March 27, 1945. E. W. MILLER 2,372,597

DRESSING APPARATUS FOR FORMED GRINDING WHEELS AND THE LIKE

Filed Jan. 19, 1942 3 Sheets-Sheet 1

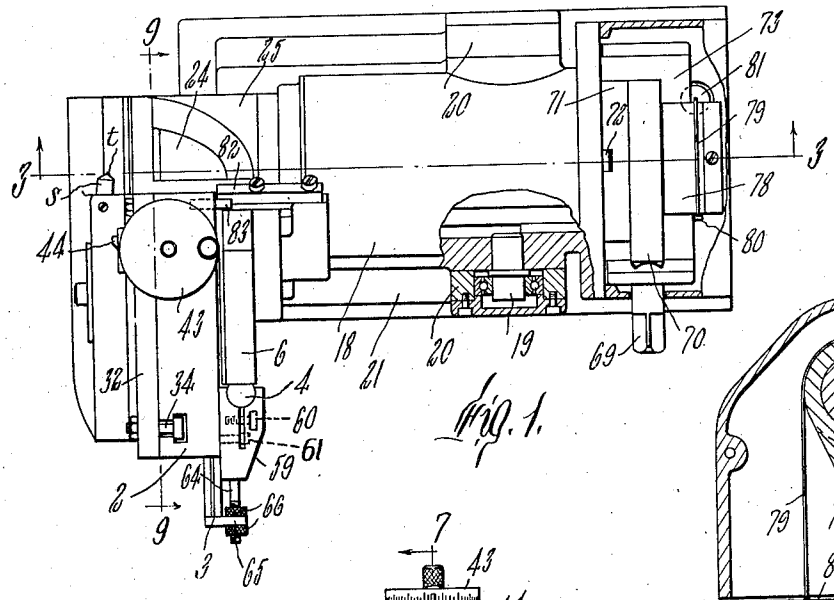


Fig. 1.

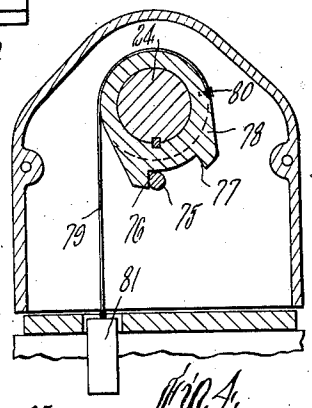


Fig. 4.

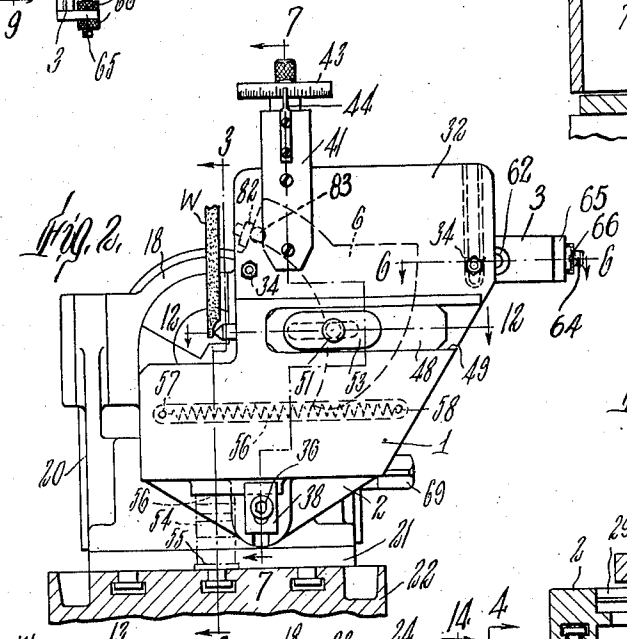


Fig. 2.

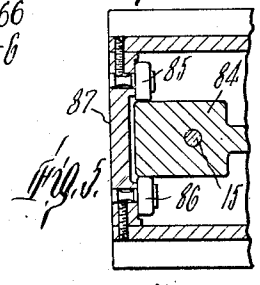


Fig. 5.

