METHOD OF AND APPARATUS FOR DRESSING GRINDING WHEELS

Filed June 1, 1927
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Application filed June 1, 1927. Serial No. 195,724.

The present invention relates to the truing or dressing of grinding wheels and particularly to the truing or dressing of grinding wheels for grinding the gashes of spirally fluted hob.

Multiple thread hobs are usually provided with spiral or helical flutes or gashes, in order that the gashes may be perpendicular or substantially perpendicular to the thread so that equal and efficient cutting action may be secured on both sides of the teeth of the hob. It is usually desirable and ordinarily essential for hobbing correct gears, that the gashes of a spirally gashed hob be of straight profile and it is the purpose of this invention to provide a method for dressing grinding wheels used in grinding spirally gashed hobs to a form capable of grinding straight profiled spiral gashes and especially straight radially profiled spiral gashes on hobs.

Heretofore, the flutes of a spirally fluted hob have usually been ground with disc grinding wheels having conical grinding surfaces, that is, surfaces of straight profile. When a spirally gashed hob is ground or sharpened with such a wheel, however, the gash will not be of straight profile but of more or less convex or bellied shape. When the amount of curvature produced on the profile of the gash by a straight sided, conical grinding wheel has been found excessive, it has been customary to dress the wheel to a curved form by hand and eye. The profile shape of the gash has then depended entirely on the experience and skill of the operator. This method is unsatisfactory and slow. With the present invention, a method is provided which is wholly independent of the judgment of the operator by which the grinding wheel may rapidly be trued to a shape which will produce an exactly correct straight profiled gash. This is effected by imparting, during the dressing operation, the same relative motion between the dressing device and the grinding wheel as is used between the grinding wheel and hob during the grinding of the spiral gashes of the hob.

The present invention has, hence, for its primary purpose a method of dressing or truing grinding wheels to give the wheels a correct profile for accurately and correctly grinding spirally fluted hobs. A further object of this invention is to provide a simple form of apparatus for dressing grinding wheels to the desired contour.

The principles upon which the present invention is based and one preferred embodiment of the mechanism for carrying out this invention are illustrated in the accompanying drawings, in which:

Figures 1 and 2 are a perspective view and a sectional view, respectively, illustrating diagrammatically the method of dressing a grinding wheel according to this invention; Figure 3 is a partial side elevation of a grinding machine arranged for grinding a spirally gashed hob;

Figure 4 is a corresponding view showing the dressing apparatus of the present invention in position on such a machine for dressing the hob-grinding wheel; and

Figure 5 is a view showing details of the gearing between the screw-shaft of the machine and the live-spindle thereof.

In grinding the flutes or gashes of a spirally fluted hob, the hob and the grinding wheel are first adjusted into proper position with the grinding wheel in engagement with the side of a gash of the hob, the grinding wheel is rotated at a high speed, and the hob is given, relative to the wheel, a helical motion back and forth past the wheel, consisting of a motion in the direction of the hob axis combined with a simultaneous rotation of the hob on its axis. This helical motion is usually effected by a lead screw actuating a table or carrier upon which the hob or wheel is mounted and gearing connecting the hob with the lead screw. After the grinding operations on one flute have been completed, the hob is indexed and the operation repeated for the next flute. In dressing a grinding wheel, according to this invention, the diamond or other truing device is moved back and forth in a straight line across the grinding surface of the rotating wheel and simultaneously the truing device is rotated about an axis, relative to the grinding wheel, in the direction of an axis exactly corresponding to the axis of the hob and at exactly the same rate as the hob during the grinding of its flutes. In this way, the grinding surface of the wheel is dressed to a profile which will produce a truly straight profiled gash on the hob. The straight line profile of the hob will have ex-
actly the same relative position to the hob axis as the straight line in which the diamond point is moved has to the axis about which the diamond rotates, so that the hob flute profile may be made either radial or non-radial.

Figures 1 and 2 show diagrammatically the theory upon which the present invention is based. A spirally fluted cylindrical hob is shown in dot and dash lines at 10. For the sake of clearness, parts of four rows of teeth only are shown. This hob is provided with a plurality of cutting teeth 11 formed by pushing a thread or threads at intervals along spiral lines. The teeth 11 are relieved back of the cutting edges 17 to provide the necessary cutting clearance. The front faces 18 of the teeth of the hob lie in the imaginary spiral or helical surfaces formed by the flutes. One of these imaginary helical flute surfaces is shown in heavy dash lines at 12, in Figure 1. In the hob shown, the cutting edges 17 are radial. In other words, the profile of the imaginary helical flute surface 12 of the hob will be straight and radial at the hob axis 13.

