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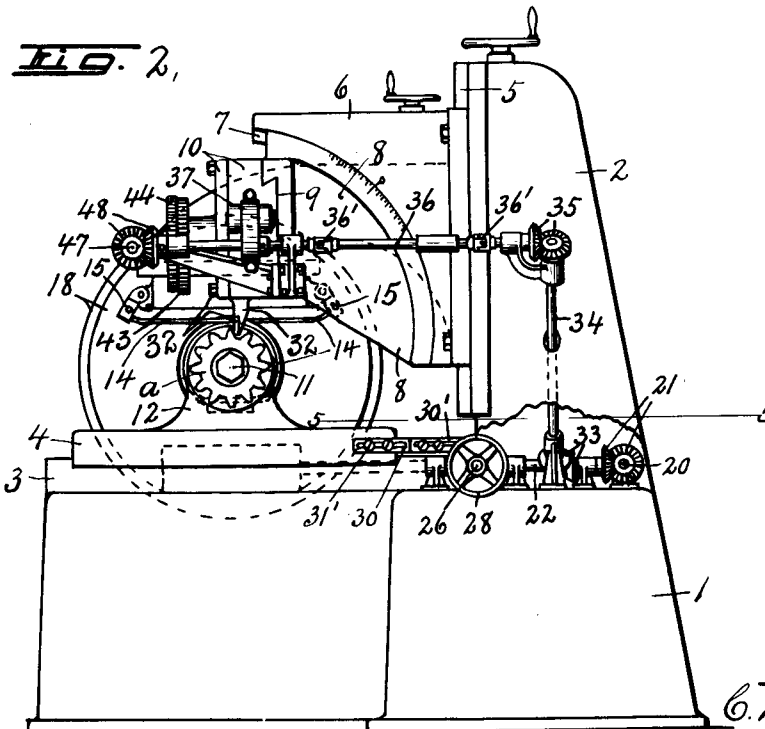
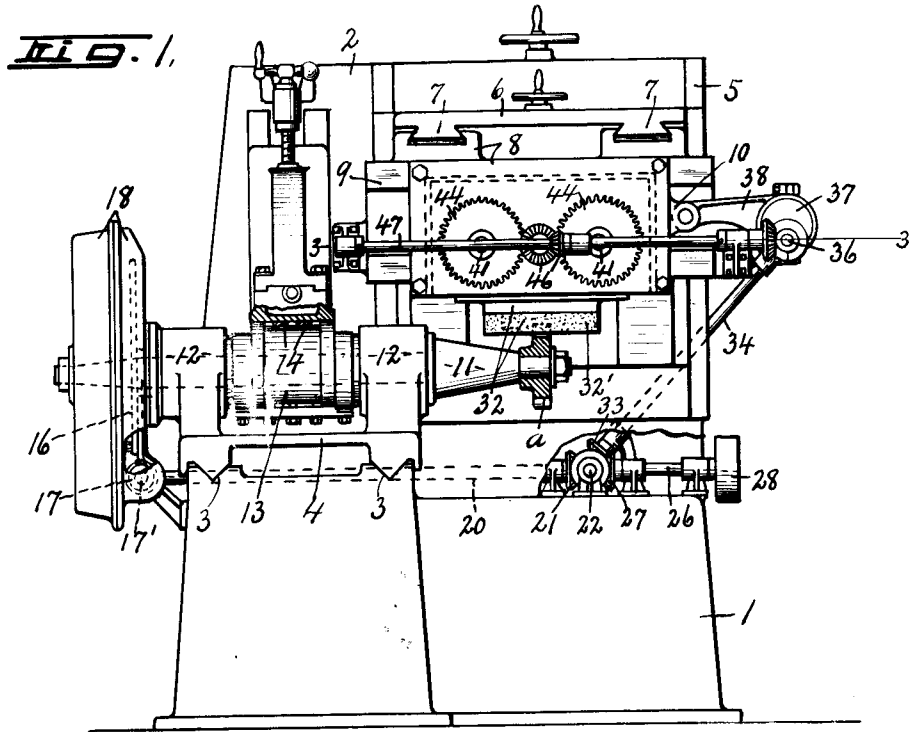
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C. H. LOGUE

GEAR LAPPING MACHINE

Filed July 3, 1925

3 Sheets-Sheet 1



WITNESS
H. H. H. H.

