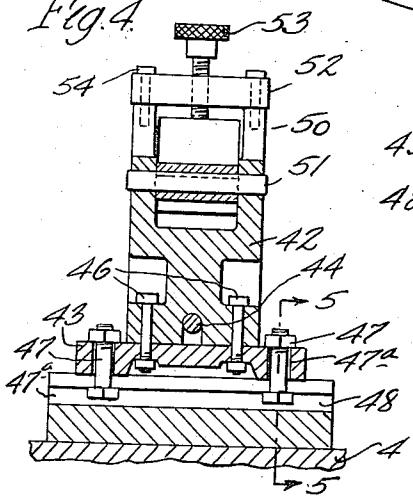


Fig. 4.



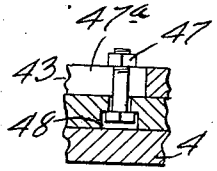


Fig. 5.

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Fig. 6.

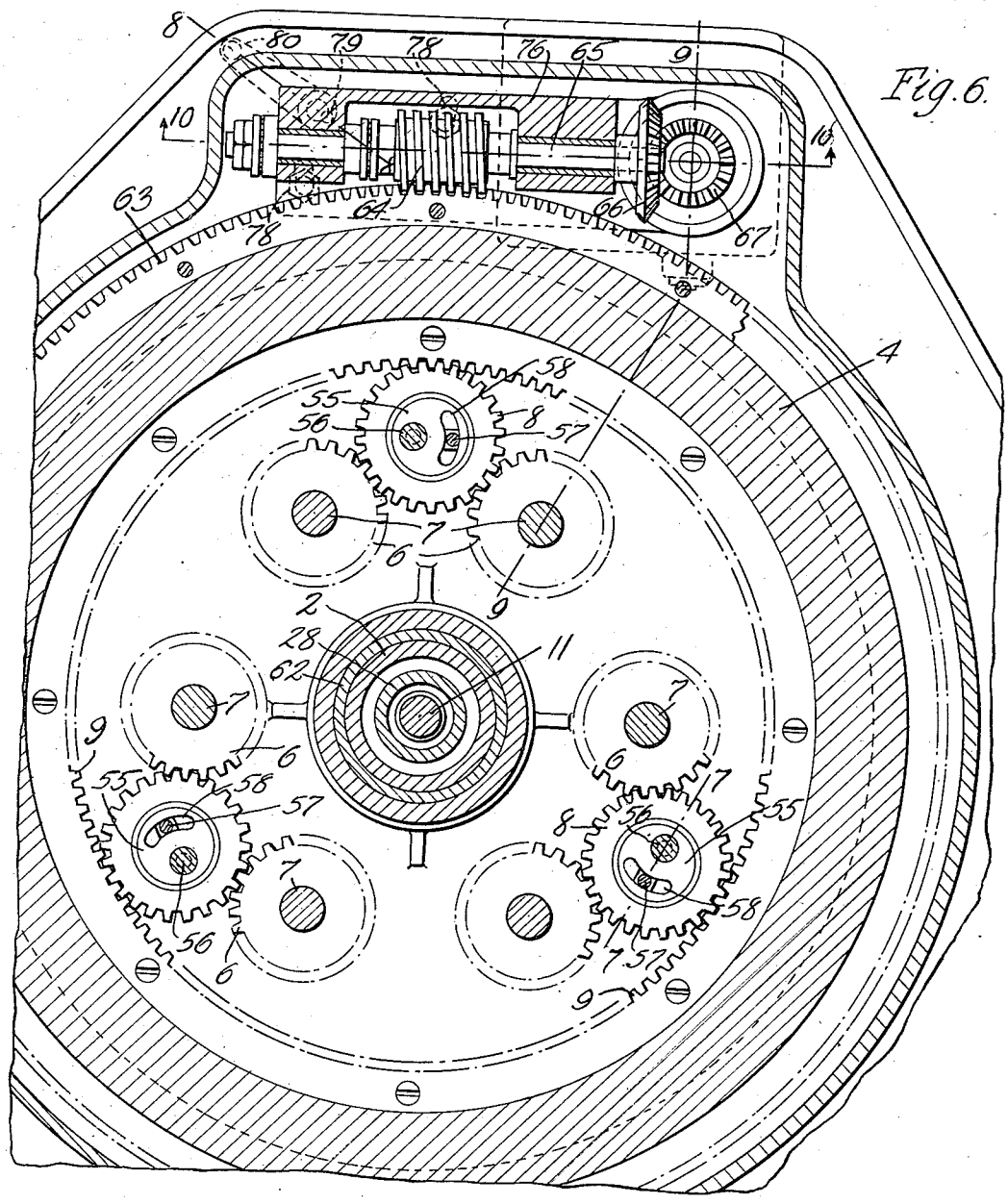
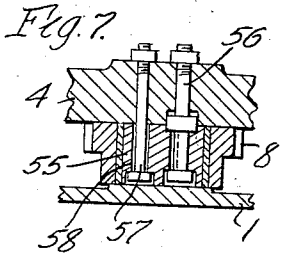


Fig. 7.