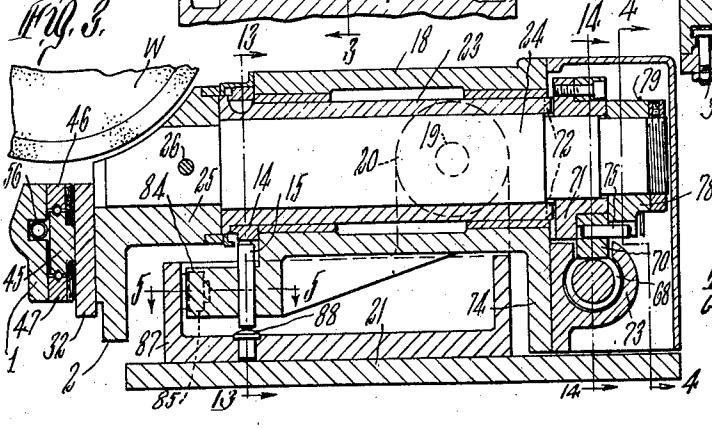


Fig. 3.

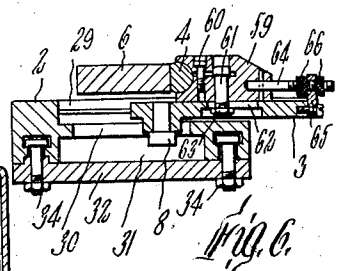


Fig. 6.

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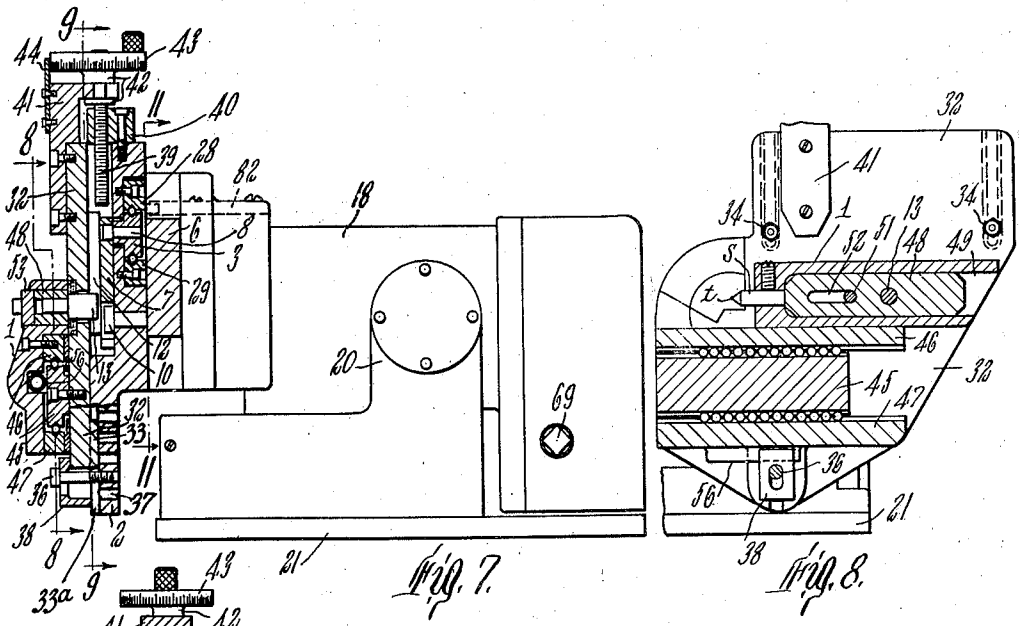


Fig. 7.



Fig. 8.

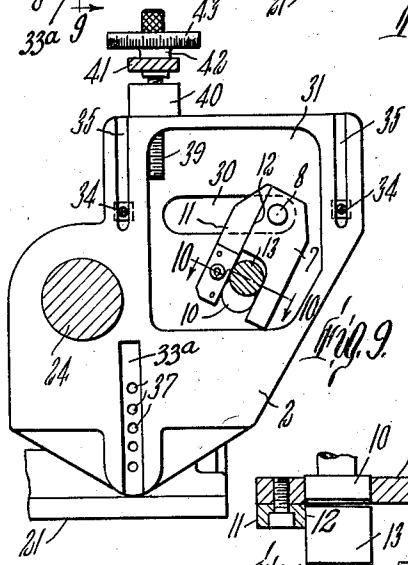


Fig. 9.