INVENTOR
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Sept. 18, 1928.

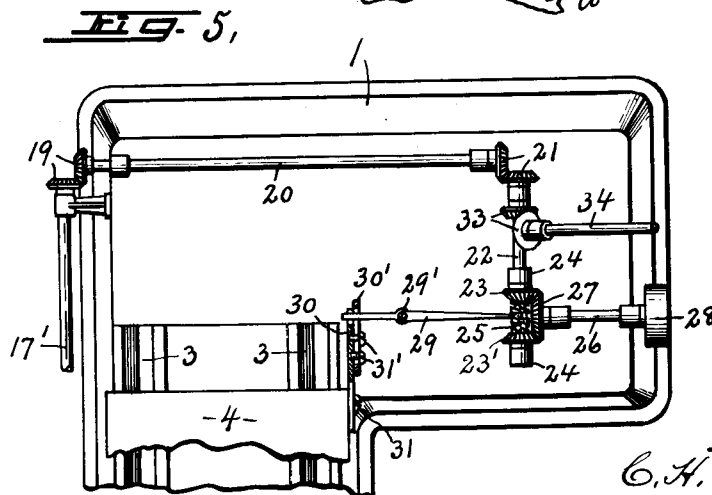
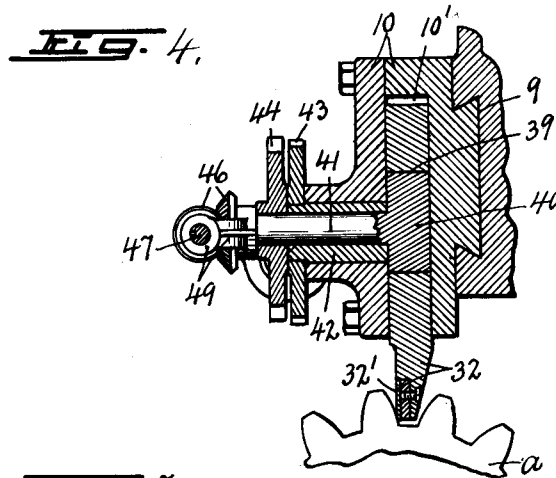
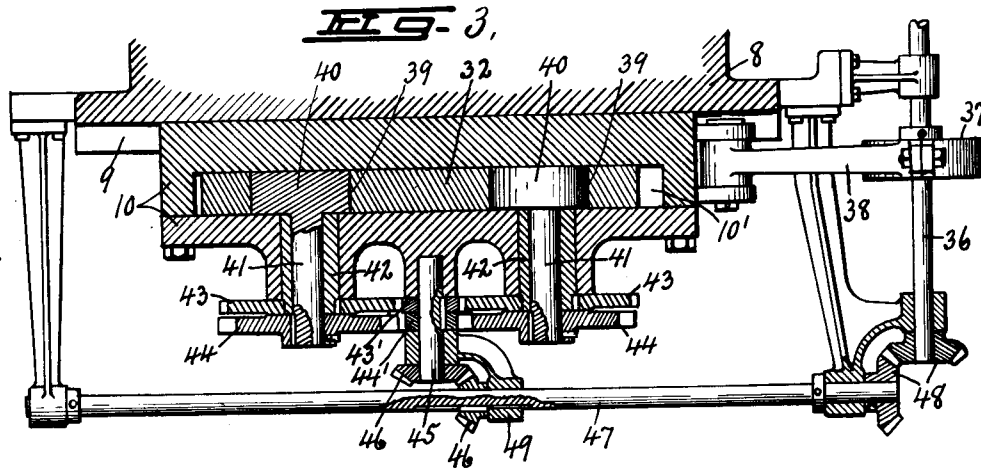
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C. H. LOGUE

GEAR LAPPING MACHINE

Filed July 3, 1925

3 Sheets-Sheet 2



WITNESS
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Sept. 18, 1928.