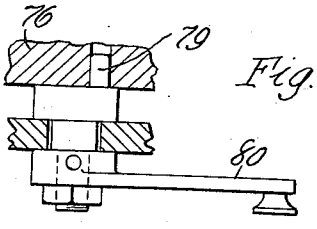


Fig. 8.

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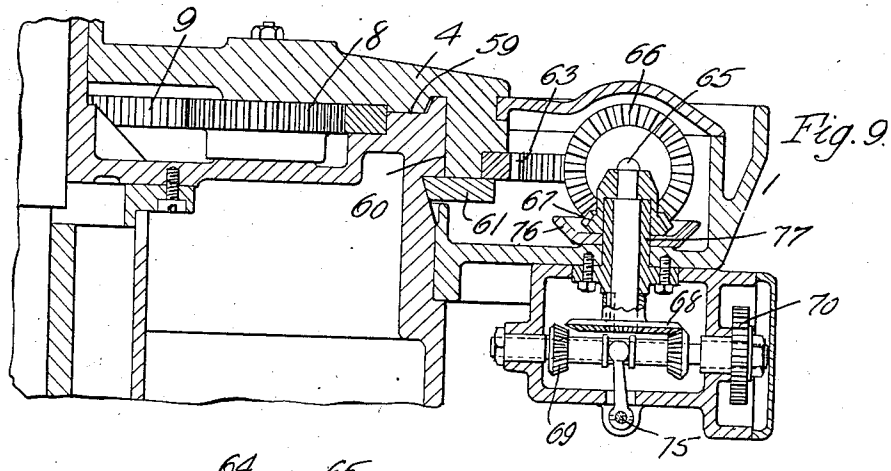


Fig. 9.

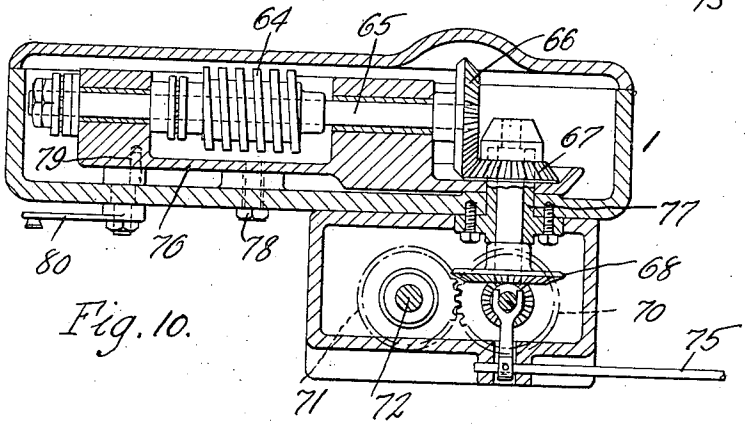


Fig. 10.

Fig. 11.

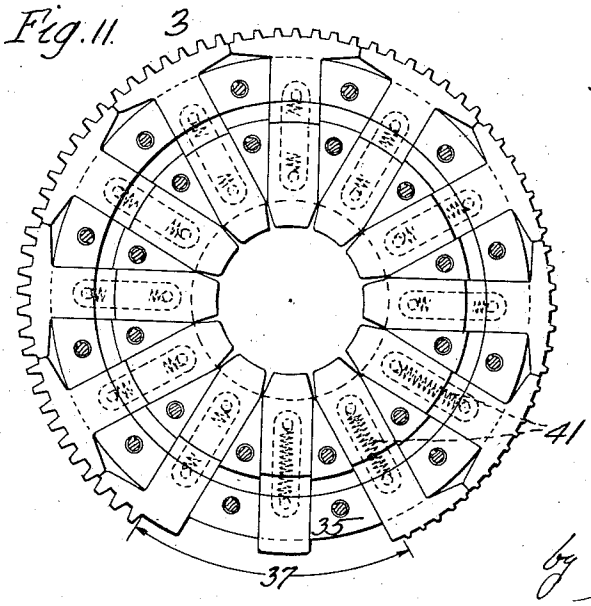
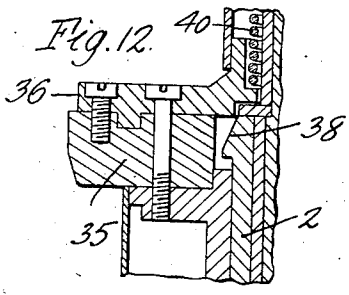


Fig. 12.



