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E. WILDHABER

METHOD OF FORMING HOBS

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Fig. 1.

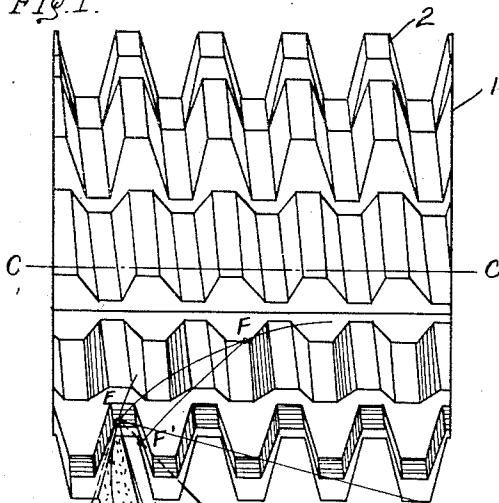


Fig. 2.

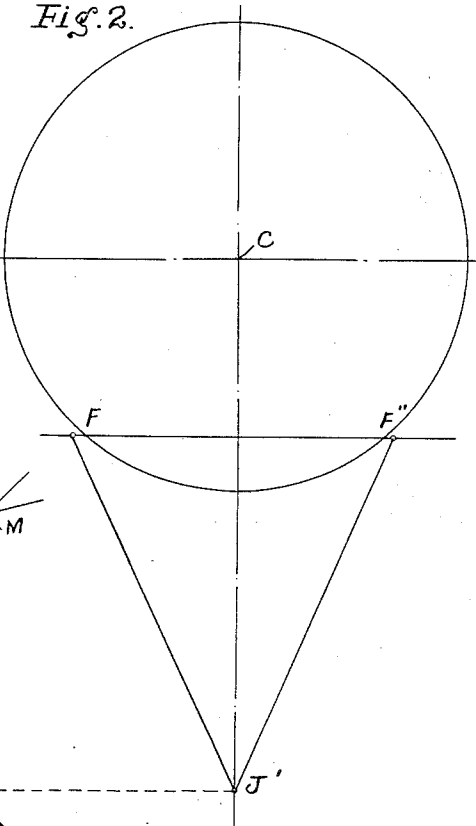
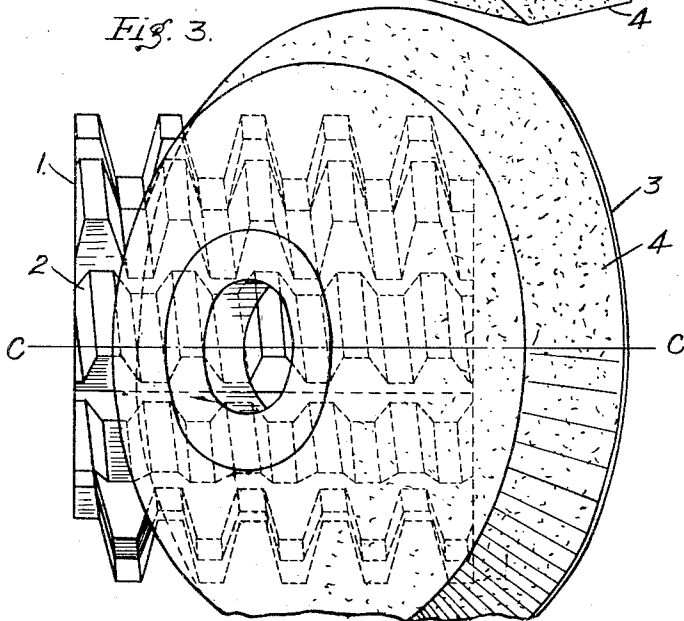


Fig. 3.



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METHOD OF FORMING HOBS.

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My invention relates to methods of grinding hobs and particularly to methods of grinding hobs which are adapted to cut gear wheels.

One object of my invention is to provide a method of grinding hobs that shall not only increase the production but shall also increase the accuracy of the hobs produced.

A further object of my invention is to provide a method of grinding a hob that shall provide a cup shaped grinding wheel having a conical grinding face on the periphery thereof and that shall position the grinding wheel axis and the axis of the hob blank in the same plane so that the axis of the grinding wheel makes a greater angle with the axis of the hob and the side angle of the hob teeth.