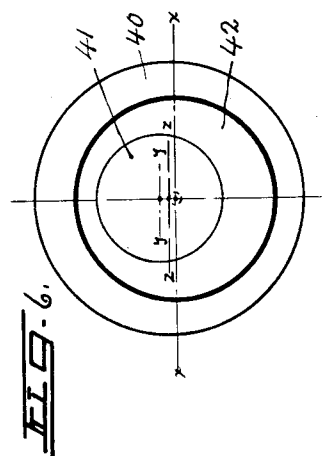
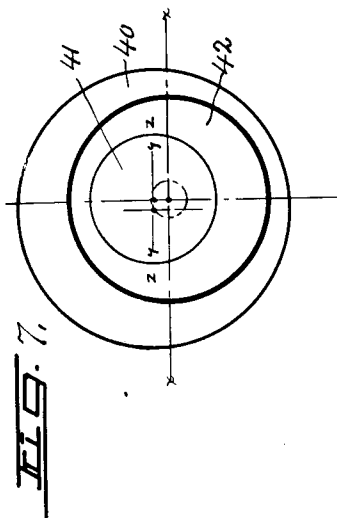
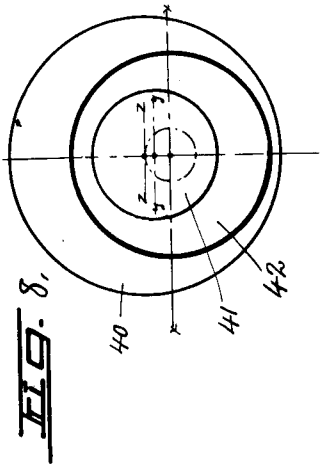
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C. H. LOGUE

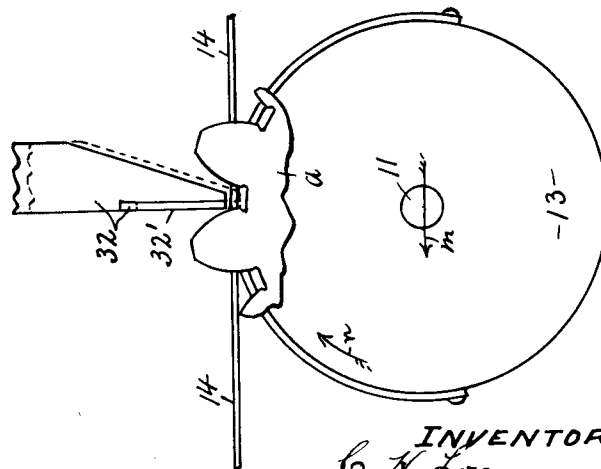
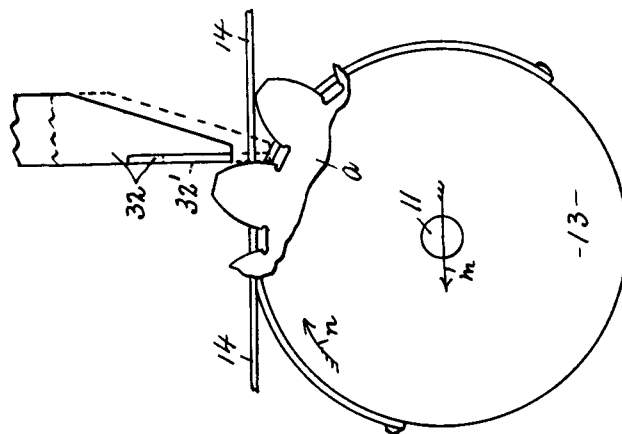
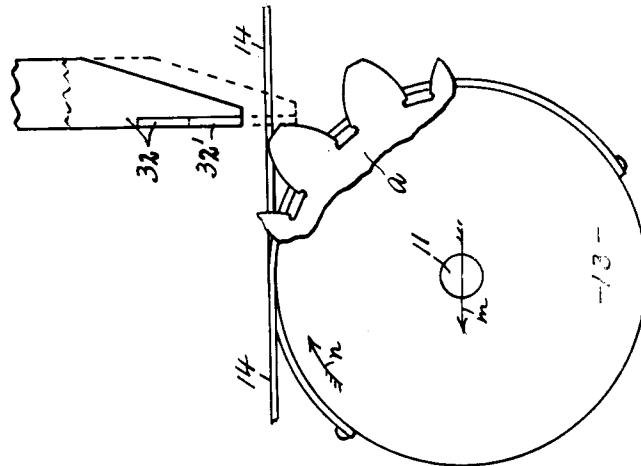
GEAR LAPPING MACHINE

