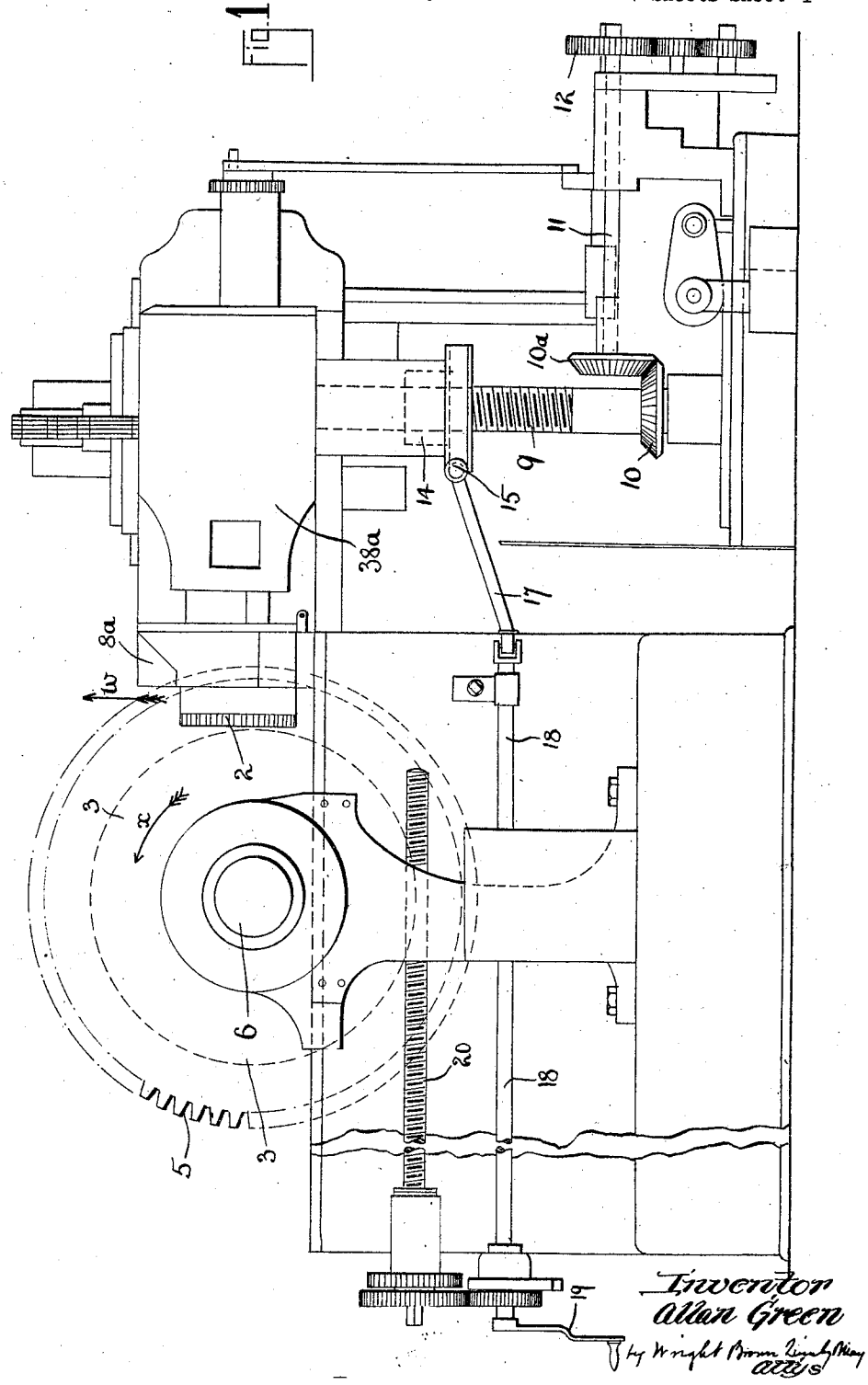
May 11, 1926. 1,583,790

A. GREEN

METHOD OF AND MEANS FOR GENERATING GEAR TEETH

Filed July 12, 1923 7 Sheets-Sheet 1

Fig. 1



Inventor
Allan Green
by Wright Brown Quinby & May
atty's

May 11, 1926. 1,583,790

A. GREEN

METHOD OF AND MEANS FOR GENERATING GEAR TEETH

Filed July 12, 1923 7 Sheets-Sheet 2