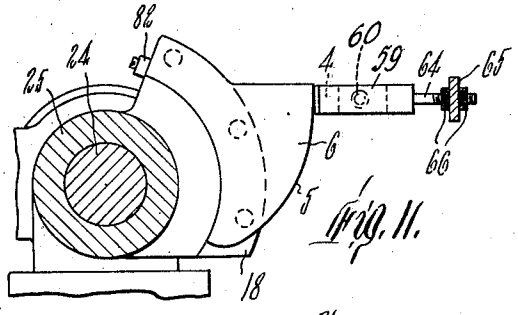


Fig. 11.



Fig. 10.

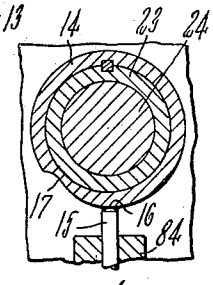


Fig. 13.

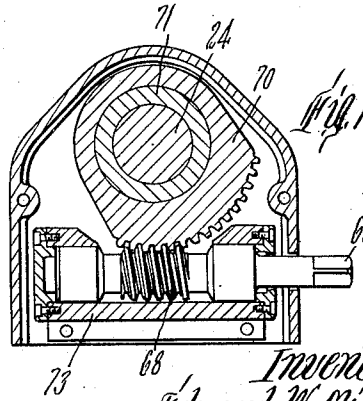


Fig. 14.

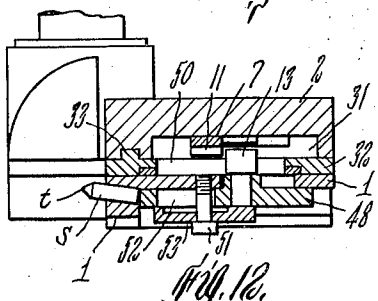


Fig. 12.

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Filed Jan. 19, 1942 3 Sheets-Sheet 3

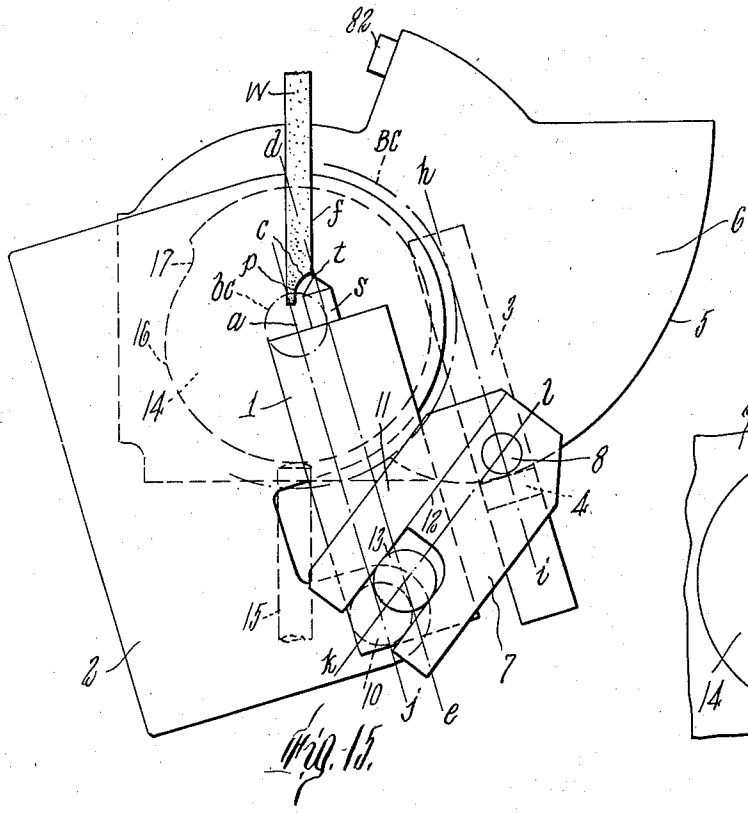



Fig. 15.