As indicated by the line 14, that is, the helical flute surface 12 intersects a plane perpendicular to the hob axis in a straight radial line as 14.

The imaginary spiral flute surface 12 is a helical surface of a definite lead. If, then, in dressing a grinding wheel 16 which is to grind such a surface, the diamond or other dressing tool is so positioned relatively to the grinding wheel as to lie in a surface corresponding exactly to the imaginary spiral flute surface 12 of the hob and is given a motion which causes it to follow and describe such a helical flute surface, it will produce or dress a surface 15 on the grinding wheel 16 which will be conjugate to the helical flute surface of the hob.

Such a wheel 16 will be able to grind a gash on the hob of the desired profile. In Figures 1 and 2, the diamond is shown positioned for dressing a grinding wheel 16 which is to grind the flute surfaces of a hob having spiral flutes of straight radial profile. The diamond 20 is positioned relative to the grinding wheel 16 so as to rotate about an axis 13 exactly corresponding to the axis of the hob to be dressed and so as to move in a line 14 radial of the axis 13. In dressing the wheel, the diamond is moved back and forth across the face of the wheel along the line 14 the wheel being rotated all the while on its axis and simultaneously the diamond 20 is moved about the axis 13 and in the direction of this axis at a rate determined by the lead of the helical flute surface 12 and such as to describe such helical surface. The grinding wheel 16 will then be dressed to a shape capable of producing an exactly straight radially profiled gash on the hob. A grinding wheel dressed according to this invention will not be straight but of curved profile, as shown more particularly in Figure 2.

A simple apparatus for carrying out this invention is illustrated. The flute surfaces of a hob may be ground upon a grinding or milling machine of any usual or suitable type. Figure 3 shows a grinding machine arranged for grinding the flute surfaces of a hob and Figure 4 shows how this same machine may be adapted for dressing the grinding wheel which is used in grinding the flute surfaces of the hob.

In grinding the flute surfaces of the hob, the wheel, 16 is mounted upon a spindle rotatably journaled in an upright 21. The hob 10 is keyed to a spindle 22 which is removable mounted between the head and tail stocks 23 and 24 of the machine. In the grinding operation, the grinding wheel 16 is rotated on its axis and the hob is given a partial rotation on its axis and simultaneously fed axially at a rate determined by the lead of the hob flutes. To this end, the head and tail stocks 23 and 24 are mounted upon a carrier 26 which is movable longitudinally of the axis of the hob by means of a feed screw 27 which threads into a nut 28 secured to the carrier 25 and this feed screw has a geared connection with the hob spindle 22, whereby the hob spindle may be rotated in the desired timed relation with the feed movement. One way of gearing the spindle 22 and the screw shaft 26 together is illustrated, for the sake of example, in Figures 3 and 5. The screw shaft 26 carries a pair of bevel gears 28 and 40. Either of these gears may be brought selectively into mesh with a bevel pinion 41 to drive the shaft 42 to which the pinion is secured in one or the other direction, by shifting them on the screw shaft 26, as by means of the yoke lever 43. Secured to the upper end of the shaft 42 is a bevel pinion 44 which meshes with and drives a bevel gear 45 upon a transverse shaft to the outer end of which is secured a spur gear 46. The spur gear 46 meshes with and drives a spur gear 47 secured to a worm shaft carrying a worm 48 and this worm 48 meshes with and drives the worm wheel 49, which is mounted on the live spindle 50 of the head stock 23. This worm wheel 49 is provided with a series of holes 51 adapted to be engaged selectively by the spring pressed plungers 52 on the lever cam 53 which is fastened to the live spindle 50. The number of holes will correspond with the number of flutes in the hob so that the hob can be indexed for grinding of the several flutes by rotating the handle 53 and locked in each indexed position during grinding by the plunger 52. Through the gearing described, then, the spindle 22 and the screw shaft 26 can be driven in timed relation with each other. The gears 48 and 47 constitute change gears governing the relative rotations of the spindle 22 and the screw shaft. By suitably selecting these gears, a flute of any desired lead can be ground on the hob 10 or the diamond moved to envelope a
helical surface of a corresponding or any desired lead. The screw shaft may be driven from any suitable source of power or rotated by hand from the crank 55. The carrier 25 is angularly adjustable upon the bed or frame 29 of the machine to permit positioning the hob to the correct angle, with reference to the grinding wheel, determined by the helix or spiral angle of the flutes of the hob.