Filed July 3, 1925

3 Sheets-Sheet 3



WITNESS
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UNITED STATES PATENT OFFICE.

CHARLES H. LOGUE, OF SYRACUSE, NEW YORK.

GEAR-LAPPING MACHINE.

Application filed July 3, 1925. Serial No. 41,298.

This invention relates to a method of and apparatus for truing surfaces of gear teeth which have become more or less deformed in the process of hardening or other heat treatment and involves the use of an abrasive element and a gear supporting element in combination with means for rolling the gear with one face of one of its teeth against the abrasive element and additional means for imparting to one of the elements a compound motion lengthwise and transversely of the axis of the gear for the purpose of finishing all portions of said surface to the degree of nicety required for noiseless and efficient operation when placed in running mesh with a companion gear for power transmission, it being understood that the surfaces of all the teeth of the gear will be similarly treated.

The main object is to provide an expeditious, economical and efficient method of lapping the gear teeth surfaces to the required accuracy of form by rendering the operation upon each tooth surface entirely automatic.

One of the specific objects is to position the abrasive surface of the lap at the proper angle of obliquity of the tooth surface to be operated upon so as to form a companion abrasive rack against which the gear is adapted to be rolled and at the same time to impart to the abrasive rack a rectilinear motion lengthwise of the surface of the teeth and additional motion transversely of said surface so that the abrasive element may act upon all portions of the toothed surface during each complete run-out of said surface due to the rolling motion of the gear.

Another specific object is to provide means for adjusting the abrasive lap to conform to different angles of obliquity of the surfaces of the teeth to be operated upon.

In the drawings:

Figure 1 is a front elevation of a gear lapping machine for carrying out the objects stated.

Figure 2 is a side elevation of the same machine except that portions thereof are broken away to show the interior parts.

Figure 3 is an enlarged horizontal sectional view taken in the plane of line 3—3, Figure 1.

Figure 4 is an enlarged transverse detail sectional view of the abrasive tool and its support and operating means.

Figure 5 is a horizontal sectional view taken in the plane of line 5—5, Figure 2, portions of the frame being broken away and certain parts of the clutch shifting mechanism being shown in section.

Figures 6, 7 and 8 are diagrammatic views of portions of the grinding lap and gear in different positions during the run-out of one of the toothed surfaces with the lap and also showing the different movements of the lap during said run-out together with the eccentrics in different positions for producing such movements.

As illustrated this machine comprises a base —1— having an upright bracket —2— extending upwardly from its rear portion, the base —1— being provided on its upper face with forwardly and rearwardly extending horizontal guide ways —3— for receiving and supporting a horizontally movable work-supporting carriage —4—.

The upper bracket —2— is provided on its front face with a vertical guide way —5— for receiving and supporting a vertically movable carriage —6— which is provided on its front face with a curved guide way —7— having its center at approximately the point of contact between the abrasive lap and surface of the gear tooth engaged thereby when at the starting position of the grinding operation.

The guide —7— is adapted to receive and support a segmental frame —8— which is movable to different angles about the center of the curvature of the guide —7— as may be required to bring the lap to the desired angle of obliquity to the surface of the gear tooth to be operated upon in a manner hereinafter more fully explained.

The segment —8— is provided on its front face with a dove-tailed guide way —9— extending transversely of and above the guide way —3— at right angles thereto for receiving and supporting a transversely movable tool-supporting carriage —10—.