The speed and also the accuracy of grinding a hob is to a great extent dependent on the size of the grinding wheel utilized. In the methods now practiced for grinding a hob either a conical wheel or a pencil wheel is used. The pencil grinding wheel is necessarily very small and the size of the conical grinding wheel must be kept below a certain limit in order not to interfere with the adjacent teeth. Consequently, the size of the grinding wheels utilized in the present day methods of grinding a gear wheel hob having radially relieved side portions on its teeth has a considerable influence on the character of the gear hob produced.

In grinding a hob in accordance with my method, a cup shaped wheel of relatively large size is used in place of a pencil grinding wheel or a conical grinding wheel. The larger sized grinding wheel permits the using of a stronger drive and moreover insures a more even wear on the grinding wheel.

In my method, the axis of the hob blank and the axis of the grinding wheel are preferably located in the same plane and preferably in a horizontal plane. The axis of the wheel makes an angle with the axis of the hob blank which is greater than the side angle of the teeth on the hob. Moreover, a conical grinding surface on the periphery of a cup shaped grinding wheel so engages the relieved sides of the hob teeth as to permit a portion of the hob to project into the cup on the grinding wheel. The permit-

ting of a portion of the hob to project into the cup on the grinding wheel insures against any interference with the sides of adjacent teeth by the grinding wheel and also permits the utilization of a much larger grinding wheel.

In the accompanying drawing:

Figure 1 is a diagrammatic plan view of a hob being ground in accordance with my method.

Fig. 2 is a diagrammatic end view of the hob and blank shown in Fig. 1.

Fig. 3 is a side elevational view of the hob and blank shown in Fig. 1.

Referring to the accompanying drawing, a hob blank 1 having an axis C—C is shown provided with teeth 2 which may be of the usual relieved type. A cup shaped grinding wheel 3 having an axis M—N is provided with a conical grinding surface 4. The conical grinding surface 4 is shown in engagement with one side of the hob teeth 2. The grinding wheel 3 is illustrated in a position which corresponds to the end of a relieving stroke, that is after finishing the relieved side surface of a tooth. A second grinding wheel 5 having an axis M—O is shown in position for grinding the same tooth as the cup shaped grinding wheel 3. The conical grinding wheel 5 is shown in position with the cup shaped grinding wheel 3 in order to compare the difference in size between the two wheels. The size of a grinding wheel in grinding the relieved surfaces of the teeth of gear hobs is limited by reason of the interference with adjacent teeth. The interference with the bottom of the teeth is of little importance inasmuch as the thread on the hob may be cut deeper without inconvenience. However, interference with the side surfaces of adjacent teeth compels the use of a grinding wheel which will in no way interfere with adjacent teeth. It is necessary to grind the teeth with a wheel having a surface which is sufficiently curved to prevent any interference. The curvature of the grinding wheel is dependent not only on the diameter of the wheel but also upon the angle of its cone.

It will be understood that in carrying out the present method the hob blank is rotated slowly upon its axis and the wheel is rapidly rotated upon its axis and advanced to-

ward and from the axis of the hob blank in timed relation to the rotation of the blank. The method can be carried out in a cutter or hob grinding machine of usual or standard construction.

The curvature of the conical surface at the point of engagement with the bottom of the teeth should not in any case exceed a given amount. The curvature, which determines the interference and which we will consider, is the curvature in an intersecting plane which is drawn normal to the straight generatrix of the conical surface. In Fig. 1 of the drawing, the straight generatrix of the conical surface 4 on the cup shaped grinding wheel 3 is indicated by the line EE'. The intersecting plane which is drawn perpendicularly to the line EE' is indicated on the drawing by the reference characters EM. The plane designated by the line EM is also considered to be drawn perpendicularly to the drawing plane.

The center of curvature of the intersection line or the center of the main or principal curvature of the conical surface is situated at the intersection point of the normal line with the axis of the conical surface and in the case under consideration is the point M. All conical surfaces, which have the same tangential plane at the point E and whose axes are situated in the drawn plane have the same curvature at E and also the same clearing ability with respect to adjacent hob teeth if their axes pass through the point M. The curvature radius in the case under consideration is indicated by the line EM.

The two grinding wheels shown have conical surfaces which are substantially equivalent as to avoiding interference with the sides of adjacent hob teeth. One grinding wheel, which is a conical grinding wheel, has an axis MO. The other grinding wheel, which is a cup shaped grinding wheel has an axis MN. It will be noted the diameter of the cup shaped grinding wheel is substantially twice the diameter of the conical grinding wheel. It is evident by the using of a cup shaped grinding wheel the diameter of the grinding wheel can be increased materially. Moreover, it is apparent the axis MN of the cup shaped grinding wheel makes a greater angle with the axis C—C of the hob blank than the side angle of the hob teeth. Thus, by the using of a cup shaped grinding wheel, a much larger wheel may be used than may be used in case the grinding wheel is conical in shape. However, if the grinding wheel is made too small, interference may develop on the inside of the cup of the grinding wheel.