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Fig. 13.

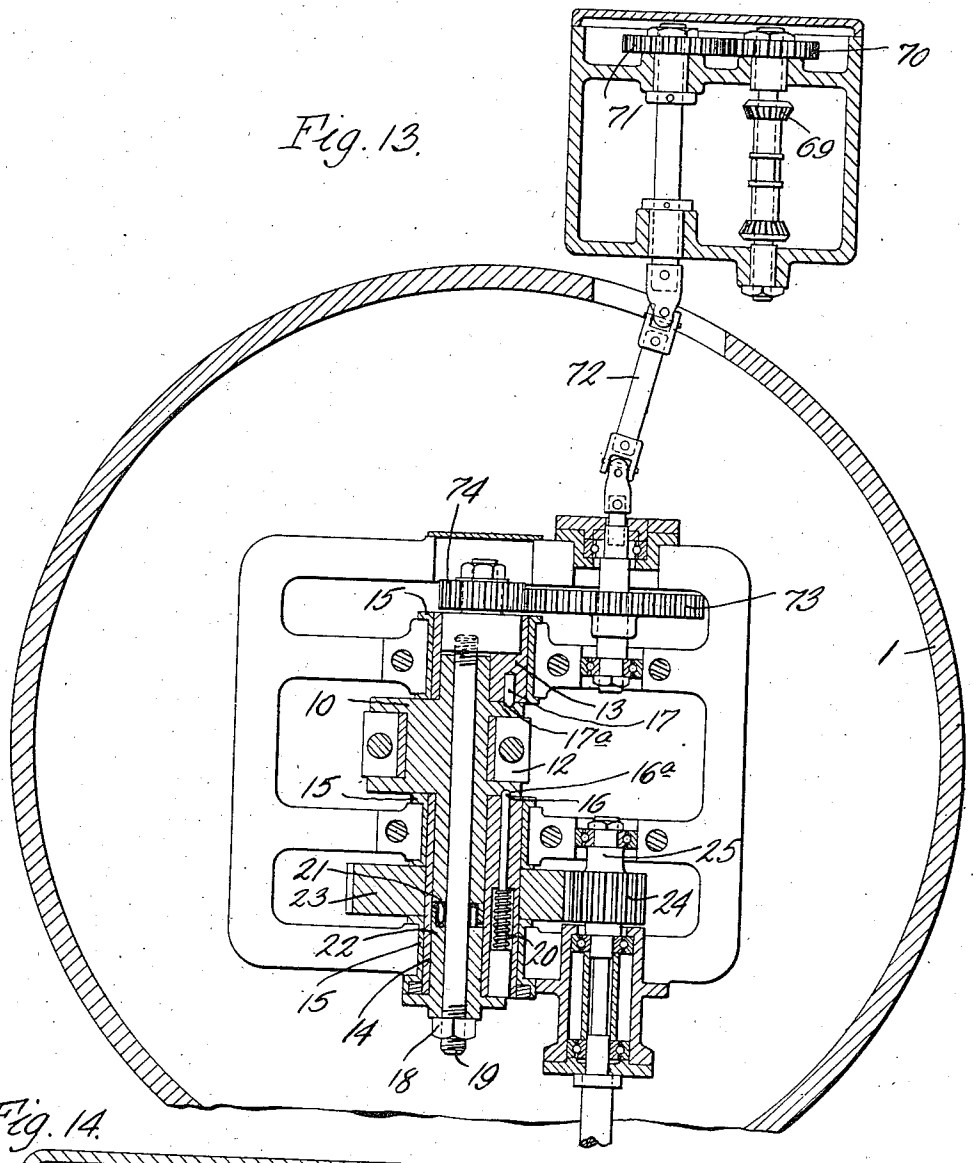
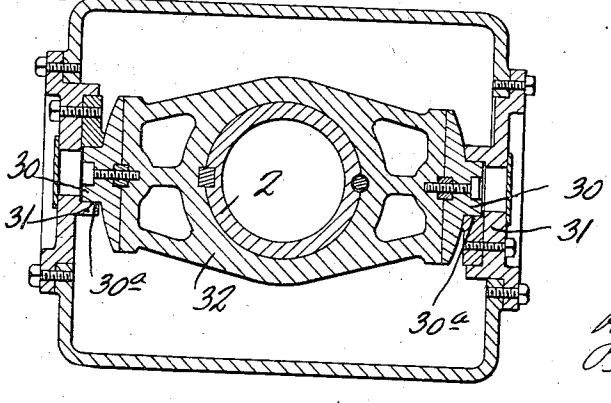


Fig. 14.