A gear supporting mandrel —11— is rotatably mounted or journaled in axially spaced bearings —12— on the carriage —4— and is provided intermediate the bearings

with a cylindrical drum —13— for receiving two or more steel or equivalent tapes or bands —14— wound thereon in reverse directions and having one end attached thereto and their opposite ends attached to relatively fixed members —15— on the main supporting frame whereby the rotation of the shaft or mandrel —11— in reverse directions will cause the carriage —4— with the mandrel thereon to be reciprocated longitudinally along its guide ways —3— for rolling the gear as —a— to be finished in grinding relation to the abrasive tool or lap presently described.

It is evident however that a similar rotary motion of the mandrel and consequent rolling action of the gear may be produced by moving the carriage along the ways.

Any suitable means may be employed for effecting either one of these movements but in the present instance I have shown suitable means for rotating the mandrel to effect the longitudinal movement of the carriage and consequent rolling action of the gear against the abrasive tool, said means consisting in this instance of a worm gear segment —16— meshing with a worm —17— which together with the segment —16— are suitably mounted in a gear case —18— which also forms a bearing for the front end of the mandrel —11—.

The object of employing the worm and segment drive for the mandrel —11— is to produce a relatively slow rotation and bodily reciprocation of the mandrel relatively to the abrasive tool but it is evident that other driving means may be substituted if desired.

The worm —17— is mounted on a suitable shaft —17'— which is journaled in the lower side of the gear case —18— and adjacent portion of the frame —1— and is operatively connected by beveled gears —19— to a counter shaft —20—, the latter being also journaled in suitable bearings on the main frame —1— as shown more clearly in Figure 5.

The shaft —20— is connected by beveled gears —21— to a cross shaft —22— which is also journaled in suitable bearings upon the main frame —1—, Figure 5, and is provided with axially spaced beveled gears —23— and —23'— loose thereon but held against inwardly axial displacement by collars —24— and —24—, Figure 5.

A clutch collar —25— is splined on the shaft —22— between the gears —24'— for axial movement into and out of engagement with clutch faces on the adjacent ends of said gears.

A drive shaft —26— is journaled in suitable bearings on the main frame, Figure 5, and has one end provided with a beveled gear —27— meshing with both of the beveled gears —23— and —23'—, the other end of

said driving shaft being provided with a pulley —28— adapted to be connected to any available source of power for rotating said shaft in one direction and thereby rotating the gears —23— and —23'— in opposite directions by reason of their engagement with the opposite faces of the gear —27—.

It is now evident that if the clutch collar —25— is shifted into engagement with one of the gears as —23— the worm shaft —17'— will be driven in one direction through the medium of the gears —19— and —21— and shaft —20— and —22— and that if the clutch is moved into engagement with the other gear as —23'— the direction of rotation of the worm shaft —17'— will be reversed.

This rotation of the worm shaft —17'— in reverse directions will cause the gear-supporting mandrel —11— with the gear —a— thereon to be rotated first in one direction and then in the opposite direction through the medium of the gear segment —16— which is secured to the gear supporting mandrel and at the same time the carriage —4— will be also reciprocated in reverse direction thereby producing the desired rolling motion of the gear —a— in grinding relation through the abrasive tool.

The shifting of the clutch collar —25— in reverse directions is preferably automatic and controlled by the movements of the carriage —4— and for this purpose is provided a shifting lever —29— pivoted at —29'— intermediate its ends and having one end engaged in an annular groove in the collar —25— and its other end adapted to be engaged by opposed spaced shoulders —30— and —30'— mounted on one side of the carriage —4— as shown in Figure 5, one of said shoulders as —30— being adjustable longitudinally upon the carriage —4— and is held in place by a clamping screw —31—.

The other shoulder —30'— is adjustable lengthwise of and upon the shoulder —30— and is held in place by clamping screws —31'—.