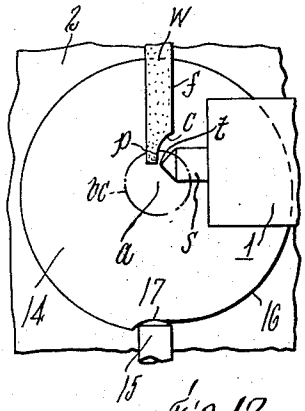
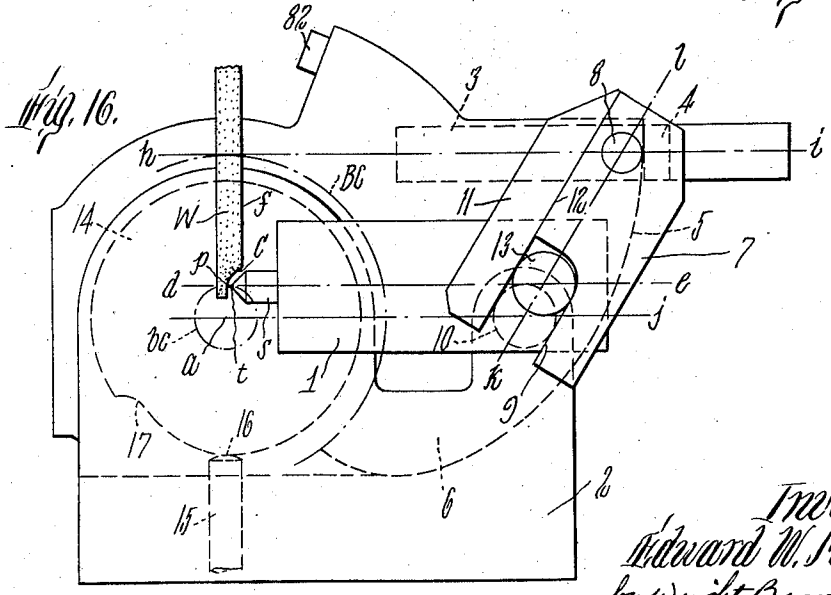



Fig. 17.

Fig. 16.




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2,372,597

# UNITED STATES PATENT OFFICE

2,372,597

## DRESSING APPARATUS FOR FORMED GRINDING WHEELS AND THE LIKE

Edward W. Miller, Springfield, Vt., assignor to The Fellows Gear Shaper Company, Springfield, Vt., a corporation of Vermont

Application January 19, 1942, Serial No. 427,218

16 Claims. (Cl. 125—11)

The invention herein disclosed is concerned with devices for imparting a prescribed curvature to the active cutting portions of grinding wheels and analogous cutting or smoothing tools. It is more particularly concerned with forming grinding wheels in profile to the counterpart curvature of gear teeth, so that such wheels may finish the gear teeth to prescribed face curvature by a simple movement of relative translation lengthwise of the gear teeth, while rotating. While I have named specifically herein a grinding wheel as the tool to be thus trued, I wish to make it clear that the principles of the truing or dressing means here shown are applicable also to dressing specifically different articles, such as metallic cutters, disks for lapping or burnishing, etc. With this understanding in mind I will, in the further description herein, generally refer to the object or tool on which the dressing appliance operates, as a grinding wheel.

The general purpose of the invention is the same as that set forth in my prior patents, 1,900,943, dated March 14, 1933, and 1,978,845, dated October 30, 1934; namely, to cut by original generation a curved zone in the lateral face of a grinding wheel adjacent to its rim, the profile of which is an involute curve. Further objects are to provide the dressing apparatus with adjustable means whereby it is enabled to generate curves derived from different base circles, and to enable the same dressing tool to generate a surface of which the radial elements are straight lines, more particularly a plane surface, between the concave zone and the rim of the wheel adapted to grind the flanks of gear teeth within the base circles of such teeth.

One embodiment of means for carrying the foregoing objects into effect is described in the following specification with reference to illustrative drawings, for the purpose of explaining the principles of the invention and without intent to limit my protection to that specific embodiment.