The grinding wheel 16 can be dressed to the correct shape, with the present invention, by removing the hob 10 and its spindle from the machine and by substituting therefor a spindle 30 to which is keyed an arm 31 provided with an opening in which the reciprocable support 32 for the diamond is mounted. The diamond is secured in a holder 33 which is adjustable in a socket formed in the support 32 and extending at right angles to the direction of movement of this support. The support 32 has a splined connection with the arm 31, whereby it may be reciprocated by hand in said arm but is held against rotation relative thereto. The diamond holder 33 may be adjusted in the socket of the support 32 to position the diamond point so that the straight line in which its point moves when reciprocated, will pass through the axis 13 of the spindle 30 and so be radial or will move in a line either side of this axis, if desired.

In Figures 1 and 2, as stated, the diamond is shown positioned radially of this axis to dress the wheel for grinding exactly radial flutes on the hob 10. The diamond may be held in any adjusted position by means of the set screw 34.

During the dressing operation, the carrier 25 is positioned or maintained at the same angle as for grinding the hob, and the same geared connection between the lead screw 26 and the head stock 23 is used, as is employed in grinding the hob flutes, so that the diamond can be given a motion relative to the grinding wheel exactly corresponding to the relative motion between the hob and grinding wheel during the grinding of the flutes of the hob. In dressing the wheel, the power is turned on, causing the grinding wheel to rotate on its axis and causing the diamond to be moved in the direction of the axis of the spindle 30, corresponding exactly to the hob axis, and to simultaneously rotate about this axis the combined rotation and translation corresponding exactly to the rotation and translation of the hob during the grinding of its flutes and being determined by the lead of the flutes of the hob. During the rotation of the grinding wheel and the rotary and translatory movements of the diamond, the operator reciprocates the support 32 back and forth across the face of the wheel, as indicated by the arrow 35 (Fig. 2) to move the diamond in a straight line across the face of the grinding wheel. This reciprocatory movement may be effected by hand. It is, of course, unnecessary to index the diamond so that the form wheel 49 remains locked to the live spindle 50 by the plunger 52 during dressing.

When a grinding wheel has been dressed in the manner described, it will grind a correct flute on a hob and if the diamond has been adjusted into a radial position will grind a straight radially profiled flute on the hob. By this invention, a grinding wheel can be correctly and accurately dressed to grind a correct and accurate cutting surface on a hob, and so produce a hob capable of cutting correct gears.

The relative motions required for giving the dressing tool the same movement relative to the grinding wheel as the hob has during grinding may be imparted all to the dressing tool, as shown, or all to the grinding wheel or part to the dressing tool and part to the grinding wheel. Instead of a diamond, it is obvious that any other suitable type of dressing device may be employed.

It is obvious that the present invention is not restricted to the dressing of grinding wheels for grinding helical flutes on hobs, but may be applied to the dressing of grinding wheels for grinding any helical surfaces for by moving a diamond or other dressing element in a straight line in any direction or in any curve whatever, and imparting the required relative helical motion between the grinding wheel and dressing element, the grinding wheel can be formed correctly to produce a helical surface containing said straight line or curve. So the present invention may be applied to the dressing of grinding wheels for grinding screws and worms and for relief-grinding hobs and the like, the diamond being given a motion along a line corresponding to the profile of the object to be ground and simultaneously moved relative to the wheel with a helical motion of a lead corresponding to the lead of the surface to be ground.

In general, while we have described our invention with relation to a particular embodiment, it is to be understood that the invention is capable of further modification within its scope and the limits of the appended claims and that this application is intended to cover any variations, uses, or adaptations, of our invention, following, in general, the principles of the invention and including such departures from the present disclosure as come within known or customary practice in the art and may be applied to the essential features hereinafore set forth and as fall within the scope of the appended claims.

Having thus described our invention, what we claim is:

1. The method of dressing a grinding wheel for grinding the gashes of a spirally gashed hob, which consists in moving a truing element repeatedly across the active face of the grinding wheel while imparting a relative
motion between the wheel and truing element exactly corresponding to that which takes place between the wheel and hob during the grinding of the gashes.