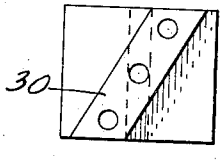


Fig. 15.

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Patented Feb. 4, 1936 2,029,398

UNITED STATES PATENT OFFICE

2,029,398

GEAR GENERATING MACHINE

William E. Sykes, Buffalo, N. Y.

Application December 12, 1932, Serial No. 646,793

18 Claims. (Cl. 90—9)

This invention relates to gear generating machines and more particularly to a multiple gear generator in which a cutter or generating device common to a plurality of gear blanks operates successively and preferably simultaneously on the several blanks.

One object of the invention is to produce a practical and efficient machine of large production capacity, in which the gear blanks can be readily mounted for operating thereon, and the finished gears removed during the uninterrupted operation of the machine.

Other objects of the invention are to produce a gear generating device or cutter having different cutting portions or sections adapted to make successive tooth-forming cuts in a gear blank and also to perform different cutting steps or stages on a plurality of gear blanks simultaneously; to produce a machine in which a series of gear blanks travel with a planetary motion relatively to a common cutter or generating device by which the successive steps or stages of the generating operation are performed during the travel of the blanks past successive portions of the generating device and the gears are finished and removed from the machine in succession after a single passage thereof past the several cutting portions of the generating device; in which the gears which produce the planetary motion of the gear blanks have a ratio which produces correct relative rotation between the gear blanks and the generating device; in which the gears for producing the planetary motion of the blanks are readily adjustable to insure proper mesh and prevent lost motion or back lash between the gears; in which the length of the cutting stroke of the generating device and the position of the generating device relatively to the gear blanks are readily adjustable to suit blanks of different face widths; which is adapted for generating either straight toothed spur gears or helical gears; which can be readily set for generating gears of different diameters or having different numbers of teeth; in which means of simple, practical construction are provided for holding the cutting tools out of contact with the gear blanks during the non-cutting return stroke of the generating device and for positively advancing and holding the tools in operative cutting position prior to engagement with the blanks in the cutting stroke of the generating device; in which the holders for the gear blanks are readily adjustable individually, both for placing the blanks in correct cutting relation to the generating device and also to insure correct engagement of the gears which produce the planetary motion of the gear blanks; in which the gear blank holders are constructed to permit ready placement of the blanks in the holders and removal of the blanks therefrom; in which the intermediate gears of the planetary gearing are mounted so as to permit ready adjustment thereof to insure their correct engagement with the stationary gear and to allow the before-mentioned adjustments of the gear blank holders; in which change speed gearing is provided for producing varying rates of travel of the gear blanks relatively to the generating device; in which the gear blank carrier is driven by gearing which is readily operable for adjusting the mesh of said gearing and to permit free manual rotation of the carrier; and also to produce a gear generating machine having the other features of improvement and advantage hereinafter described and set forth in the claims.

In the machine illustrated in the accompanying drawings as one practical embodiment of my invention, the teeth are generated on the gear blanks by a central circular cutter or generating device which may be in the form of either a straight toothed spur or helical gear, having cutting teeth disposed around its circumference, of constant pitch, but in groups of varying radial depth and thickness or of varying depth only. Said cutter is reciprocated across the faces of several gear blanks arranged in planetary formation around and equally distant from the axis of the cutter. Concurrently with the reciprocation of the cutter, the gear blanks are given a relative rotation around the cutter equal to the movement of similar intermeshing conjugate planetary gears.

In said drawings:

Fig. 1 is a vertical cross section of a gear generating machine illustrative of an embodiment of my invention.

Fig. 2 is a plan view of a clutch bushing or member used in connection with the vertical adjustment of the gear cutter or generating device.

Fig. 3 is a top plan view of the machine.

Fig. 4 is a vertical cross section of one of the work-carrying heads taken approximately on line 4—4, Fig. 3.

Fig. 5 is a detail, vertical section on line 5—5, Fig. 4 of an adjustable clamping device for the work-carrying head.

Fig. 6 is a horizontal section on line 6—6, Fig. 1.

Fig. 7 is a vertical, cross sectional detail on line 7—7, Fig. 6.

Fig. 8 is a fragmentary, vertical section on line 8—8, Fig. 6, showing the means for adjusting

a movable bearing member of the driving mechanism.

Figs. 9 and 10 are vertical sections on lines 9—9 and 10—10 respectively, of Fig. 6, showing a portion of the driving mechanism.