The object in making these shoulders is to permit the shifting of the clutch collar and consequent reverse motion of the gear supporting mandrel earlier or later in the stroke of the carriage —4— or rather to regulate the amount of reciprocal movement of said carriage and resultant amount of rocking movement of the gear supporting mandrel —11— with the gear —a— thereon as may be necessary to effect a complete run-out of the toothed surface contact with the abrasive tool sufficient to effect the grinding and finishing of all portions of said surface from the base to the point to the tooth.

The tool supporting carriage —10— is provided with a lengthwise and transverse guide opening —10'— in which is fitted for

sliding movement an abrasive tool —32— having a flat abrasive surface —32'— for engagement with the toothed surface of the gear —a— to be operated upon, said tool
 5 being properly supported in the carriage —10— with its abrasive member —32— at the proper angle of obliquity to the toothed surface to be finished and constitutes a single tooth rack against which the toothed surface
 10 is adapted to roll as the mandrel is reciprocated bodily from one, extreme position to another.

In other words, the run-out contact between the surface of the tooth and abrasive
 15 surface is similar in action to that produced by the proper meshing of two gears or a gear and a rack for transmitting motion from one to the other and a part of the grinding or finishing operation is ac-
 20 complished by this rolling contact.

It is found, however, that the output of finished gears may be greatly increased for a given time by producing additional rela-
 25 tive movements between the contact surfaces of the gear tooth and abrasive element and for this purpose one of the elements, in this instance, the abrasive tool is given a compound reciprocal motion lengthwise and transversely of the axis of the gear
 30 simultaneously with the rolling movement of said gear against the abrasive face.

Any suitable means may be provided for producing this compound reciprocal motion consisting in this instance of a pair of
 35 beveled gears —33— for transmitting motion from the shaft —22— to an upwardly inclined shaft —34— having its upper end connected by beveled gears —35— to a forwardly and rearwardly extending cross
 40 shaft —36— which is journaled in suitable bearings on the upright bracket —2— and segment —8—, the portion of the shaft —36— between the segment —8— and upright bracket —2— being preferably flexi-
 45 ble through the medium of universal joints —36'— to allow for the relative adjustment of the segment —8— as may be required to bring the abrasive tool —32— into proper grinding relation with the teeth of the gear
 50 —a—.

The shaft —36— is provided with an eccentric —37— connected by a pitman
 55 —38— to one end of the sliding carriage —10— for reciprocating the abrasive tool —32— lengthwise of and against the surfaces of the teeth of the gear —a— as they are successively presented thereto, the length of the abrasive tool being at least equal to the length of the stroke of the carriage
 60 —10— and of greater length than the gear teeth so as to maintain grinding relation with the latter throughout the longitudinal movement of the tool from one extreme position to another.

65 In addition to this longitudinal reciproc-

atory movement the abrasive tool is also reciprocated transversely of the gear teeth and for this purpose is provided intermediate its ends with a pair of circular openings
 70 —39— in which are journaled rotary eccentrics —40— on the rear ends of separate forwardly projecting parallel shafts —41—.

These shafts —41— are journaled in separate rotary eccentric sleeves —42— which, in turn, are journaled in suitable bearings
 75 in the wall of the carriage —10— as shown more clearly in Figures 3 and 4 and are provided on their front ends with similar gears —43— concentric therewith.

The shafts —41— extend forwardly beyond the corresponding ends of their respective eccentric sleeves —42— and are provided on their front ends with similar gears —44— concentric therewith and therefore eccentric to their respective sleeves —42— and gears
 80 —43—.

A stub shaft —45— is journaled in a suitable bearing in the front wall of the carriage —10— midway between and parallel with the shaft —41— to extend forwardly be-
 85 tween the opposite sets of gears —43— and —44— and upon this stub shaft is keyed or otherwise secured a pair of pinions —43'— and —44'— meshing respectively with the gears —43— and —44— for transmitting
 90 rotary motion thereto.

The front end of the stub shaft —45— is connected by beveled gears —46— to a cross shaft —47— which is journaled in suitable
 95 bearings on the segment —8— diametrically across the front sides of the gears —43— and —44— and is connected by beveled gears —48— to the shaft —36— for receiving rotary motion therefrom, the stub —45— and cross shaft —47— being additionally
 100 journaled in a connecting yoke —49—.

