No. 616,648. Patented Dec. 27, 1898.

O. J. BEALE.

DEVICE FOR GENERATING GEAR TEETH.

(Application filed Feb. 25, 1898.)

(No Model.) 2 Sheets—Sheet I.

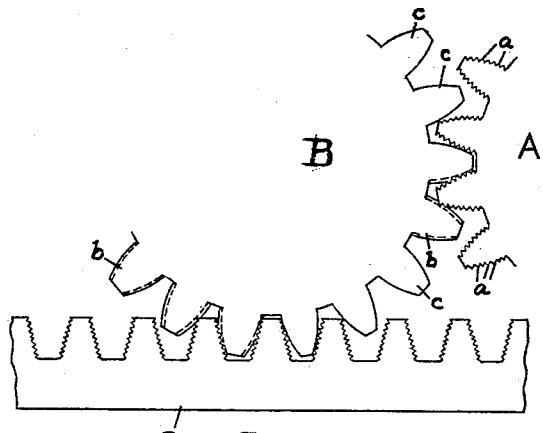


FIG. 1.

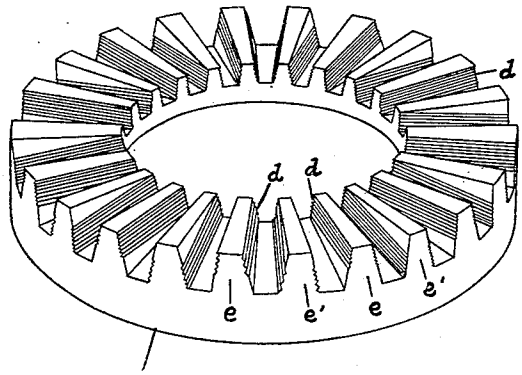


FIG. 2.

WITNESSES

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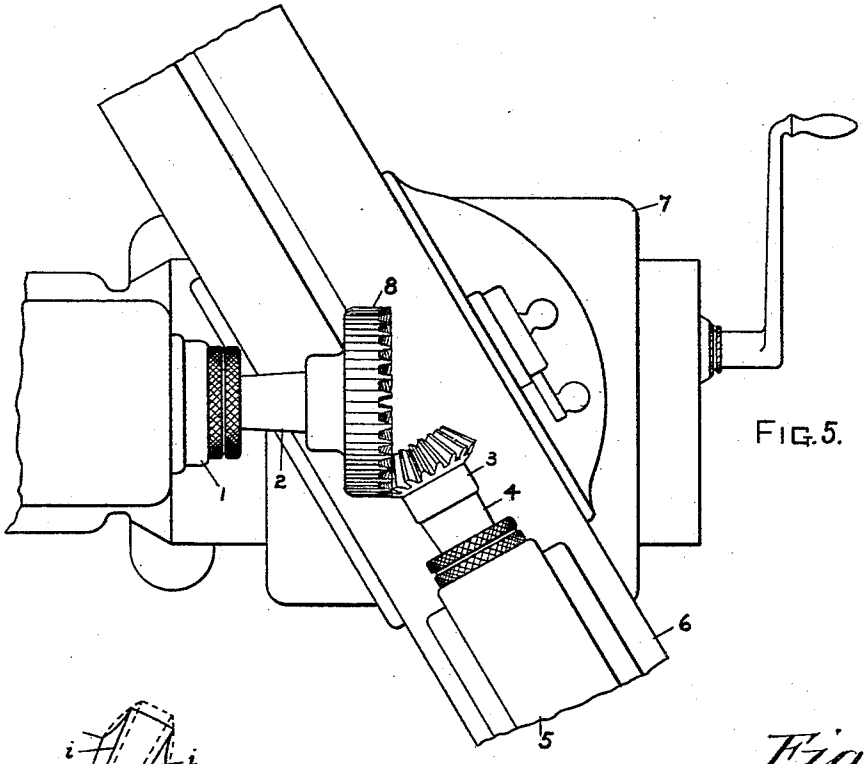


FIG. 5.

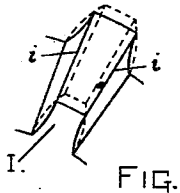


FIG. 4.

FIG. 3.