Fig. 11 is a plan view of the gear cutter or generating device assembly.

Fig. 12 is a fragmentary, vertical section on line 12—12, Fig. 3, of a portion of the means securing the cutter on the machine.

Fig. 13 is a horizontal section on line 13—13, Fig. 1, showing the part of the cutter reciprocating mechanism, and also a part of the driving means for actuating the rotating work table of the machine.

Fig. 14 is a horizontal section on line 14—14, Fig. 1 of the cutter reciprocating mechanism.

Fig. 15 is a detail elevation of a guide plate or member of said reciprocating mechanism.

The stationary frame 1 provides guide bearings for a reciprocating ram 2 carrying the cutter or generating device 3, and the rotating table 4 carrying the gear blanks 5 encircling in planet fashion said cutter.

The rotation of each gear blank 5 about its own axis is derived from a gear 6 at the lower end of the blank carrying spindle 7 engaging an intermediate gear 8, the latter being also in mesh with a stationary internal gear 9 fixed to frame 1. Intermediate gear 8 is inserted to rotate gear blank 5 in the correct rolling direction relatively to the cutter 3. The diameters of gears 6, 8 and 9 may be arranged so that one intermediate gear drives two gear blanks, or one only. The ratio of said gears must cause correct relative rotation between the cutter 3 and the gear blank 5.

Reciprocation of the cutter 3 across the faces of the gear blanks 5 is derived preferably from an adjustable eccentric crank 10 linked to central rod 11 in the ram 2, by connecting rod 12.

Adjustment of the length of stroke to suit different face widths of gear blanks 5 is made by adjusting the double-throw crank 10, Fig. 13. The bearing for connecting-rod 12 is eccentric to the crank extensions carried by sleeves 13 and 14, rotating in bushings 15, and the bore of said sleeves receiving said crank extensions is also eccentric. By rotating said crank relatively to sleeves 13 and 14, the two eccentricities may be added together to give maximum stroke, one may be entirely subtracted from the other for minimum stroke, or some intermediate position may be chosen.

For locking the crank to the sleeves 13 and 14 in different angular adjustments relatively to the sleeves, the following construction is shown. The crank 10 is positively locked in any one of several positions, to sleeve 14 by a plunger 16 entering corresponding holes 16a in one flange of said crank, and to sleeve 13 by the pointed plug 17 entering corresponding dimples 17a in the opposite flange of crank 10. Releasing nut 18 on a bolt 19 allows compression spring 20 encircling plunger 16 to push said plunger clear of the adjacent flange of crank 10. This endwise movement is insufficient to disengage the intermeshing jaws 21 on the crank 10 and a clutch 22, and a rotation of said clutch will rotate crank 10 to a new position bringing other holes 16a and dimples 17a in line with plunger 16 and pointed plug 17. By tightening nut 18, the flange on clutch 22 forces plunger 16 into the new locating hole, and pointed plug 17 is also clamped into the corresponding dimple, thus locking crank 10 and sleeves 13 and 14 together as a unit, see Fig. 13.

Crank 10 may be driven by any suitable means, such as a gear 23 keyed to sleeve 14 and engaging a pinion 24 on a shaft 25 which is driven by any suitable source of power.

Adjustment of the vertical position of the cutter to coincide with the height of gear blank 5 is preferably made by releasing a nut 26, Fig. 1 on the central rod 11 until the jaw clutch bush 27, Figs. 1 and 2 can be withdrawn from the corresponding jaws at the upper end of a thrust tube 28, allowing said tube to be rotated independently of central rod 11. When the thrust tube is rotated, a nut 29 engaging the threaded part 29a of said rod imparts the requisite vertical movement to the whole cutter unit in relation to central rod 11 and crank 10.

When cutting spur gears a vertical or axial reciprocation of cutter 3 is sufficient, but for generating helical gears, the cutting teeth should be of helical form and an angular reciprocation is combined with the axial movement of the cutter. As shown, this is accomplished by helical guides 30, Figs. 14 and 15 engaging corresponding grooves 30a in fixed brackets 31 on the stationary frame. Guides are used also for cutting straight spur gears, but in this case said guides act simply as straight sliding keys for preventing angular movement of the cutter. Said guides 30 are attached to a spider 32 keyed to ram 2, Figs. 1 and 14, to which cutter 3 is attached.

As previously described, cutter 3 receives vertical movement from crank 10. Also, as just described, when cutting helical gears, an angular motion is also imparted to said cutter and ram 2 is free to rotate on thrust tube 28. Anti-friction thrust bearings 33 and 34, Fig. 1 are preferably interposed between thrust tube 28 and ram 2, so that the relative angular reciprocation may be accompanied with as little friction as possible.