The beveled gear —46— on the shaft —47— is splined thereon for axial movement relatively thereto and for rotary move-
 105 ment therewith, thus permitting the sliding movement of the carriage —10— and parts carried thereby lengthwise of the shaft —47— without breaking the driving connections between the shaft —36— and eccen-
 110 trics —40— and —42—.

It will be noted from the foregoing description and upon reference to Figures 3 and 4 that the eccentric sleeves —42— re-
 115 volve in their respective bearings about parallel axes which are in fixed relation to the carriage —10— while the shafts —41— carrying the eccentrics —40— are eccentrically journaled in their respective sleeves —42— in parallel relation and are there-
 120 fore moved bodily about the axes of their respective sleeves as the latter are rotated by the pinion —43'— through the medium of their corresponding gears —43—.

In view of the fact that the shafts —41— are rotated eccentrically with reference to
 125 130

the bearings for the sleeves —42— the teeth of the gears —44— and pinion —44'— are relatively longer radially than those of the gears —43— and pinion —43'— so as to maintain intermeshing engagement during the eccentric movement of the gears —44—.

The gears —43— are of substantially the same pitch while the gears —44— are of slightly different pitch, the object of which is to avoid repetitive travel of the contact face of the abrasive tool in the same path during successive cycles of movement of the carriage and tool and thereby to present different portions of the abrasive face to the toothed surface at each cycle of movement of both the gear and the tool.

The object of the two eccentric motions of the abrasive tool —32— about the axes of the eccentric sleeves —42— and shafts —41— is to cause a progressively increasing transverse movement of the tool across the face of the gear tooth as the gear is rolled from a starting position to the limit of its extreme run-out at which time the rolling action of the gear is reversed and then to progressively diminish the transverse movement of the tool as the gear is rolled back to its starting position thus completing the cycle of operation of the abrasive tool upon the toothed surface, it being understood however that this cycle operation may be repeated if necessary until the tooth is finished to the desired perfection of contour but upon the return of the gear to its starting position after the face of one tooth has been finished the gear may be removed from the mandrel and indexed for a similar operation upon the surface of any other tooth, these operations being repeated until the surfaces of the teeth are properly finished.

As shown diagrammatically in Figures 6, 7 and 8 the gear is set or secured upon the mandrel in a starting position in Figure 6 with the base of the toothed surface to be ground in the plane of the abrasive surface —32'— at which time the centers of the shaft —41—, sleeve —42— and eccentric —40— will be in vertical alignment with the center of the eccentric —40— between the center of the shaft —41— and the center of the shaft —42— for imparting a minimum transverse movement to the tool —32— at the beginning of the run-out of the surface of the tooth against the abrasive surface.

Now as the tape drum —13— is moved bodily in the direction indicated by arrows —m—, rotary motion will be imparted thereto in the direction indicated by arrow —n— through the medium of one of the straps —14— thereby rolling the toothed surface under treatment against the abrasive surface —32'—, this movement being continued until the entire toothed surface from base to point is brought into contact with the abrasive surface thereby establishing a complete

run-out of the tooth against the abrasive tool.

The bodily movement of the drum —13— in the direction indicated by arrow —m— to effect this complete run-out is limited by the action of the shoulder —30'— upon the clutch shifting lever —29— which causes the release of the clutch —25— at the end of the run-out and thereby stops the further movement of the carriage —4— and drum —13— carried thereby in that direction and at the same time the reversing of the shifting lever —29— under the momentum of the carriage —4— will cause the clutch to engage the opposite gear as —23— for reversing the motion of the carriage to its starting position thereby reversing the rolling motion of the gear against the abrasive tool until the carriage returns to its starting position at which time the other stop —30— will act upon the shifting gear —29— to stop the further movement of the carriage and drum at the starting point thus completing one cycle of operation which may be repeated upon the same toothed surface or the gear may be shifted rotarily to bring another toothed surface into operative engagement with the abrasive tool, it being understood that each toothed surface is operated upon in the same manner.

