May 15, 1945. A. AEPPLI 2,376,109

DEVICE FOR RECTIFYING THE INVOLUTE TOOTH-PROFILE OF GEAR GRINDING DISCS

Filed Nov. 12, 1943

Fig.1

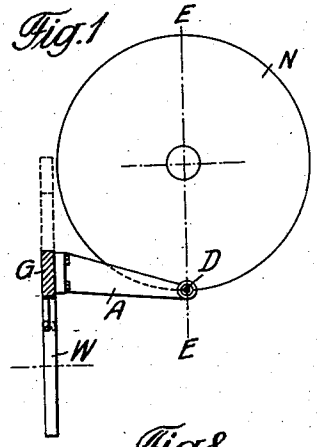


Fig.2

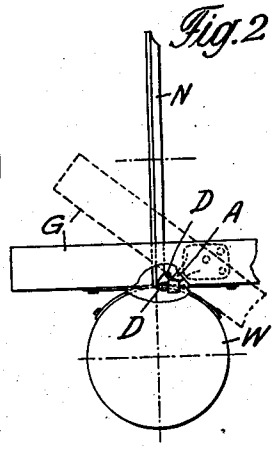


Fig.5

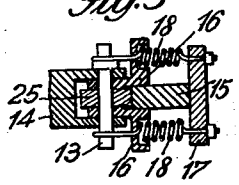


Fig.6

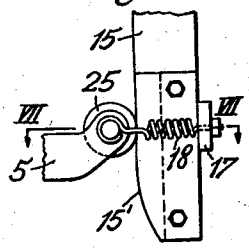


Fig.8

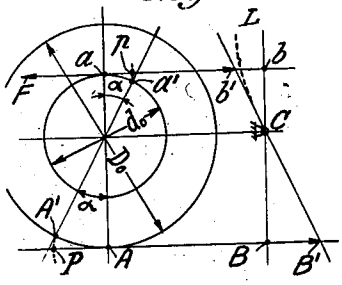


Fig.9

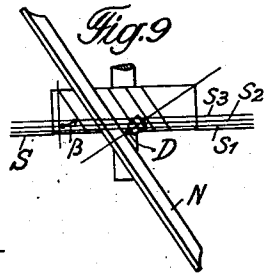


Fig.7

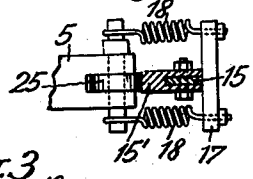


Fig.4

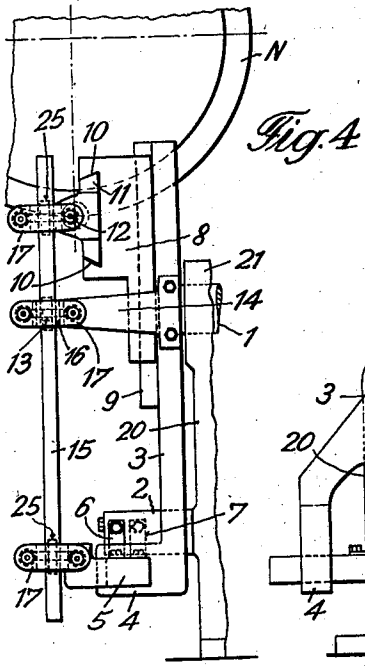
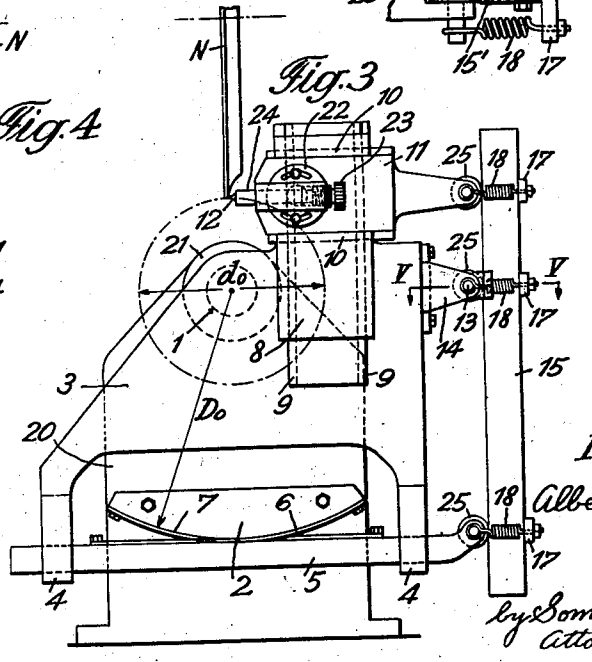