The cutter or generating device 3 shown, see Figs. 1, 3 and 11 consists of a number of independent sections each having a segmental circular outer end formed with a group of cutting teeth, and each section is slidably carried in a separate radial groove in a cutter body 35, and retained therein by cover 36. In the operation of the machine, a gear blank 5 is mounted upon a spindle 7 during the interval of traversing the gap 37, Fig. 11 devoid of cutter teeth. After this, the blank engages first, a series of shallow cutter teeth sufficient in number to cut a series of shallow grooves around the whole circumference of said gear blank, then a second series of deeper teeth which penetrate further into the passing gear blank and so on until the final series, containing enough cutter teeth of a height and thickness to impart the finishing cuts around the whole circumference of a finished gear is reached. When the finishing teeth are passed, the gear will be opposite the original gap 37 where the finished gear can be removed and replaced by an uncut blank. The teeth of each different group or series may be formed on one or more than one cutter section, depending upon the diameters of the blanks being cut, and preferably each group contains sufficient teeth of one size to cut teeth completely around the blank during the travel of the blank past such group of cutter teeth. If desired, however, the teeth can be graduated around the cutter from the shallowest to the finishing teeth.

During the non-cutting stroke of cutter 3, the cutting tools or cutter sections are withdrawn from contact with gear blanks 5 in order to

avoid rubbing contact of the cutter on the work.

For this purpose, the following construction is preferably employed. Before the upward thrust of thrust tube 28 is communicated to cutter 3 for the cutting stroke, a tapered sleeve 38, Fig. 1, within the ram, forces all the cutting tools, which have a corresponding inner tapered end, outward against the projecting ring 39 on the underside of the cover 36. A compression spring 40 surrounding the thrust tube 28 between the bearing 34 and a shoulder on the cutter cover, assists the weight and inertia of the ram unit during this interval, to hold cutter 3 down until the wedging action between tapered sleeve 38 and cutting tools in cutter 3 and cover 36 is completed. On the downward or non-cutting stroke, the central rod 11 is first pulled down carrying positively with it the tapered sleeve 38, but cutter 3 and ram 2 are not moved until the increased compression of spring 40 or the face to face contact of anti-friction thrust bearing 34 with the upper end of the central part of cover 36 occurs. If spring 40 has not sufficient strength to depress ram 2, it at least serves to nullify the otherwise hammer-like blow between thrust bearing 34 and cover 36. This short, independent, downward movement of tapered sleeve 38 releases the cutting tools in cutter 3 thereby allowing the light tension springs 41 to pull said tools inward to avoid rubbing contact.

The gear blanks 5 are carried by individual holders 42 fitted to bases 43, Figs. 1, 3 and 4, adjustable both radially for correct distance from cutter 3, and circumferentially, for correct engagement of gears 6 and 8. A further fine radial adjustment of the holder in a guide on the base is obtained by rotating a screw 44, having a bearing in holder 42, and fitting a nut 45 anchored in base 43. Bolts 46, Fig. 4 bind holder 42 and base 43 together, while bolts 47 passing through radial slots 47a in the base and having heads retained in circumferential T grooves 48 on the table 4 permit the coarse or axial and circumferential adjustments, and when tightened, clamp the whole unit to rotating table 4.

In order to brace the upper end of the blank spindle and nevertheless permit blanks to be readily secured on and removed from the spindle, the upper end of holder 42 preferably carries the swinging tail support 50 pivoted on pin 51 and clamped by cross piece 52 and screw 53. One end of said cross piece is slotted to engage a headed stud 54 and can be swung clear of the stud to allow support 50 sufficient unobstructed rotation about pivot 51 to give easy access for removal or placement of a gear blank 5.

Preferably the intermediate gear 8 revolves upon a plug 55, Figs. 6 and 7, mounted eccentrically upon and keyed to pivot stud 56, thus allowing said gear to be adjusted to correct engagement with the stationary internal gear 9, and doubly locked by stud 56 and a bolt 57, said bolt engaging an arcuate slot 58 in the plug 55.

Rotary table 4, Fig. 1, mounted on frame 1, rests upon face 59 and is a rotatable fit around cylindrical surface 60. Keep ring 61 and the flange of the ram bushing 62 prevents table 4 from being lifted away from frame 1 by the upward thrust of the cutting stroke.