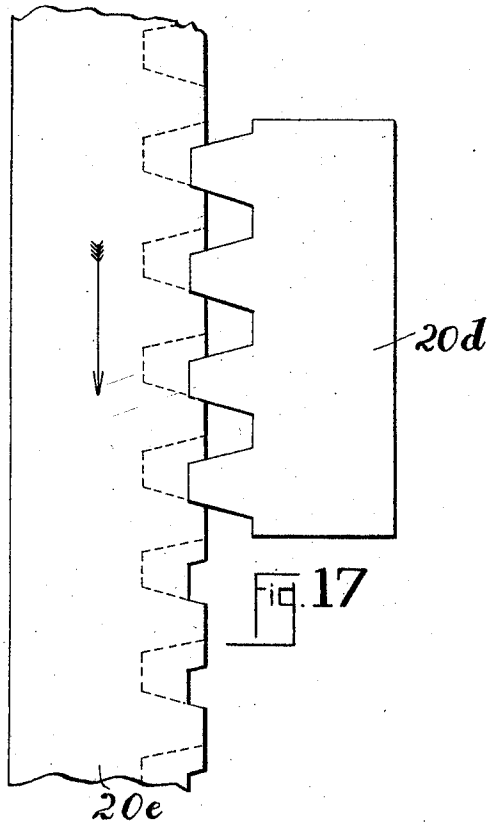


Fig. 17

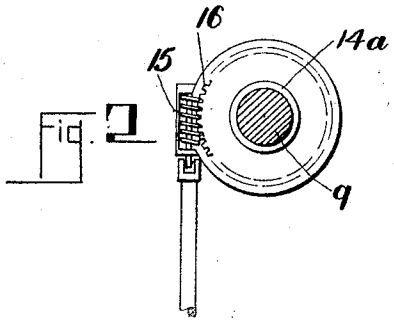


Fig. 2

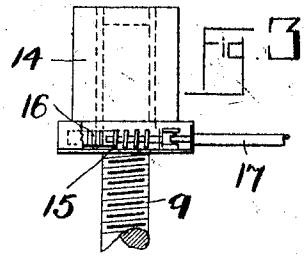


Fig. 3

Inventor
Allan Green
Wright Brown Quinby & May
Attys

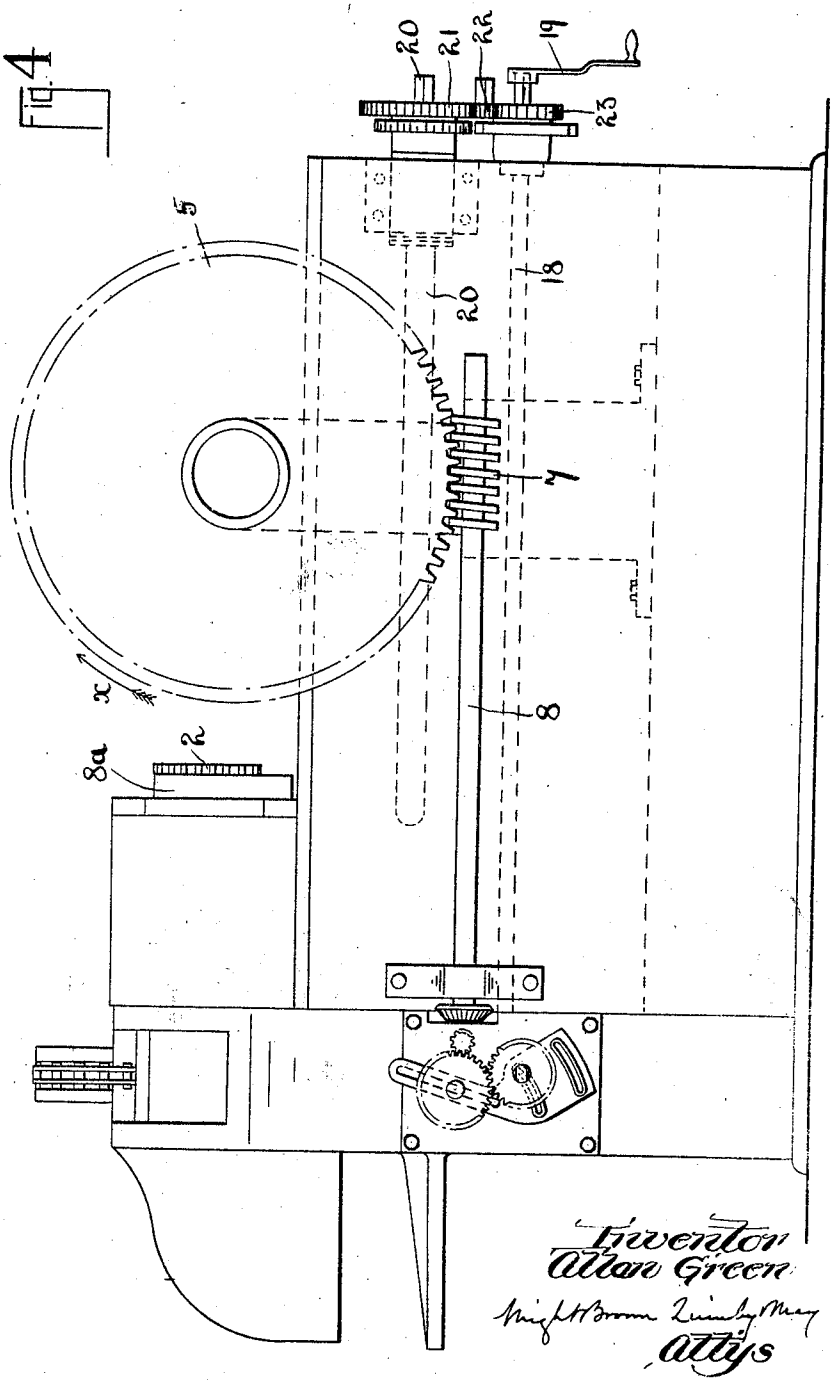
May 11 , 1926. 1,583,790

A. GREEN

METHOD OF AND MEANS FOR GENERATING GEAR TEETH

Filed July 12, 1923 7 Sheets-Sheet 3

Fig. 4



Inventor