Fig.3



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DEVICE FOR RECTIFYING THE INVOLUTE TOOTH-PROFILE OF GEAR GRINDING DISKS

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9 Claims. (Cl. 125—11)

This invention relates to devices for rectifying the involuble tooth-profile of gear grinding disks.

In devices of this kind hitherto known in which the involuble tooth-profile to be formed on the grinding disk is produced on the principle of relative rolling motion between elements, the rolling disk must always be displaced laterally from the plane passing through the axis of the grinding disk and the point of the diamond in an amount approximating the radial length of the grinding disk, for the purpose of giving free the space required for the rolling elements to perform their rolling movements. This leads to an arrangement in which the diamond is fastened to the end of a long arm whereby the device becomes unstable and the exactness of the involute form produced is impaired.

The present invention has for its object to arrange the rolling disk directly underneath the grinding disk with a view to dispensing with the arm for supporting the diamond turning tool and providing for the device to become rigid and the involute curve produced to be true to form.

A further object of the present invention consists in that with a single rolling arc involute curves for gears with different pitch circles can be produced.

A still further object consists in producing with the device, in a simple manner, a tooth-outline diverting somewhat from the true involute curve, that is, the tooth-profile of the disk is intended to be given, for example, such a form that the hitherto often required additional rounding off of the face or the rooth of the teeth, respectively, can be dispensed with.

The first named object is carried into effect in that a carrier is arranged for rocking movement about the axis of a rolling disk on which carrier on one side of said axis of rotation a rectilinear rolling member is guided and is secured to said disk by means of rolling strips, the diamond being mounted on the opposite side on a plunger, the guide means of which on the carrier extends parallel with the rectilinear rolling member, and the latter and the plunger of the diamond turning tool being operatively connected with each other by means of a leverage.

The aforesaid second object is realised in that for the plunger of the diamond turning tool a guideway is arranged on a sliding member which is displaceably guided on the rockable carrier at right angles to the rolling member. Proof of this is the fact that in consequence of said displacing movement the ratio of arm lengths of said leverage from the axis of rotation of the latter to the point of contact of the rolling member and from said rotation axis to the point of contact of the diamond turning tool is varied. This ratio is however like that existing between the diameter of the rolling disk and that of the pitch circle of the tooth system to be ground. The diameter of this pitch circle can thus be varied while the rolling disk used can remain unchanged. Finally, the third mentioned object can be carried out in that one of the ends of the lever of the leverage is diverted from the rectilinear form by which means a form of tooth-profile is obtained which deviates from the involute curve.

In the accompanying drawing an old form of rectifying device is illustrated together with an exemplification of the subject of the present invention inclusive of detail modifications of the latter.

Fig. 1 shows a side elevation of a known rectifying device;

Fig. 2 shows a corresponding front elevation;

Fig. 3 shows a front elevation of a preferred form of the present invention;

Fig. 4 shows a corresponding side elevation;

Fig. 5 is a section on the line V—V in Fig. 3;

Fig. 6 shows a modified detail of Fig. 3;

Fig. 7 is a section on the line VII—VII in Fig. 6;

Fig. 8 is a diagram illustrating different relative movements, and

Fig. 9 is a schematic view representing a modified form of the device according to the present invention adapted for working with screw wheel grinding disks.