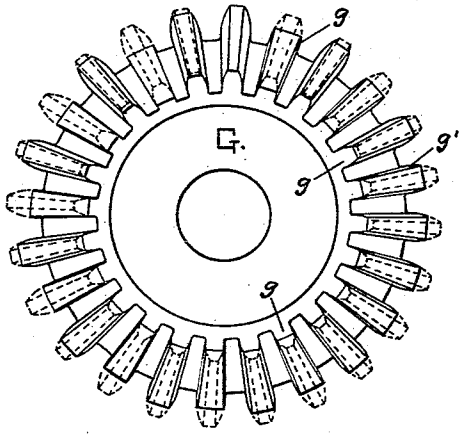
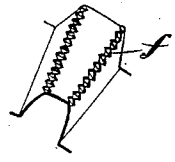


Fig. 4a



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UNITED STATES PATENT OFFICE.

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DEVICE FOR GENERATING GEAR-TEETH.

SPECIFICATION forming part of Letters Patent No. 616,648, dated December 27, 1898.

Application filed February 25, 1898. Serial No. 671,568. (No model.)

To all whom it may concern:

Be it known that I, OSCAR J. BEALE, of the city and county of Providence, in the State of Rhode Island, have invented a certain new and useful Device for Generating Gear-Teeth; and I do hereby declare the following specification, taken in connection with the accompanying drawings, forming a part of the same, to be a full, clear, and exact description thereof.

The present invention is based upon the principle that if two pitch-surfaces be rolled together without slip a tooth upon one surface will develop or generate a tooth upon the other pitch-surface, which is conjugate to the generating-tooth; and it consists in a generator having a series of edges or points so arranged with relation to the pitch-surface that they will remove the surplus stock on the blank-teeth and reduce the teeth to the correct shape by the rolling together of the pitch-surfaces of the blank and generator. As the pitch-surfaces of the blank and generator are rolled together, each edge or point of the generator removes a portion of the surplus stock on the blank and forms a conjugate line or point on the surface of a tooth of the blank. Thus line by line or point by point the surfaces of the teeth upon the blank are developed or generated by the action of successive edges or points upon the generator. The edges or points on the generator correspond to lines or points in the tooth-surfaces of a gear conjugate to the gear to be generated, and in order that the edges or points of the generator, which act successively upon the same tooth of the blank, may remove the surplus stock at varying points upon the tooth-surface the location of the edges or points with relation to the pitch-surface of the generator is varied.

The generator is preferably in the form of a gear, and the edges or points may be formed by cutting away or removing portions of the tooth-surfaces of the gear. The arrangement and character of the edges or points may be varied as desired without departing from the invention. Thus a series of edges or points may be formed upon the same tooth-surface, if desired, and these edges or points may be so arranged that the surfaces of the tooth become in effect abrading-surfaces. In such a case a tooth upon the generator will generate a conjugate tooth upon the blank, the edges or points upon a single tooth acting successively upon the surface of a tooth upon the blank as the pitch-surfaces roll together and cutting away or abrading the surplus stock. Again, a single edge or line of points may be formed upon each tooth-surface. In this case as the pitch-surfaces roll together an edge or series of points upon the generator will generate a line upon a tooth-surface of the blank, and the number of teeth in the generator and in the blank should be so proportioned that each generator-tooth will act upon a different tooth in the blank at each revolution of the generator until every tooth of the blank has been engaged by every tooth of the generator and has therefore been acted upon successively by all the cutting edges or points upon the generator. In this case, as well as where a series of edges or points are formed on a single tooth of the generator, the generator may be so formed that it may act to drive the blank or be driven thereby while the blank-teeth are being reduced to the correct form, and it is preferred to so construct the generator that it may thus drive the blank. If desired, however, the surfaces of the generator-teeth may be so cut away that the generator will not act as a driver, in which case mechanism must be used for producing the proper rolling motion between the pitch-surfaces of the blank and generator.

The invention may be used in the manufacture of any form of gearing, but is especially useful in the manufacture of bevel-gearing in which the curvature of the tooth-surfaces changes from one end of a tooth to the other and which cannot therefore be accurately cut in the usual way, but require filing and fitting before they will run properly.