Allan Green
Wright Brown Quinby & May
Attys

May 11 , 1926. 1,583,790

A. GREEN

METHOD OF AND MEANS FOR GENERATING GEAR TEETH

Filed July 12, 1923 7 Sheets-Sheet 4

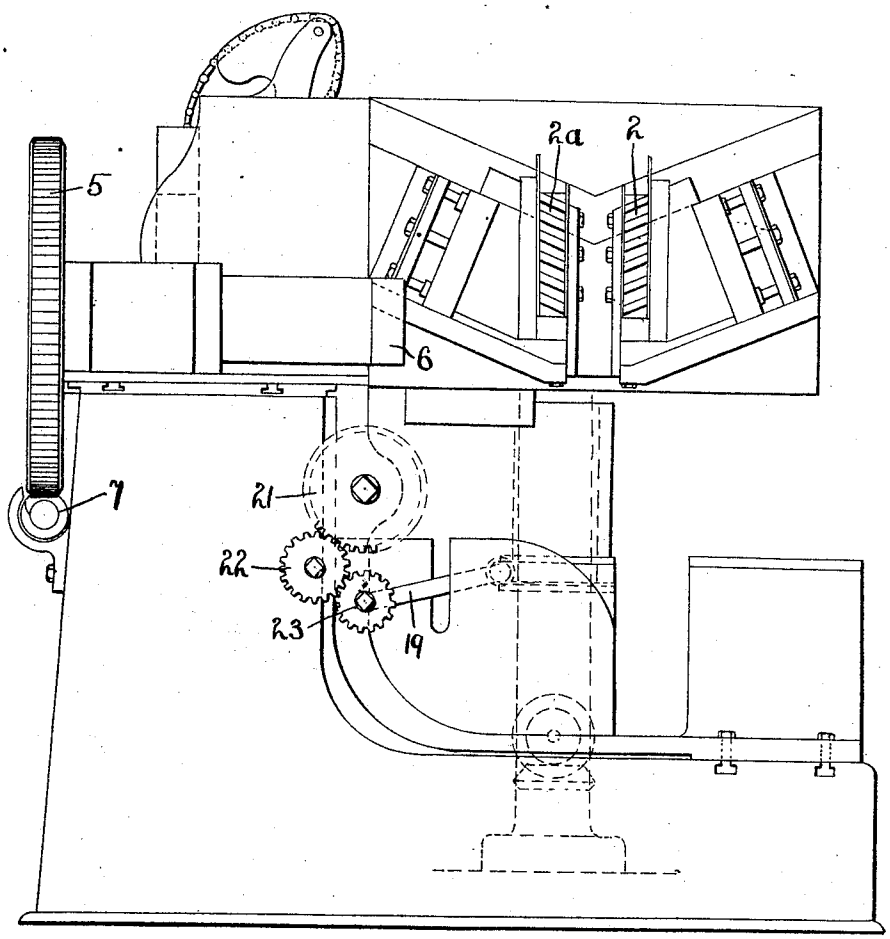


Fig. 5

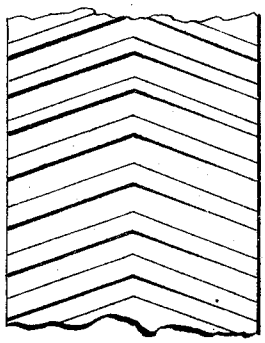


Fig. 7

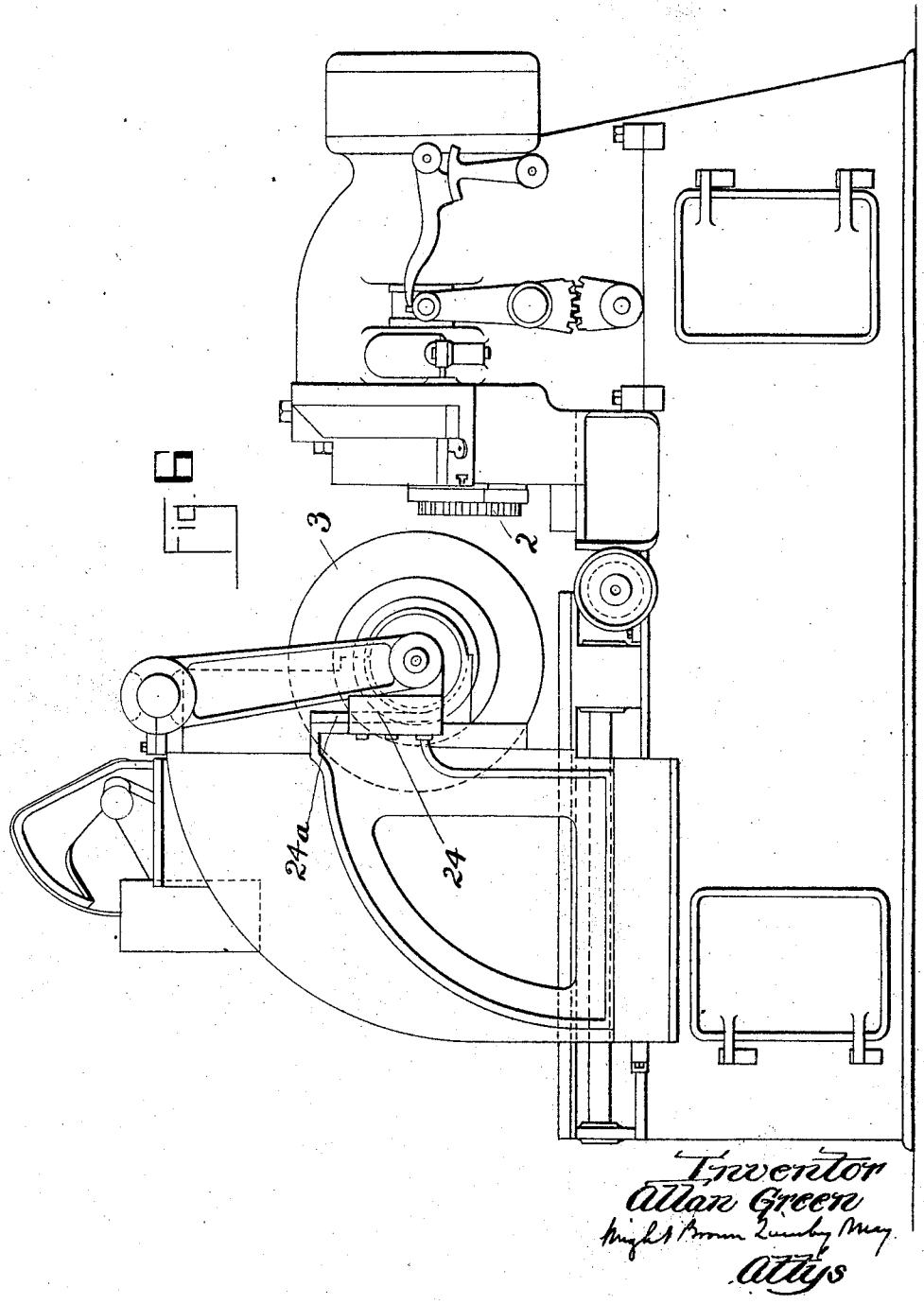
Inventor
Allan Green
Wright Brown Quinby & May
Attys