In the drawings,

Fig. 1 is a plan view of the illustrative wheel dressing aparatus referred to, partly broken away to show interior constructions;

Fig. 2 is an end elevation as seen from the left of Fig. 1;

Fig. 3 is a longitudinal section taken on line 3—3 of Figs. 1 and 2;

Fig. 4 is a vertical cross section taken on line 4—4 of Fig. 3;

Fig. 5 is a horizontal section of another detail of the machine taken on line 5—5 of Fig. 3;

Fig. 6 is a horizontal sectional view of a detail of the machine taken on line 6—6 of Fig. 2;

Fig. 7 is a vertical section of the left hand end of the machine taken on line 7—7 of Fig. 2, and a side elevation of the balance of the machine;

Fig. 8 is in part an end elevation and in part a cross section on line 8—8 of Fig. 7;

Fig. 9 is a cross section on line 9—9 of Figs. 1 and 7;

Fig. 10 is a detail section taken on line 10—10 of Fig. 9;

Fig. 11 is a cross section on line 11—11 of Fig. 7;

Fig. 12 is a horizontal section on line 12—12 of Fig. 2;

Figs. 13 and 14 are detail cross sections on lines 13—13 and 14—14, respectively, of Fig. 7;

Figs. 15, 16 and 17 are diagrams illustrating the principles according to which the apparatus operates in truing a grinding wheel.

Like reference characters designate the same parts wherever they occur in all the figures.

A fragment of a grinding wheel in position to be trued is represented at W in many of the figures. The principles of the invention, and the mode of operation of one of its embodiments, will first be described with reference to diagrams (Figs. 15, 16 and 17), in which the operating parts of that embodiment are shown in conventionalized form. The operation consists in moving a dressing tool *t* in a curve *c*, from the face *f* of the grinding wheel toward the rim of the wheel to a given point, as *p*; thereby, in conjunction with continuous rotation of the wheel, generating a concave zone; and then shifting the dressing tool from the point *p* to the rim of the wheel in a path which causes generation of a straight line profile contiguous to the wheel rim. The dressing tool here used is a diamond set into the tapered extremity of a shank *s*; such as is commonly employed for dressing grinding wheels. In traversing the curve *c*, the dressing tool is moved angularly around an axis *a* and linearly along a straight line *d—e* which is at a fixed distance from said axis and shifts angularly with the dressing tool; said movements being imparted simultaneously at velocities such that the curve generated is the involute of a base circle *bc* tangent to the line *d—e*. In passing from *p* to the rim of the wheel, the dressing tool travels in a path lying in a plane radial to the axis *a*.

Ability to generate curves of different base circles than the circle *bc* shown in these diagrams is an important feature of the invention;

and the mechanism which imparts the compound movement to the dressing tool is organized to effect such variations of the base circle. The dressing tool is secured to a carriage 1 which is mounted movably on a carriage holder 2 and is constrained to move along the line *d*—*e*. The carriage holder 2 is pivotally mounted to swing around the axis *a*, and it also supports and carries a slide 3 guided to move along a line *h*—*i* which is parallel to the line *d*—*e* and is tangent to a circle BC centered on the axis *a* and of substantially larger diameter than the circle *bc*. Attached to the slide 3 is an abutment or cam follower 4 which bears against the surface 5 of a stationary cam or former 6. The face 5 is an involute of the circle BC.

A lever 7, which is here called a ratio lever, is connected by a pivot pin 8 with the slide 3 and is formed with a notch 9 which embraces a stud 10 secured to the carriage holder 2; the center of which stud is in a line *a*—*j*, parallel to lines *d*—*e* and *h*—*i*, passing through the axis *a*. The ratio lever carries on one face a bar 11 having a contact surface 12 parallel with the line of centers *k*—*l* of the pivot 8 and stud 10. The dressing tool carriage extends over or in front of the ratio lever actually, although it is represented in these diagrams as behind the ratio lever, for clarity, and carries a rearwardly projecting stud 13 which overlaps the contact-face 12. The center of stud 13 is in the line of centers *k*—*l*, and its radius is equal to that of stud 10. A spring, later described, is arranged to force the stud 13 against the contact face 12 and the abutment 4 against the surface 5 of the former or cam. Stud 10 is the fulcrum of the ratio lever which reacts to the force thus exerted. The direction of force application on the dressing tool carriage and abutment 4 is toward the grinding wheel.