In the application of the invention to the manufacture of bevel-gearing the pitch-cone of the generator may be varied and the edges or points of the generator may be arranged to develop any desired form of teeth upon the blank; but it is preferred to use a generator in the form of a crown-gear and to so arrange the edges or points that they correspond to edges or points in the surfaces of teeth having plane surfaces, since such surfaces may

be readily and accurately cut, and the gears which are formed by such a generator will accurately run with each other and form an interchangeable set.

Referring to the drawings, Figure 1 is a diagrammatic view indicating two forms of generators and the manner in which they operate upon the gear-blank. Fig. 2 is a perspective view of a preferred form of generator for generating the teeth of bevel-gears. Fig. 3 is an end elevation of a modified form of generator. Fig. 4 is a detail showing a portion of a modified form of generator, and Fig. 4ª is a detail of the tooth provided with a series of points. Fig. 5 is a plan view of so much of a milling-machine as is necessary to show one manner of using the generator.

In Fig. 1, A represents a portion of a generator in the form of a spur-gear having a series of edges *a*, arranged in varying relation to the pitch-surface of the generator. These edges *a* are formed by cutting away portions of the surface of the gear-teeth, and a series of edges are formed upon each tooth-surface, so that said surfaces become substantially filing or abrading surfaces. B represents a blank, the teeth *b* of which have been roughed out to approximately the correct form. As the pitch-surfaces of the blank and generator roll together the edges *a* upon the generator, acting upon the teeth of the blank, remove the surplus stock and reduce the teeth to the correct form shown at *c*. D in the same figure shows a similar generator in the form of a rack, and it will be understood that where the term "gear" is used in the claims and specification it is intended to include racks also.

In Fig. 2 is shown a preferred form of generator for forming the teeth of bevel-gears. This generator is in the form of a crown-gear E, which is the dividing-line between an external bevel-gear and an internal bevel-gear and corresponds to the rack in spur-gearing—that is to say, its pitch-surface is a plane surface. The teeth *e e'* of the generator may be of any desired shape, but are preferably truncated wedges in cross-section and their surfaces plane surfaces, as this form of teeth may be conveniently and accurately cut. The generating edges may be formed upon the generator in any desired manner; but it is preferred to form a series of edges *d* upon each surface and to convert the surfaces of the teeth into substantially file-surfaces, which will act to abrade or cut away the surplus stock of the blank by an action similar to the action of a file. The edges are produced by removing portions of the surfaces of the teeth, and the direction of these edges in relation to the pitch-surface may, and preferably does, vary upon different teeth. The edges may be subdivided by grooves, so that said edges become, substantially, points *f*, as shown in Fig. 4ª, and the surfaces of the teeth are formed by a number of points arranged in varying relation with the pitch-surface. In the generator shown the edges *d* are formed by cutting a series of grooves in the surfaces of the teeth at varying distances from the pitch-surface, and said grooves are parallel to the base of the teeth upon alternate teeth *e'* and parallel to the tops of the teeth upon the other tooth *e*. When the pitch-surface of this generator rolls upon the pitch-surface of a blank, the teeth of which have been roughed, the edges or points upon each tooth act successively upon the surface of a blank-tooth, and thus the surfaces of the blank-teeth are reduced to the correct shape conjugate to the surfaces of teeth of the generator by the cutting or abrading action of the generating-surfaces.

Instead of generating the surface of a blank-tooth by a series of edges or points upon the same surface of a generator-tooth the surface of a tooth on the blank may be generated by the action of a series of surfaces of different teeth of the generator and the number of edges upon the same tooth-surface may be reduced to a single edge, if desired. In Fig. 3 is shown one form of such generator. In this view the generator is shown in the form of a bevel-gear G, having varying portions of its teeth *g* removed to form edges *g'*, which lie in the surfaces of the gear-teeth. The dotted lines indicate the outline of the portions of the teeth which are removed. The portions of the teeth remaining are preferably so related to each other that the edges upon every tooth are in a different relation to the pitch-surface from the edges upon every other tooth. It is also preferred to so cut away the teeth that any tooth having the greater portion cut away will lie between two teeth which are only slightly cut away, so that there will always be at least one tooth in mesh with the blank-teeth of sufficient height to drive said blank. With this form of generator the number of teeth in the blank should be so related to the number of teeth in the generator that each tooth of the generator will in turn act upon each tooth of the blank. Then at each revolution of the blank one of the tooth-surfaces of the generator will act upon a tooth-surface of the blank, and the edges *g'* upon that surface of the generator will remove a portion of the surplus stock upon the blank-tooth and generate a line upon the tooth-surface of the blank. When the blank has made as many revolutions as there are teeth in the generator, every tooth-surface of the blank will have been acted upon by an edge upon each of the teeth of the generator, and the blank-tooth will be generated, therefore, by generating a series of lines upon the tooth-surfaces.