May 11 , 1926. 1,583,790

A. GREEN

METHOD OF AND MEANS FOR GENERATING GEAR TEETH

Filed July 12, 1923 7 Sheets-Sheet 5



Inventor
Allan Green
Wright Brown Quinby & May
Attys

May 11, 1926. 1,583,790

A. GREEN

METHOD OF AND MEANS FOR GENERATING GEAR TEETH

Filed July 12, 1923 7 Sheets-Sheet 6

Fig. 8

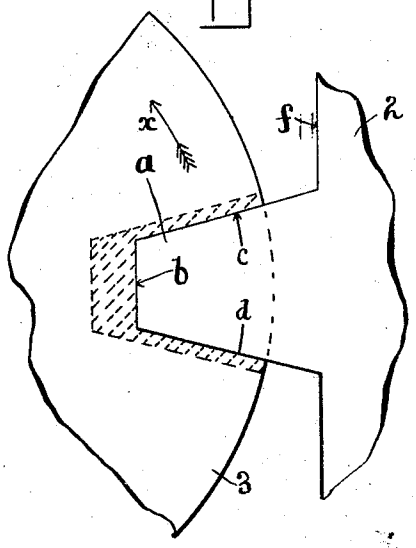


Fig. 10

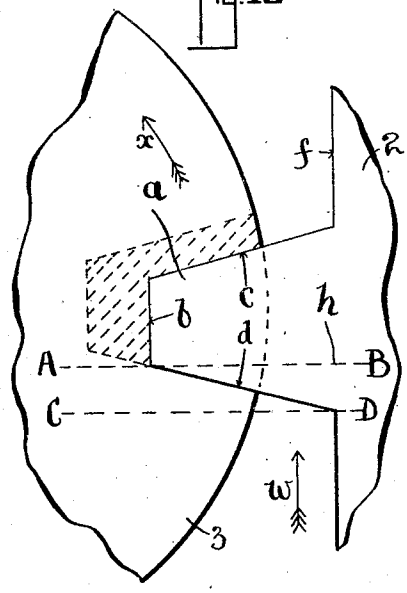


Fig. 9