The table 4 is rotated by a worm wheel 63, Figs. 1 and 6, fixed to the table and receiving motion from worm 64, Figs. 6 and 10, keyed to shaft 65 which is preferably driven by bevel gears 66, 67, 68, double bevel pinion 69, Fig. 9, pick-off spur gears 70 and 71, Fig. 13, the universal jointed shaft 72 and spur gears 73, 74. Pinion 74 is fixed to and rotates with crank eccentric sleeve 13. Rotation of table 4 is started, stopped or reversed in direction by the engagement and disengagement of the sliding, double bevel pinion 69, controlled in well known manner by a lever on shaft 75.

By replacing pick-off spur gears 70 and 71, Fig. 13, by pairs of gears of different numbers of teeth, but the same center distance, varying rates of rotation are imparted to rotary table 4.

As shown, worm shaft 65 is carried by bracket 76, Figs. 6 and 10, pivoted upon bushing 77. Releasing nuts 78 allow eccentric pin 79 controlled by lever 80 to swing worm 64 clear of engagement with worm wheel 63, permitting free rotation of table 4, and also allowing adjustable meshing engagement between said work and worm wheel to take up wear.

I claim:

1. In a gear generating machine, the combination of a tooth generating device carrying a series of cutters movable on said device and adapted to perform successive tooth generating steps, means for producing a planetary motion of a gear blank whereby the blank revolves about its own axis and travels in succession past said successive portions of the generating device in cutting relation thereto, means for reciprocating said generating device transversely of the plane of travel of the blank for cutting the blank, whereby successive portions of the generating device operate in succession on said gear blank and the generation of the teeth on the blank is completed when said blank has passed the several portions of the generating device, and mechanism for retracting the cutters on the generating device and maintaining them out of contact with the blank during the return non-cutting stroke of the generating device.

2. In a gear generating machine, the combination of a tooth generating device having separate movable cutters disposed circumferentially of said device and adapted to make successive different tooth generating cuts, means for producing a planetary motion of a gear blank whereby the blank revolves about its own axis and travels in succession past said successive cutters in cutting relation thereto, means for reciprocating said generating device transversely of the plane of travel of the blank for cutting the blank, whereby successive cutters of the generating device operate in succession on said blank, and means for retaining said cutters in cutting relation to the blank during the cutting stroke of the generating device and holding said cutters out of contact with the blank during the return non-cutting stroke of the generating device.

3. In a gear generating machine, the combination of a tooth generating device having circumferential cutting portions adapted to make successive tooth generating cuts, means for producing a planetary motion of a gear blank whereby the blank revolves about its own axis and travels in succession past said successive portions of the generating device in cutting relation thereto, said generating device having a tubular stem, a bearing in which said stem reciprocates and is capable of turning, means for reciprocating said generating device including a part arranged within said stem and relatively to which said stem is rotatable, and a guide which limits turning movement of said stem in its bearing.

4. In a gear generating machine, the combination of a tooth generating device having circum-

ferential cutting portions, means for revolving a gear blank about its own axis and producing a relative advance motion between the generating device and the blank whereby the blank is presented successively to said cutting portions of the generating device in cutting relation thereto, said generating device having a tubular stem, a bearing in which said stem reciprocates and is capable of turning, means for reciprocating said generating device including a part arranged within said stem and relatively to which said stem is rotatable, and a helical guide which produces a limited turning movement of said stem during its reciprocation in its bearing.

5. In a gear generating machine, the combination of a tooth generating device having circumferential cutters, means for revolving a gear blank about its own axis and producing a relative advance motion between the generating device and the blank whereby the blank is presented successively to said cutters of the generating device in cutting relation thereto, said generating device having a tubular stem, a bearing in which said stem reciprocates, means for reciprocating said generating device including a part arranged within said stem and which is adjustable axially of said stem for varying the position of said generating device relatively to the blank, and a guide which limits movement of said stem rotatably about its axis.

6. In a gear generating machine, the combination of a tooth generating device having movable circumferential cutters, means for producing a planetary motion of a gear blank whereby the blank revolves about its own axis and travels in succession past said cutters of the generating device in cutting relation thereto, said generating device having a tubular stem, a bearing in which said stem reciprocates, means for reciprocating said generating device including a tube arranged within said stem and having a limited axial movement relatively to said generating device for shifting the circumferential cutters of the generating device into and out of cutting relation to the blank, and a guide for limiting movement of said stem rotatably about its axis.

7. In a gear generating machine, the combination of a circular tooth generating device having circumferential cutting portions, a blank holder arranged to travel in a circular path about said generating device, a supporting spindle for a gear blank rotatable in said holder, a stationary internal gear concentric with said generating device, a gear secured to said spindle, an intermediate gear meshing with said spindle gear and with said internal gear, and means for rotating said blank holder about said generating device, whereby a planetary motion of said spindle and gear blank is produced, said blank holder being adjustable radially toward and from said generating device and also circumferentially relatively thereto for placing the gear blank in cutting relation to said generating device and maintaining proper mesh of said gears.