In the old device a turning mechanism operating on the principle of relative rolling motion between two parts is used for rectifying the involute tooth-profile of the grinding disk N, the stationary rolling disk W of which mechanism extends in a plane the distance of which from the middle plane E—E of the grinding disk amounts to the radial length of said disk at least. On this rolling disk W rolls a rule G which can be connected with the disk W by means of rolling strips. To this rule is connected an arm A which lies transversely to the latter and carries the diamond turning tool D. Due to the fact that the thrust to be transmitted to the diamond acts in a plane differing from that in which act the elements W and G a heavy torque is set up by the arm A in consequence whereof the rigidity and the working of this arrangement are unsatisfactory. Therefore the present invention tends in the first place to do away with the arm A.

In the form of this invention shown in Fig. 3 this result has been obtained by securing a supporting structure **20** to the bed of the machine, in which this disk to be rectified by being turned off is mounted underneath the profile generating disk N, which structure includes a shaft bearing **21** and a rolling segment **2** coaxially connected with the supporting structure. In the bearing **21** rests a journal pin **1** which is rotatable in said bearing and secured to the carrier **3**. The carrier **3** is provided with two perforated ears **4** in which a rectilinear rolling member or rule **5** is mounted free from play. This rule is connected with the rolling segment **2** by means of rolling strips **6** and **7**.

In addition, the carrier **3** is provided with a slideway **9** which extends at right angles to the rule **5** and on which a slide **8** is displaceably guided and adapted to be secured in position of adjustment. The slide **8** in turn carries a slideway which extends transversely of its longitudinal direction and serves for the reception of a plunger **11**. On the latter the diamond turning tool **12** is adjustably fastened. For effecting this fastening on the plunger **11** a turntable **22** is arranged relative to which a holder **24** for the diamond **12** can be shifted and can be fixed thereon in position of adjustment by means of a spindle and a knurled button **23**.

Further to the carrier **3** a mounting support **14** is screwed which receives an axle pin **13** extending parallel with the pin **1**. On this axle pin a roller **25** and guide pieces **16** are mounted as well as springs **18** which maintain a rail **15** in bearing engagement with the roller **25** by means of a cross piece. This rail is positioned between the guide pieces **16**. The connecting line between the centers **1** and **13** extends parallel to the rule **5**.

The rail **15** forms a two-armed lever with which the plunger **11** of the diamond turning tool and the rule **5** are articulated. Such a pivot joint is shown in plan in Fig. 6 on a larger scale. It is similar to that existing between the carrier **3** and the rail **15** and formed by a roller **25** which is forced into bearing engagement with the rule by means of springs **18** and a cross piece **17**. The rollers **25** are mounted on the parts **11** and **5** respectively, in such manner, that a line extending tangentially to the rolling segment **2** in parallelism to the rule **5** passes through the axis of the roller on the rule **5**, and that a straight line extending parallel to said tangent and passing through the diamond turning tool **12** intersects the center of the roller **25** on the slide **11**, if the projection represented by Fig. 3 is taken into consideration. As the carrier **3** is pivotally displaced relative to the support **20** the point of the diamond describes an involute curve. It will be seen that the rectifying device described is arranged directly underneath the grinding disk so that the supporting arm A shown in Figs. 1 and 2 is dispensed with. Therefore, the described arrangement provides for guiding the diamond turning tool much more rigidly and precisely.

In Fig. 8 the relative movements of parts are represented. The character d_o denotes the diameter of the pitch circle for which the involute curve is to be evolved. Do refers to the diameter of the rolling segment **2** in Fig. 3 by means of which the involute is to be effected. The character C indicates the fulcrum **13** of the lever **15**. The tangent to the root circle of diameter d_o represents the joining line passing through the point of the diamond **12** and the point of contact of the lever **15** with the plunger **11**. The tangent to the rolling circle of diameter Do corresponds to the contacting line of the guide rule **5** passing through the point of contact between the lever **15** and said rule and extends tangentially to the rolling segment **2**.