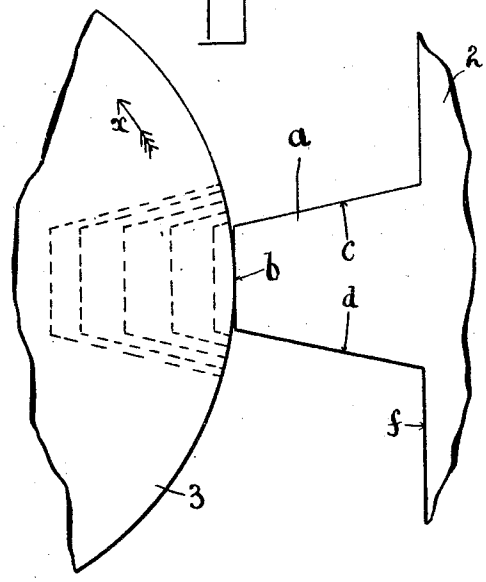
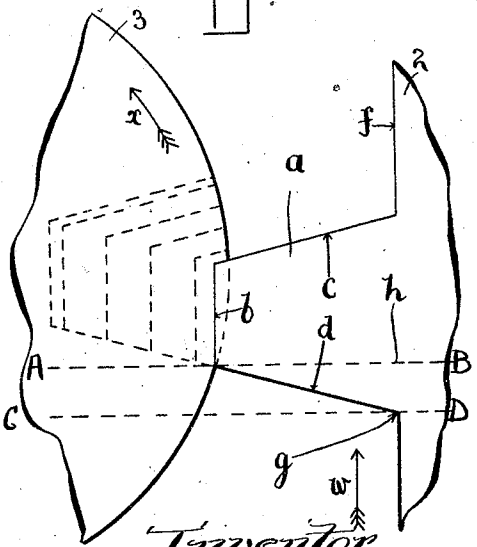


Fig. 11



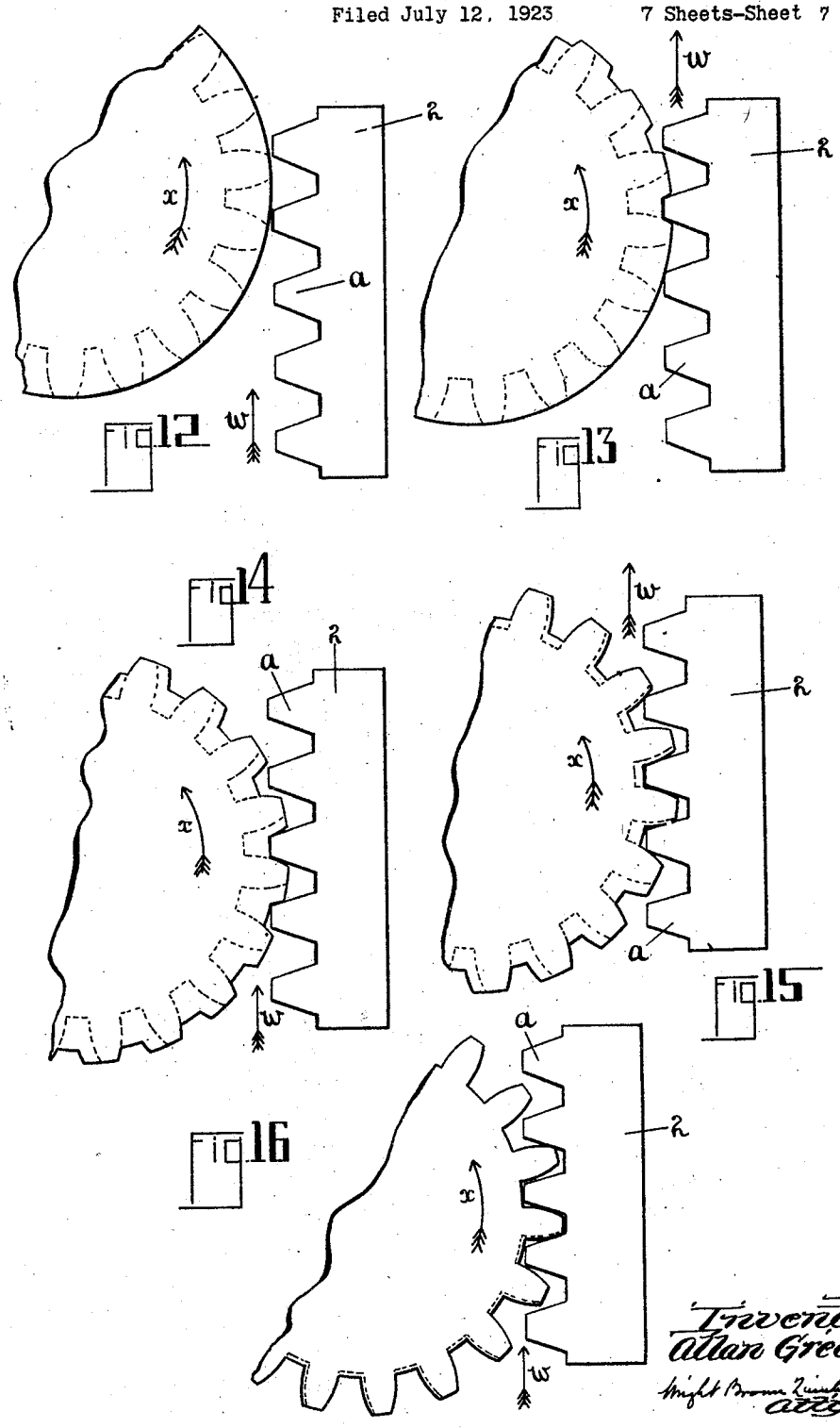
Inventor
Allan Green
Wright Brown Quinby & May
Attys

May 11 , 1926. 1,583,790

A. GREEN

METHOD OF AND MEANS FOR GENERATING GEAR TEETH

Filed July 12, 1923 7 Sheets-Sheet 7



Inventor
Allan Green
Wright Brown Quinby & May
Attys

Patented May 11, 1926. 1,583,790

UNITED STATES PATENT OFFICE.