It may be assumed for this explanation that the dressing action is commenced when the carriage holder 2 is in the position of Fig. 15, and is carried on by swinging this holder counterclockwise to the position of Fig. 16. This is the logical direction when the apparatus is designed to form a surface of straight line profile adjacent to the rim of the wheel; although the curved zone may be dressed by swinging in either direction. The abutment 4 then travels upwardly along the surface 5 of the former and is displaced outwardly to progressively greater distances from the axis *a*. The ratio lever 7, being then turned about the fulcrum stud 10, moves the carriage 1 through proportional distances. The ratio between the movement thus given to the dressing tool along the line *d*—*e* and the movement of the abutment along the line *h*—*i* is equal to the ratio between the radii of the base circles *bc* and BC. The dressing tool is thus caused to trace a curve which is an involute of the circle *bc*. In order to generate in like manner curves of other base circles, the carriage is shifted so as to alter the distance of the line *d*—*e* from the line *a*—*j*; and the machine is provided with means, later described, for so shifting the carriage while maintaining the lines *a*—*j*, *d*—*e* and *h*—*i* parallel to one another at all times.

The foregoing explanation covers the design and use of the invention for generating involute curves. But the invention is not limited to that design and use only. It may be organized for generating a wide variety of other curves in the cutting areas of grinding wheels and other cutting tools, by the substitution of other formers for the one of involute outline shown here. Almost any curve may be employed, of either continuous or reversed curvature, and whether continuously curved or consisting of angularly related straight lines in part or all of its extent; provided only that the cam outline is such that it can be traversed by a suitable cam follower without interference, and that interferences are not caused between the dressing tool, in its continuing motion, and previously dressed parts of the wheel face. The curve generated in the grinding wheel is similar and proportional to the cam face of the former.

For dressing the wheel with a straight line profile from the point *p* to the rim, the whole assemblage is allowed to descend from the position of Fig. 16 to that of Fig. 17. This is accomplished by a cam 14 associated with the holder 2, and a support 15 on which the cam rests. The cam is capable of turning through a limited angle with respect to the holder about an axis which, during the traverse of the dressing tool along curve *c*, coincides with the axis *a*. It has a descent from the point 16 to the point 17, and in the rest of its circumference it is concentric with its axis. During the traverse of the dressing tool over the curve *c*, the cam turns with the carriage holder and a concentric arc of its surface rests on the support 15. The cam is so designed that the point 16 of its surface arrives at the support 15 when the dressing tool reaches the point *p*. Then the holder is prevented from rotating further and cam 14 is independently rotated so that its descending surface permits descent of the dressing tool in a path which, compounded with the rotation of the grinding wheel, causes the zone from *p* to the rim of the wheel to be given a straight line profile. By sutiable design and operation of the cam, the location of the point *p* with respect to the base circle *bc* may be controlled. Here the point *p* lies in that base circle and the profile of the grinding face from *p* to the rim is radial to the base circle. Variations from these characteristics may be made within the scope of the invention.

In the operative apparatus or machine which I have shown in these drawings for performing the operations thus described, the operating parts are mounted in a housing 18 having alined transverse trunnions or pivots 19 supported rotatably in brackets 20 which rise at opposite sides of the housing 18 from a base 21. Said base is adapted to be placed on the bed 22 of a gear grinding machine, or on any other supporting structure which permits the dressing tool to be brought into correct engagement with the grinding wheel. The housing 18 contains a rotatably mounted quill or shell 23 and the quill contains a rotatable shaft 24. The quill 23 and shaft 24 are coaxial and their common axis is substantially horizontal and intersects at right angles the axis of the trunnions 19, which is also horizontal.

The former 6 is rigidly secured to a part of the housing 18. The dresser carriage holder 2, which is essentially a plate of extended area, has a hub portion 25 mounted on the front end of shaft 24, which protrudes from the quill, and secured thereto by a pin 26 (Fig. 3). In the rear side of holder 2 is mounted slide 3 confined between guides 28 and 29 with interposed balls constructed to guide the slide without backlash accurately in a prescribed path, and with silght frictional resistance. Slide 3 carries the abutment 4 at its rear side and the pivot pin 8 protruding from its

forward side through a slot 30 in the holder 2. The ratio lever 7 is contained within a chamber 31 in the holder 2, and the fulcrum stud 10 is mounted in the rear wall of said chamber so as to enter the fork of the ratio lever, as is well shown in Figs. 7 and 9.