If, with the center assumed to remain in stationary position, the pitch circle *do* (Fig. 8) is to roll on the straight line $a-b$ this line $a-b$ must be displaced relative to the center in the direction of arrow F, on rotation of the pitch circle through an angle α, for a stretch $a-p$ equal to an arc length $a-a'$. If $a-p$ equals $a-a'$ point p coincides with point a' at the end of the rotational displacement for the angular range α. From Fig. 8 it is evident that on rolling movement for the angular range on the rolling circle of diameter Do a length of rolling equalling the arc length $A-A'$ is obtained. If the length $A-P$ of the straight line equals $A-A'$ the points A' and P coincide on the termination of the rotation movement.

Therefore, as

$$A-A'=a-a'.\frac{do}{Do}$$

and

$$A-P=a-p.\frac{do}{Do}$$

it follows that on the circle of diameter Do rolling on the straight line $A-B$ the pitch circle of diameter *do* performs a rolling motion on the straight line $a-b$. Therefore, it is possible to evolve the involute on a pitch circle of any desired diameter of pitch circle in using the leverage described, as long as the relation

$$\frac{C-b}{C-B}=\frac{Do}{do}$$

exists.

With the aid of such rectifying devices tooth-profiles diverting from the involute, having, for example, the tooth faces rounded off can be produced in a simple manner, for example, by giving to the lever a form which is diverted from the rectilinear contour, as indicated by a dotted line in Fig. 8.

Such a device can be carried into effect by varying the construction, for example in a manner as shown in Fig. 6. The lever end portion situated on the side of the rolling segment **2** in Fig. 3 is thus provided with an exchangeable piece **15'** which is accordingly curved. By this means the result is obtained that during the end portion of the rolling motion the displacement of the diamond plunger is somewhat increased, so as to become greater than required for producing the true involute form. Consequently the tooth-profile turned onto the disk is bulged outward.

The desired result can, however, be obtained also in that, for example, contacting engagement between the rolling rule **5** and the lever **15** is effected with the aid of a cam which is controlled by a lever arm and comes to bear either on the carrier **3** or the lever **15** when the rolling motion has been carried on to a certain extent. Thereby, a rotating movement is initiated by effect of which the diamond is displaced at variance from the displacement imparted to it through the correct leverage.

In applying the last named procedure, the varying of the ratio of leverage cannot be effected to any desired extent with the same ease as resulting from the use of a curved lever end portion.

In effecting the tooth-profiles on the grinding disk the rectifying device is conveniently clamped in position between the centering points instead of thus clampingly holding in place the gear to be ground. By rocking the carrier 3 to and fro the involute is evolved and the disk turned off. In producing spur as well as screw gears always the involute appropriate for the gear end face is carried into effect for the reason that the rolling motion can be carried out only in the plane of the rolling disk which extends parallel to the front plane S (Fig. 9).

By means of the device described also such grinding disks can be rectified which are intended for grinding screw gears. In so doing, apart from the rolling motion which in this instant is effected by the diamond plunger, the rolling plane must be gradually displaced longitudinally of a helix in a manner known per se. The turning off of the disk must, therefore, be effected in planes S1, S2, S3 (Fig. 9) lying collaterally of each other at minute spacings apart with a view to obtaining the true involute form. In connection therewith the point of the diamond must be adjusted into a position substantially at right angles to the plane of the grinding disk. For this purpose, in rectifying devices for screw wheels the diamond holder is arranged on the diamond plunger so that it can be turned relatively thereto and clamped in position thereon.

In the preceding description it is stated that the rolling operation is carried out by means of a rolling rule through the intermediary of rolling strips. It is, however, also feasible to use a toothed sector cooperating with a rack.