ALLAN GREEN, OF SUTTON, NEAR KEIGHLEY, ENGLAND, ASSIGNOR TO DAVID BROWN AND SONS (HUDDERSFIELD) LIMITED, OF LOCKWOOD, HUDDERSFIELD, YORK, ENGLAND.

METHOD OF AND MEANS FOR GENERATING GEAR TEETH.

Application filed July 12, 1923. Serial No. 651,060.

In the cutting or generating of the teeth of toothed gearing (including those wheels which have single helical or double helical teeth) and in the performing of like operations wherein the work is fed to the cutters or the cutters are fed to the work in both a lateral and longitudinal direction and wherein the cutting tools fill or approximately fill the cross sectional area of the spaces which they cut (as for example in carrying out the process or method, in which reciprocating cutters are made use of and in which said cutters are moved crosswise of the metal blanks, or discs that have to be cut while said discs are revolving), I have found that the actions of the cutters upon said discs when cutting in the ordinary manner or method as heretofore followed, have the effect of forcing against or pressing in such a direction upon the sides of the grooves which they are forming that such jamming and other resistances are encountered as cause the bearings either of the cutters or of the blanks to spring or yield to an undesirable extent. My present invention consists in following such a method of cutting or generating said tooth-profiles and in so using devices which enable me to carry said method into effect, that I avoid exercising any undesirable pressure against the side or lateral surfaces of the teeth which are being generated or of the the space being cut with greater accuracy as well as being enabled to carry out the cutting operations with an increased feed and therefore with a greater output of work than is the case when cutting teeth by the method heretofore followed. My method may be briefly said to consist in performing the feeding operations by such relative movements that the major portion of the cut is effected by the two cutting edges of each cutter which respectively determine the depth and form one side of the cut (these edges being called the depth cutting) edge and the leading cutting edges, while the other cutting edge called the following edge is only required to perform minor cuts as when forming the profile curve of a tooth.

In the carrying out of my invention in connection with machines for generating the teeth of wheels in which the rotating of the blank or the rolling of same is in the path of a tangentially moving cutter which cutter has also reciprocatory motion transmitted to it, the depth cut is taken by the depth cutting edge in step by step order, while the generating cutting actions are effected by a continuously advancing tangential feed and to these two combined movements I now add a third or differential movement which I carry out simultaneously with the step by step depth feed.

In order to explain fully my invention I hereinafter describe how I carry same into effect by the use of various well known types or classes of machines which I arrange to operate according to my said invention. These machines and parts are illustrated by the accompanying sheets of drawings in which:—

Fig. 1 is a side elevation of a machine of known type for cutting (with rack cutters) double helical teeth, said machine having applied to it my improved mechanism.

Figs. 2 and 3 are a sectional plan and an elevation showing my improved parts which I add to the machine shown by Fig. 1.

Fig. 4 is also a side elevation of certain parts of the machine shown by Fig. 1 but as seen from the opposite side thereof.

Fig. 5 is an elevation of the machine shown by Fig. 1 when viewed in the direction from left to right of said figure.

Fig. 6 is an elevation showing a modified form of machine to which my invention is applicable.

Fig. 7 is edge view of a portion of a wheel showing a double helical tooth.

Figs. 8 and 9 are diagrams showing the progressive stages of the cutting actions when the cutter is acting under the old and well known method of cutting and when no other motion than the cutting motions are being performed.

Figs. 10 and 11 are similar diagrams to Figs. 8 and 9 and are made to show the stages or progress and direction of the stages followed under my new method of producing the teeth desired.

Fig. 12 shows a blank and a rack cutter in relative positions just prior to the com-

mencement of the cutting operations to form the teeth of the shape shown in broken lines on the blank.

Fig. 13 is a similar view to Fig. 12 but shows the blank as advanced one stage and the rack as having taken its first cut on certain parts of the blank.

Fig. 14 is also a similar view to Fig. 13 but shows by the advancing of the cutter and the blank that certain of the teeth which have passed said cutter have received the second cut while the following teeth show the first cut as illustrated by Fig. 13.

Fig. 15 shows the third cut that has been taken in the teeth which have passed the rack cutter while on the remainder of the teeth the second cut only has been taken.

Fig. 16 shows the blank with the teeth which have passed the cutter finished while the others require the last cut to finish them.

Fig. 17 is a plan showing a rack and cutters for producing same.

In the ordinary process of cutting teeth of the character described each cutter *a* of the series of cutters in the rack 2 is caused to advance and cut with its front end *b* and inclined cutting edges *c* and *d* (which extend from said end *b* to the base *f* of the cutting tool 2) so that these cutting edges cut their way and enter centrally as shown by Figs. 8 and 9 in order to carry out the cut by the depth cutting edge *b* cutting its way inwardly and the two lateral edges *c* and *d* cutting the spaces on each side thereof equally, thus the centre of the cutter *a* always follows the centre of the groove that it produces. Fig. 8 and Fig. 9 show the effect such a cutter has upon the blank 3 when said blank is held against rotation during the cutting operations of the cutter *a*. The parts in broken and section lines on Fig. 8 indicate what the finished groove will be like when produced under such conditions, while Fig. 9 shows the varied stages that the cutter *a* advances and cuts in a forward direction and to each side thereof in the proportions shown by broken lines in the blank 3.