During the run-out of the tooth from its starting position to the limit of its movement in one direction, the axis of the sleeve —42— will remain at a constant level but the axis of the shaft —41— and eccentric —40— will be gradually changed to different levels as indicated in Figures 6, 7 and 8 in such manner that the resultant movement of the abrasive tool transversely of the toothed surface will be gradually increased from minimum *a* the start, Figure 6, to the maximum at the finish of the run-out, Figure 8, while on the return movement of the carriage —4— and drum —13— this transverse movement of the abrasive tool will be gradually reduced from the maximum throw at the limit of the run-out to the minimum throw at the return to the starting position, it being understood that the eccentric relation of the parts —40—, —41— and —42— will be so adjusted and that their operation is so timed as to complete one-half cycle of rotation during the run-out of the gear against the abrasive element and the remaining half of the cycle of rotation during the return of the rolling contact of the gear against the abrasive element.

Operation.

Assuming that the pulley —28— and its shaft —26— is driven continuously through its connection with a suitable source of power and that the gear —a— to be finished is set to its starting position shown in Figure 6 at which time the eccentrics —40—, —41— and

—42— in a position to effect a minimum reciprocatory movement of the abrasive element —32— transversely of the toothed surface to be operated upon.

5 Under these conditions the clutch —25— will have been shifted to cause the movement of the carriage —4— and tape drum —13— in the direction indicated by arrow —*m*—, Figures 6, 7 and 8 thereby causing the rotation of the gear in the direction indicated by arrow —*n*—, these movements continuing until the toothed surface acted upon effects a complete run-out of contact with the abrasive tool which during this run-out will be reciprocated progressively increasing distances transversely of the face of the tool and at the same time will be moved longitudinally or lengthwise of the toothed surface.

20 This compound lengthwise and transversely reciprocatory movement of the abrasive element will continue not only during the run-out from the starting to the finishing positions as shown in Figures 6, 7 and 8 but also will continue during the reverse rotation of the gear to its starting position resulting in a more efficient and expeditious finishing of the toothed surface than has heretofore been practiced and greatly increasing the output of the work for a given period of time.

What I claim is:

1. In a gear lapping machine, an abrasive element, a gear supporting element, means for rolling the gear with one face of one of its teeth against the abrasive element, and means for moving one of said elements lengthwise and transversely of the axis of the gear.

2. In a gear lapping machine, an abrasive element, a gear supporting element, means for rolling the gear with one face of one of its teeth against the abrasive element, and means including a rotary eccentric

for imparting to the abrasive element a compound lengthwise and transverse motion relatively to said face.

3. In a gear lapping machine, an abrasive element, a gear supporting element, means for rolling the gear a limited distance in reverse directions with one face of one of its teeth in contact with the abrasive element, and means for imparting a compound lengthwise and transverse motion to said abrasive element relatively to said face during said rolling motion.

4. In a gear lapping machine, an abrasive element, a gear element and means for rolling one element relatively to the other element with one of the gear tooth surfaces and abrasive element in contact, and means for moving one of said elements transversely of the axis of the gear including a rotating eccentric and means for synchronizing the rotation of said eccentric with the movement of the movable element.

5. In a gear lapping machine, a work-supporting carriage, a mandrel journaled on the carriage for supporting the gear treated, means for reciprocating the carriage rectilinearly at right angles to the axis of the mandrel, means for causing the rotation of the mandrel during said reciprocatory movement, a tool-supporting carriage, an abrasive element mounted on the tool-supporting carriage, and operatively engaged with one of the teeth of the gear, and means for reciprocating the tool-supporting carriage rectilinearly and at right angles to the direction of movement of the work-supporting carriage.

6. A gear lapping machine as in claim 5 in which means is provided for reciprocating the abrasive tool relatively to and transversely of the second-named carriage.

In witness whereof I have hereunto set my hand this 20th day of June, 1925.

CHARLES H. LOGUE.