I claim:

1. In a device for rectifying involute-tooth profiles on grinding disks for gear grinding machines, a rolling disk, coordinated with the axis of rolling movement, and a cooperative rectilinear rolling member, means for effecting relative rolling movement between said disk and said member about said axis, a carrier coaxially arranged with said disk for pivoting movement about said axis, slide guides for displaceably guiding said rectilinear rolling member arranged on said carrier on one side of said axis, a turning tool carrier plunger disposed on said carrier on the other side of said axis, means for guiding said plunger parallel with said rolling member, and a leverage operatively connecting said member with said plunger.

2. In a device for rectifying involute-tooth profiles on grinding disks for gear grinding machines, a rolling disk, coordinated with the axis of rolling movement, and a cooperative rectilinear rolling member, means for effecting relative rolling movement between said disk and said member about said axis, a carrier coaxially arranged with said disk for pivoting movement about said axis, slide guides for displaceably guiding said rectilinear rolling member arranged on said carrier on one side of said axis, a turning tool carrier plunger disposed on said carrier on the other side of said axis, means for guiding said plunger parallel with said rolling member, a leverage including a two-armed lever operatively connecting said member with said plunger, and a fulcrum arranged for said lever on said carrier so that the joining line intersecting said fulcrum and said axis extends parallel with said rolling member.

3. In a device for rectifying involute-tooth profiles on griding disks for gear grinding machines, for grinding work pieces constituted by a gear having a pitch circle, in combination, a rolling disk, coordinated with the axis of rolling movement, and a cooperative rectilinear member, means for effecting relative rolling movement between said disk and said member about said axis, a carrier coaxially arranged with said disk for pivoting movement about said axis, slide guides for displaceably guiding said rectilinear rolling member arranged on said carrier on one side of said axis, a turning tool carrier plunger disposed on said carrier on the other side of said axis, means for guiding said plunger parallel with said rolling member, a leverage including a two-armed lever operatively connecting said member with said plunger, a fulcrum arranged for said lever on said carrier so that the joining line intersecting said fulcrum and said axis extends parallel with said rolling member, and an articulation between one arm of said lever and said plunger, said leverage arranged to provide a ratio of theoretical lever arm lengths between said fulcrum and the point of rolling contact of said member and between said fulcrum and said articulation equalling the ratio of the diameter of said rolling disk and said pitch circle diameter.

4. In a device for rectifying involute-tooth profiles on grinding disks for gear grinding machines, for grinding work pieces constituted by a gear having a pitch circle, in combination, a rolling disk coordinated with the axis of rolling movement, the diameter of said disk being greater than that of said pitch circle, a rectilinear rolling member cooperating with said disc, means for effecting relative rolling movement between said disk and said member about said axis, a carrier coaxially arranged with said disk for pivoting movement about said axis, slide guides for displaceably guiding said rectilinear rolling member arranged on said carrier on one side of said axis, a turning tool carrier plunger disposed on said carrier on the other side of said axis, means for guiding said plunger parallel with said rolling member, a leverage including a two-armed lever operatively connecting said member with said plunger, a fulcrum arranged for said lever on said carrier so that the joining line intersecting said fulcrum and said axis extends parallel with said rolling member, and articulations between said lever arms and said plunger and said member respectively, said leverage arranged to provide a ratio of theoretical lever arm lengths between said fulcrum and the point of rolling contact of said member and between said plunger articulation equalling the ratio of the diameter of said rolling disk and said pitch circle diameter.

5. In a device for rectifying involute-tooth profiles on grinding disks for gear grinding machines, for grinding work pieces constituted by a gear having a pitch circle, in combination, a rolling disk coordinated with the axis of rolling movement, the diameter of said disk being greater than that of said pitch circle, a rectilinear rolling member cooperating with said disk, means for effecting relative rolling movement between said disc and said member about said axis, a carrier coaxially arranged with said disc for pivoting movement about said axis, slide guides for displaceably guiding said rectilinear rolling member arranged on said carrier on one side of said axis, a turning tool carrier plunger disposed on said carrier on the other side of said axis, means for guiding said plunger parallel with said rolling member, a slide carrying said plunger guide means displaceably ar-

ranged on said carrier in a direction at right angles to said rectilinear rolling member, a leverage including a two-armed lever operatively connecting said member with said plunger, and a fulcrum arranged for said lever on said carrier so that the joining line intersecting said fulcrum and said axis extends parallel with said rolling member.