In case it is not desired to drive the blank by the action of the generator-teeth the surfaces of the generator-teeth may be entirely cut away, leaving only a series of edges. A fragment of such a generator is indicated in Fig. 4, in which the dotted lines indicate the form of tooth which is conjugate to the teeth

to be formed by the generator. In this form of generator the edges *i* are formed by cutting away the tops of the teeth, and the surfaces of the teeth below the edges are also cut away. The edges are arranged in varying relations to the pitch-surface, as in the other forms of generators. The operation is the same as the operation of the generator shown in Fig. 3 so far as the action of the edges upon the blank is concerned; but the generator will not act to drive the blank.

In Fig. 5 is shown one manner of using a generator which is adapted to drive the blank. In said figure, 1 represents the spindle of a milling-machine. The generator 8 is secured to an arbor 2, carried by the spindle 1, and a gear-blank 3 is mounted to rotate freely upon an arbor 4, secured to the support 5, carried by the carriage 6. The carriage 6 is adjusted to bring the axis of the blank 3 into proper relation to the axis of the generator 8, and the teeth of the blank 3 are brought into mesh with the teeth of the generator. The spindle now revolves, and the saddle 7 is gradually fed forward until the pitch-surfaces of the blank and generator are in contact. In case a generator with teeth having abrading-surfaces is used a single revolution of the blank after the pitch-surfaces are in contact will be sufficient to finish the teeth of the blank; but in case a generator is used in which the generating is done by the action of edges or points located upon the different teeth of the generator then the blank should make as many revolutions after the pitch-surfaces are in contact as there are teeth in the generator.

Instead of mounting the generator on the spindle 1 the blank may be mounted thereon, if desired, in which case the blank will act to drive the generator.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. A device for generating gear-teeth provided with a series of edges or points corresponding to lines or points in the tooth-surfaces of a gear, and arranged in varying relation to the pitch-surface of said gear, substantially as described.

2. A device for generating gear-teeth provided with a series of edges or points corresponding to lines or points in the tooth-surfaces of a bevel-gear, and arranged in varying relations to the pitch-surface of the gear, substantially as described.

3. A device for generating gear-teeth in the form of a gear having a series of edges or points arranged in varying relation with the pitch-surface, substantially as described.

4. A device for generating gear-teeth in the form of a bevel-gear having a series of edges or points arranged in varying relation to the pitch-surface, substantially as described.

5. A device for generating gear-teeth in the form of a crown-gear having a series of edges or points arranged in varying relation to the pitch-surface, substantially as described.

6. A device for generating gear-teeth in the form of a gear having a series of edges or points in the same tooth-surface, substantially as described.

7. A device for generating gear-teeth in the form of a gear having a series of edges or points in each tooth-surface, the arrangement of the edges or points varying upon alternate teeth, substantially as described.

8. A device for generating gear-teeth in the form of a gear having varying portions of the tooth-surfaces removed to form edges or points, substantially as described.

9. A device for generating gear-teeth in the form of a gear provided with teeth having abrading-surfaces, substantially as described.

10. A device for generating gear-teeth in the form of a gear provided with teeth having plane abrading-surfaces, substantially as described.

11. A device for generating gear-teeth in the form of a bevel-gear provided with teeth having abrading-surfaces, substantially as described.

12. A device for generating gear-teeth in the form of a crown-gear provided with teeth having abrading-surfaces, substantially as described.

13. A device for generating gear-teeth in the form of a crown-gear provided with teeth having plane abrading-surfaces, substantially as described.

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Witnesses:
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W. H. THURSTON.