According to my method I now arrange the cutter to commence its cutting operations (as shown by Fig. 11) below the central line of the space that it will eventually cut in the periphery of the blank 3 under the conditions before stated, that is to say, with the blank 3 stationary and the cutter advancing towards the centre thereof under my improved arrangement. My improved method consists in causing the cutter *a* to advance to cut with its depth cutting edge *b* as heretofore but in addition to advancing the cutter *a* I also move it relatively with the blank 3 (or laterally in a direction indicated by the arrows *w*) such a space as will carry said cutter *a* forward a distance indicated by the space between the broken lines A—B and C—D on said Figs. 10 and 11, while the blank 3 is stationary, thus the cutting actions under my conditions show that the end *b* of the cutter and the edge *c* of said cutter perform (according to Figs. 10 and 11) the entire cut producing the space of the shape shown in broken section lines Fig. 10 and in stages as shown by broken lines in Fig. 11.

When generating the proper shape of teeth or teeth having the required profile the variations from said straight sides produced by the cutting edge *c* and the cutting edge *d* are varied by the additional movements of the blank 3 and the cutter 2 when said blank 3 and cutter 2 are being moved so that the one rolls over the other in the ordinary method followed in the generating of said type of teeth.

By making use of this additional movement of the cutter 2 relatively to the rolling or revolving movement of the blank 3 I increase said movement of the cutter 2 in addition to its ordinary advancing movement in the direction indicated by the arrows *x* so that I have this additional relative movement carried out and the process of cutting of the tooth of the wheel secured as is illustrated by Figs. 12 to 16 inclusive. That is to say, if the pitch of the teeth being produced is one inch heretofore the advancing action of the cutter 2 has been one inch of tangential motion in the direction indicated by the arrows *w* while the blank 3 has rotated one inch on the pitch line from one tooth to the centre line of the next tooth in the direction indicated by the arrows *x*. I now cause said cutters 2 to advance more than said inch of pitch and the increase is exactly equal to the inclination of the side cutting edge *d* to a straight line A—B drawn at right angles to the base of the cutters from the outward corner of the cutting edge *b* and *d* as shown by Figs. 10 and 11, thus if the rear edge *d* of the cutting tool *a* is fourteen and one half degrees at an angle to the line A B which is at right angles to the base of the cutting tool, then the advancement of the cutter 2 during the time from taking the first cut by the outer end of the tool *b* as shown by Fig. 12 until said outer end has reached the depth of the groove that it has to form (as is shown by Fig. 16) is increased by the length of the base of the triangle (shown by Figs. 10 and 11) formed by the cutting edge *d* with the line A—B and a line from the point *h* to the point *g*.

In an inch of depth of tooth the extra advancing of the tool 2 will be approximately a quarter of an inch, it may be more or it may be less according, as is before stated, to the angularity of the edge *d* of the cutting tool to the base of said tool.

By this arrangement and method of cutting the depth and leading cutting edges are caused to effect the major portion of the cut and the following cutting edge is caused

to effect only a minor portion, so that all wedging action is avoided and the cuts that are taken by the leading cutting edge *c* and the depth cutting edge *b* can be increased since the tools are more free to act and by not putting too great a pressure upon the blank 3 and upon the cutting tool 2 a more accurate formation of tooth is secured.

As is hereinbefore stated I may make use of varied forms of mechanism for obtaining the relatively increased speed of the cutter 2 as compared with that of the blank 3 so that I would have it understood that the devices which I actually employ and which I hereinafter explain are to be taken as only those which I have proved will efficiently carry out my improved functions, while I am aware that it may be possible for other mechanism and devices to be produced to attain the said object of my invention.

The devices shown by Figs. 1 to 5 illustrate the application of my improved parts to a well known type of machine for cutting the class of wheel to which my invention relates.

In this type of machine the rack cutters 2, 2^a are reciprocated in their inclined paths in well known manner and by well known mechanism, while the blank 3 is mounted to be rotated by the worm wheel 5 so that such blank 3 (shown in broken lines Fig. 1) by being fixed upon the shaft 6 of said worm wheel 5 revolves in the direction indicated by the arrow *x* of said figure.

The rotary motions of the wheel 5 are effected by the worm 7 which is splined upon a shaft 8 deriving its motion from change speed gearing at the end thereof in well known manner in order that the relative speed of the shaft 6 with the advancing motion of the bearings or carriage 8^a upon which the cutters 2 are mounted, are such that the blank 3 carried in its rotary motions will roll over the cutters 2 in well known manner.

During the rotary motions of the blank 3 as is effected by the wheel 5, the tool carriage or bearings 8^a upon which the cutting tools 2, 2^a are mounted, is caused to rise by the actions of the screw 9 as effected by the gearing 10, 10^a shaft 11 and change speed gearing 12 so that as before stated the rising motion of the tool carriage 8^a relatively to the rotations of the blank 3 is maintained or is secured as is well understood.