6. In a device for rectifying involute-tooth profiles on griding disks for gear grinding machines, for grinding work pieces constituted by a gear having a pitch circle, in combination, a rolling disk coordinated with the axis of rolling movement, the diameter of said disc being greater than that of said pitch circle, a rectilinear rolling member cooperating with said disk, means for effecting relative rolling movement between said disk and said member about said axis, a carrier coaxially arranged with said disk for pivoting movement about said axis, slide guides for displaceably guiding said rectilinear rolling member arranged on said carrier on one side of said axis, a turning tool carrier plunger disposed on said carrier on the other side of said axis, means for guiding said plunger parallel with said rolling member, means for altering said parallel movement of said plunger for diverting said tool from its course for producing the correct involute form at certain points of the tooth-profile, a leverage including a two-armed lever operatively connecting said member with said plunger, and a fulcrum arranged for said lever on said carrier so that the joining line intersecting said fulcrum and said axis extends parallel with said rolling member.

7. In a device for rectifying involute-tooth profiles on grinding disks for gear grinding machines, for grinding work pieces constituted by a gear having a pitch circle, in combination, a rolling disk coordinated with the axis of rolling movement, the diameter of said disk being greater than that of said pitch circle, a rectilinear rolling member cooperating with said disk, means for effecting relative rolling movement between said disk and said member about said axis, a carrier coaxially arranged with said disk for pivoting movement about said axis, slide guides for displaceably guiding said rectilinear rolling member arranged on said carrier on one side of said axis, a turning tool carrier plunger disposed on said carrier on the other side of said axis, means for guiding said plunger parallel with said rolling member, a leverage including a two-armed lever operatively connecting said member with said plunger, said lever having an end portion diverting from its rectilinear outline for diverting said tool from its course for producing the correct involute form, and a fulcrum arranged for said lever on said carrier so that the joining line intersecting said fulcrum and said axis extends parallel with said rolling member.

8. In a device for rectifying involute-tooth profiles on grinding disks for gear grinding machines, for grinding work pieces constituted by a gear having a pitch circle, in combination, a rolling disk coordinated with the axis of rolling movement, the diameter of said disk being greater than that of said pitch circle, a rectilinear rolling member cooperating with said disk, means for effecting relative rolling movement between said disk and said member about said axis, a carrier coaxially arranged with said disk for pivoting movement about said axis, slide guides for displaceably guiding said rectilinear rolling member arranged on said carrier on one side of said axis, a turning tool carrier plunger disposed on said carrier on the other side of said axis, means for guiding said plunger parallel with said rolling member, a leverage including a two-armed lever operatively connecting said member with said plunger, a separate piece exchangeably connected to an end portion of said lever and provided with an outline diverting from the rectilinear outline of said lever for diverting said tool from its course for producing the correct involute form, and a fulcrum arranged for said lever on said carrier so that the joining line intersecting said fulcrum and said axis extends parallel with said rolling member.

9. In a device for rectifying involute-tooth profiles on grinding disks for gear grinding machines, a rolling disk, coordinated with the axis of rolling movement, and a cooperative rectilinear rolling member, means for effecting relative rolling movement between said disk and said member about said axis, a carrier coaxially arranged with said disk for pivoting movement about said axis, slide guides for displaceably guiding said rectilinear rolling member arranged on said carrier on one side of said axis, a diamond turning tool carrier plunger disposed on said carrier on the other side of said axis, means for guiding said plunger parallel with said rolling member, and a leverage operatively connecting said member with said plunger.

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