8. In a gear generating machine, the combination of a circular tooth generating device having circumferential cutting portions, a blank holder arranged to travel in a circular path about said generating device, a supporting spindle for a gear blank rotatable in said holder, a stationary internal gear concentric with said generating device, a gear secured to said spindle, an intermediate gear meshing with said spindle gear and with said internal gear, and means for rotating said blank holder about said generating device, whereby a planetary motion of said spindle and gear blank is produced, said intermediate gear being adjustable relatively to said spindle and internal gears.

9. In a gear generating machine, the combination of a circular tooth generating device having circumferential cutting portions, a blank holder arranged to travel in a circular path about said generating device, a blank-supporting spindle rotatable in said blank holder, and mechanism for moving said blank holder in a circular path concentric with said generating device and rotating said blank supporting spindle about its axis, including a stationary internal gear and change speed gears for varying the rate of travel of said blank holder relatively to said generating device.

10. In a gear generating machine, the combination of a tooth generating device, a spindle having a projecting end on which the gear blank is secured, a carrier on which said spindle is journalled, mechanism for rotating said carrier and producing a planetary motion of said spindle and blank relatively to said generating device, a tail support for said spindle mounted on said carrier to move laterally to and from supporting position in engagement with the end of the spindle outwardly beyond the blank to facilitate the securing of the blank on and its removal from the said spindle, and means for releasably securing said tail support in spindle-supporting position.

11. In a gear generating machine, the combination of a tooth generating device, a gear blank carrier, and mechanism for rotating said carrier and producing a planetary motion of the gear blank relatively to said generating device including a gear connected with said carrier, a gear for driving said first mentioned gear and a stationary internal gear operatively geared to the blank, and means for shifting said driving gear relatively to said other gear for adjusting the mesh of said gears and for freeing said carrier.

12. In a gear generating machine, the combination of a tooth generating device having circumferential cutting portions, a gear blank holder, and mechanism for producing a planetary motion of said gear blank relatively to the generating device, comprising a master gear larger than the gear blank connected therewith, an internal gear, and an intermediate gear operatively connecting said master and internal gears.

13. A gear generating device of gear wheel type comprising separate circumferentially disposed cutting sections having cutting teeth of uniform pitch but of different dimensions and independently adjustable relatively to each other to and from cutting position.

14. A gear generating device of gear wheel type comprising a body, and cutting sections disposed circumferentially of said body and independently adjustable radially thereon to and from cutting position, said sections providing cutting teeth of uniform pitch but of different dimensions.

15. A gear generating device of gear wheel type comprising a body, cutting sections disposed circumferentially of said body and independently adjustable radially thereon to and from cutting position, said sections providing cutting teeth of uniform pitch but of different dimensions and a means operable to hold said sections in cutting position and to allow relief movement thereof.

16. In a gear generating machine, the combination of a tooth generating device carrying a series of cutters movable on said device and adapted to perform successive tooth generating steps, means for revolving a gear blank about its own

axis and producing a relative advance motion between the generating device and the blank whereby the blank is presented to and revolved in cutting relation to said cutters in succession, means for producing relative reciprocations of the generating device and the gear blank transversely of the plane of revolution of the blank for cutting the blank, and mechanism for retracting and holding said cutters of the generating device out of contact with the blank during the non-cutting return strokes of said reciprocations.

17. In a gear generating machine, the combination of a tooth generating device carrying a series of cutters movable on said device and adapted to perform successive tooth generating steps, means for revolving a gear blank about its own axis and producing a relative advance motion between the generating device and the blank whereby the blank is presented to and revolved in cutting relation to said cutters in succession, and mechanism for reciprocating said generating device for cutting the blank and including a member having a limited movement relatively to said generating device for shifting said cutters on the generating device into and out of cutting relation to the blank.

18. In a gear generating machine, the combination of a circular tooth generating device having circumferential cutting portions, a gear blank-supporting spindle having a projecting end on which the blank is secured, a carrier on which said spindle is rotatably mounted, mechanism for revolving said spindle about its own axis and producing a relative advance motion between the generating device and said spindle carrier, whereby the blank is presented to and revolved in cutting relation to said cutting portions in succession, a tail support for said spindle mounted on said carrier to move laterally to and from supporting engagement with the end of said spindle outwardly beyond the blank to facilitate placing the blank on and removing it from the spindle, and means for releasably securing said tail support in its spindle-engaging position.

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