In order to secure an additional motion of the carriage 8^a and therefore of the cutters 2 carried by same the screwed nut 14 through which the screw 9 passes and which nut is carried by the framework 38^a which supports the carriage 8^a I now form to revolve under the actions of a worm 15 engaging with worm wheel teeth 16 formed upon the revolving part 14^a of said nut 14, and this worm 15 is mounted in bearings which will move vertically with said nut as same is carried by its screw 9, its vertical motion being allowed by the flexible shaft 17 which couples the worm shaft to a horizontal shaft 18 upon the outer end of which a handle 19 may be placed. The handle 19 is the handle usually employed in connection with feed screw 20 which feeds the bearings or work head of the wheel 5, its shaft 6 and the blank 3 to the cutters 2 causing same to advance to carry out the depth of cut desired. The shaft 18 is coupled by change speed gearing wheels 21, 22 and 23 to the screw 20 so that whenever the handle 19 is used for rotating the screw 20 to advance the blank to the cutters in order to commence the next cut (after the series of cuts throughout one revolution have been effected) the rotary motion of said screw 20 will have transmitted the desired amount of motion to the shaft 18 and therefore through the connecting shafts to the worm 15 so that the nut 14^a will, by its worm wheel 16, have been advanced the proportion desired for carrying out the increase of movement of the cutters 2 as is hereinbefore described.

In another type of machine (as shown by Fig. 6) the cutters 2 merely have reciprocatory motion transmitted to them and remain stationary so far as regards any further motion other than following the inclined paths of their guiding supports while the blank 3 carried by the shaft 6 is supported by the bearings 24 for said shaft, said bearings being arranged to descend or move in a vertical path over the guiding surfaces 24^a in manner well known. The rolling actions of the blank 3 over the cutters 2 are secured as is well known and in this type of machine I arrange the extra motion to be transmitted to the sliding bearings 24 in the same proportion or to the same degree as I add to the motion of the cutters 2 under the former conditions hereinbefore explained in connection with the machine shown by Figs. 1 to 5 of the drawings.

When making use of reciprocating rack cutters for producing spur gearing with the blank revolving or rolling over said rack cutters the space moved through the tangential path by said cutter travel has to agree with the space that the revolving blank advances during each cutting operation, and I can carry out my method of advancing the cutter so that the depth and leading cutting edge of each cutting portion will always act as is hereinbefore described when producing said spur teeth, the same as when producing double helical or single helical teeth.

When producing racks I follow the same method of feed for the rack to the cutter or vice-versa that I follow according to the other productions hereinbefore described,

and this I carry out by devices as is shown by Fig. 17 in which I use the rack cutter 20^d for producing the rack 20^e.

Such being the nature and object of my invention what I claim is:—

1. That improvement in the method of generating gear teeth, which consists in imparting to a cutter having a depth cutting edge, a leading cutting edge, and a following cutting edge, an entering movement advancing the cutter into a moving blank, and a lateral movement at an angle to the entering movement, said movements causing the depth and leading cutting edges to effect substantially the entire cut.

2. That improvement in the method of generating the teeth of gear wheels, which consists in imparting to a cutter having a depth cutting edge, a leading cutting edge, and a following cutting edge, an entering movement advancing the cutter into a rotating blank, and a lateral movement at an angle to the entering movement, said movements causing the depth and leading cutting edges to effect the major portion of the cut, and the following cutting edge to cooperate with the rotating blank in effecting a minor portion of the cut.

3. A machine for generating gear teeth, comprising means for supporting and moving a blank, a cutter having a depth cutting edge, a leading cutting edge, and a following cutting edge, and means for imparting to the cutter an entering movement advancing the cutter into the blank, and a lateral movement at an angle to the entering movement, said movements causing the depth and leading cutting edges to effect the major portion of the cut.

4. A machine for generating the teeth of gear wheels, comprising means for supporting and rotating a blank, a cutter having a depth cutting edge, a leading cutting edge, and a following cutting edge, and means for imparting to the cutter an entering movement advancing the cutter into the blank, and a lateral movement at an angle to the entering movement, said movements causing the depth and leading cutting edges to effect the major portion of the cut, and the following cutting edge to cooperate with the rotating blank in effecting a minor portion of the cut.

5. A machine for generating the teeth of gear wheels comprising a rotary shaft carrying the blank to be cut, change speed gearing for rotating said shaft, bearings for said shaft and gearing, means for transmitting motion to said gearing, a cutting tool, bearings therefor, means for transmitting reciprocatory motion to said tool, means for moving the tools tangentially over the blank, and other means for intermittently giving additional tangential motion to said tool.

6. A machine for generating the teeth of gear wheels comprising a shaft, adapted to hold a blank, sliding bearings on which said shaft is mounted, supports, for said bearings, cutters having depth cutting edges, leading cutting edges and following cutting edges, cutter operating mechanism including means for laterally moving the cutters, means for advancing the cutters into the blank, supplemental means for giving an additional lateral movement to the cutter, and means for sliding the said bearings to carry the blank into the path of the cutters, the arrangement being such that the depth and leading cutting edges effect the major portion of the cut.

ALLAN GREEN.