2. The method of dressing a grinding wheel for grinding the gashes of a spirally gashed hob, which consists in reciprocating a truing element across the active face of the grinding wheel while rotating the grinding wheel on its axis, and simultaneously producing a feed motion between the truing element and wheel in the direction of an axis exactly corresponding to the axis of the hob to be ground and in timed relation therewith rotating the truing element about the last named axis at a rate determined by the lead of the hob gashes.

3. The method of dressing a grinding wheel for grinding the gashes of a spirally gashed hob, which consists in positioning a truing element relative to the wheel so that it operates in a line exactly corresponding to a radial line of the hob to be ground, reciprocating said diamond across the face of the wheel, while rotating the wheel on its axis and while simultaneously rotating the truing element about an axis exactly corresponding to the axis of the hob to be ground and simultaneously therewith producing a relative feed motion between the truing element and wheel in the direction of the last named axis, said two motions being timed to conform exactly to the lead of the gashes of the hob to be ground.

4. In apparatus for dressing a grinding wheel for grinding the gashes of a spirally gashed hob, a rotatable grinding wheel, means for rotating the grinding wheel, a truing element adapted to be moved across the face of the grinding wheel during the reciprocating motion thereof, and means for simultaneously producing, during the movement of said truing element, a relative movement between the truing element and grinding wheel exactly corresponding to that which takes place between the wheel and hob during the grinding of the gashes of the hob.

5. In apparatus for dressing a grinding wheel, a grinding wheel spindle, a disc grinding wheel mounted thereon, a movable diamond holder, a removable spindle adapted to carry said holder, one of said spindles being angularly adjustable relative to the other, means for rotating the grinding wheel spindle, means for rotating the removable spindle and means for simultaneously and in timed relation therewith moving said removable spindle axially while said diamond is moved across the face of the wheel.

6. In apparatus for dressing grinding wheels, a grinding wheel spindle and a disc grinding wheel mounted thereon, a movable diamond holder, a removable spindle adapted to carry said holder, one of said spindles being angularly adjustable relative to the other, means for rotating the grinding wheel spindle, means for rotating the removable spindle and means for simultaneously and in timed relation therewith moving said removable spindle axially while said diamond is moved across the face of the wheel.

7. In apparatus for dressing grinding wheels, a grinding wheel spindle, a disc grinding wheel mounted thereon, a removable spindle, a movable diamond holder secured to said removable spindle, a diamond carried thereby, said diamond holder being adjustable on said spindle to position the point of the diamond into a plane radial of the axis of said removable spindle, means for rotating the grinding wheel spindle, means for rotating the removable spindle, and means for simultaneously imparting a relative movement between the grinding wheel spindle and removable spindle axially of the latter spindle while said diamond is being moved across the face of the wheel.

8. In apparatus for dressing grinding wheels, a grinding wheel spindle, a disc grinding wheel mounted thereon, a removable spindle, a reciprocable diamond holder mounted on said removable spindle, a diamond carried by said holder and adjustable thereon to position its point into a plane radial of the axis of said removable spindle, means for rotating the grinding wheel spindle, means for rotating the removable spindle, and means for simultaneously and in timed relation therewith moving said removable spindle axially while said diamond is being reciprocated across the face of the wheel.

9. The method of forming a rotating grinding wheel to the correct shape required for grinding a helical surface of a given profile, which consists in moving a truing element in a path conforming to said profile and imparting a relative helical motion between the grinding wheel and truing element in which the truing device relatively describes said helical surface.

10. In apparatus for dressing grinding wheels, a rotatable grinding wheel, a truing element reciprocable across the face of the grinding wheel and means for imparting a relative helical motion between said grinding wheel and truing element.

11. The method of forming a rotating grinding wheel for grinding a helical surface of straight profile, which consists in reciprocating a truing element in a straight path while imparting a relative helical motion between the grinding wheel and truing element in which the truing element relatively describes said helical surface.

12. The method of dressing a grinding wheel for grinding the gashes of a spirally...
gashed hob, which consists in positioning a truing element relative to the grinding wheel so that it operates in a line exactly corresponding to a radial line of the hob to be ground, reciprocating said truing element in a straight line across the face of the wheel, while rotating the wheel on its axis and simultaneously producing a relative helical motion between the wheel and truing element to cause the truing element to describe a helical surface of the same lead as that of the spiral gashes of the hob.

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