In order to check whether or not a grinding wheel will interfere with adjacent hob teeth a plane is drawn tangent to the thread of the hob on the side opposite to that side of the thread which is in engagement with

the grinding wheel. The tangential plane is drawn perpendicular to the drawing plane and is indicated in Fig. 1 of the drawing by the reference characters F' J. The inclination of a hob thread is approximately equal to the pressure angle of the hob. In Fig. 1 of the drawing, the pressure angle has been used instead of the exact inclination of the tangential plane.

A conical surface having a profile EJ may be drawn which extends over the profile of the cup on the wheel 3, as shown in Fig. 1 of the drawing. The tangential plane F' J intersects the conical surface having the profile EJ and the axis MN in a straight line, since it passes through the apex J. The intersection line necessarily falls on the line F' J since the tangent line in question is projected on such line. The intersection line of the cone EJ intersects the perpendicular line at the point F' in a point F. The elevation of the point F over the point F' may be determined by considering the plane EG which is perpendicular to the axis MN. The plane intersects the conical surface in the circle having a radius EG. The portion of the circle is shown on Fig. 1 of the drawing and is indicated by the reference characters EF. The point F is necessarily situated on such circle and on a line perpendicular to the point F'. The distance F' F can easily be determined by measuring the distance indicated in Fig. 1 of the drawing.

In Fig. 2 of the drawing the straight intersection lines of the considered tangential plane with the assumed conical surface EJ are shown as lines J' F and J' F''. The point J' is the projection of the point J shown in Fig. 1 and the points F and F'' are laid off from the center line a distance equal to the length of the line F' F as shown in Fig. 1 of the drawing. The tangential line under consideration intersects the imaginary cylindrical outside surface of the hob in an ellipse, which in Fig. 2 of the drawing is indicated as a circle having a center C and a diameter equal to the outside diameter of the hob. The considered lines J' F and J' F'' do not extend inside the circle and consequently no interference will take place on the side of the hob teeth opposite to the side being ground.

Briefly, it may be stated if the points F and F'' shown in Fig. 2 are on or outside the indicated circle then no interference will take place. Even if the lines J' F and J' F'' did extend into the circle there is no sure sign that interference will take place and merely serves as an indication that interference is liable to take place and care should be taken in the design of the grinding wheel. If the outside circumference of the grinding wheel and the cup surface clear the considered tangential plane F' J as far as the outside circumference of the hob then certainly

no interference will take place between the grinding wheel and the thread.

It will be understood that such changes and modifications may be made in my invention as fall within the limits of the appended claims.

What I claim is:

1. The method of grinding a hob which consists in providing a cup shaped grinding wheel, in positioning the axis of the grinding wheel and the axis of the hob blank in the same horizontal plane, in setting the axis of the grinding wheel at an angle with respect to the blank axis which is greater than the side angle of the hob teeth, and in effecting engagement between the side of the hob thread and an external conical periphery of the wheel so that a portion of the blank projects into the cup of the grinding wheel.

2. The method of grinding a hob blank which consists in providing a cup shaped grinding wheel, in positioning the axis of the wheel and the axis of the hob in the same plane, in positioning the hob blank with respect to the wheel so that a portion of the hob blank projects into the cup of the grinding wheel, and in grinding the side of the hob thread by an external conical surface located on the periphery of the grinding wheel.

3. The method of grinding a hob blank which consists in providing a cup shaped grinding wheel, in setting the axis of the grinding wheel at an angle with respect to the blank axis which is greater than the side angle of the hob teeth, in grinding the side of the hob thread by a conical surface located on the periphery of the grinding wheel, and permitting teeth adjacent to that being ground to extend into the cupped portion of the wheel.

4. The method of grinding a hob which consists in providing a cup shaped grinding wheel having an external conical work engaging surface, in setting the axis of the grinding wheel at an angle with respect to the blank axis which is greater than the side angle of the hob teeth, in effecting engagement between the side of the hob thread and the external conical surface of the wheel so that a portion of the blank projects into the cup of the grinding wheel, and in rotating the blank and moving the wheel to form relieved surfaces.

In testimony whereof, I hereto affix my signature.

ERNEST WILDHABER.