The means for mounting the dressing tool carriage 1 on the holder 2, with capability for the movements and adjustments previously described, comprises the following. A plate 32 is mounted on the forward side of the holder 2, with provisions for vertical adjustment, having a tongue 33 on its rear side fitting slidingly a groove 33a in the forward face of the holder, and carrying clamping bolts 34, the heads of which occupy undercut channels 35 in the holder. A third clamping bolt, 36, is passed into one of a number of holes 37 in the lower part of the holder through a slot in a bridge 38 which bears on both the plate and holder. By means of the clamping bolts, the plate 32 may be secured firmly in any position within its range of adjustment. An adjusting screw 39 for shifting the plate in its prescribed path is threaded into a nut 40, fastened to the holder 2, and has a rotative bearing in a bracket 41 secured to the plate 32. Shoulders 42 on the screw flank the bearing portion of bracket 40, and transmit endwise displacement of the screw to the plate. A graduated hand wheel 43 serves for manual rotation of the screw, and an index 44 on the bracket 41 coacts with the graduations on the hand wheel to give a micrometric indication of the screw adjustments.

A guide rib 45 is secured to the forward side of the plate 32 and guides the dresser carriage 1 through guides 46 and 47 on the rear side of the carriage and interposed balls. The carriage is thus constrained to move in a prescribed path, without backlash, and with minimum friction. The rib 45 and slide 3, and their respective guides, are parallel to each other, wherefore the paths of the carriage and slide are parallel. The stud 13 is coupled adjustably to the carriage 1, being mounted in a block 48 which occupies a guideway 49 in the carriage, the stud extending through a slot 50 in the plate 32 (Fig. 12). A screw 51 passing through a slot 52 in the block 48, and threaded into the carriage, applies pressure by means of a bridge 53 against the block to secure it in its various positions. The adjustment thus provided enables the dressing tool to be set at different points along the line *d*—*e*, so as to locate the involute curve which it traces in any desired relation to the base circle.

If a more exact determination of the base circle for which the dressing tool is set, than can be afforded by the micrometer hand wheel 43, is needed, this may be obtained by placing gauge blocks, shown in dotted lines at 54 in Fig. 2, between a seat 55 on the bed 22 and an abutment surface 56 on the plate 32.

A spring 56 is located in a chamber in the rear side of the carriage 1 and is anchored at one end, 57, to the rib 45 and at its other end, 58, to the carriage. It holds the stud 13 against the surface 12 of the ratio lever, and the abutment or cam follower 4 against the face of the former. Consequently it also exerts force on the dressing tool toward the face of the wheel being dressed.

In addition to the adjustments previously described, the abutment 4 is also adjustable relatively to the slide 3. The abutment itself is a cylindrical block of hard material having a flat face at the side toward the former and arranged to make tangent contact with the latter on a line intersecting the line *h*—*i* of the diagrams. The abutment is clamped between resilient jaws of a holder 59 by means of a clamp screw 60 and the holder occupies a guideway in the back of the slide 3, in which it is secured by a bolt 61. This bolt passes through a slot 62 in the slide and a nut 63 on the bolt overlaps the bounding walls of the slot. A threaded rod 64 is secured to the outer end of holder 59 and extends through a bracket 65 which is secured to the outer end of slide 3, and meshes with nuts 66 which embrace this bracket. The nuts are rotated to adjust the abutment holder, and may be graduated to measure such adjustments.

The cam 14, previously mentioned as causing the peripheral zone of the grinding wheel to be dressed, is keyed fast to the quill 23 and rotates with it. Rotation is imparted to the quill by a worm and gear mechanism consisting of a worm 68 having a shank 69 adapted to receive a crank or wrench, and a gear segment 70 fastened to a collar 71 which fits rotatably on the shaft 24 adjacent to the rear end of the quill, and is coupled to the quill by keys 72. The worm is mounted rotatably in a bearing 73 secured to a flange 74 on the adjacent end of the housing 18. Gear 70 carries a pin 75 projecting into the space between two angularly separated shoulders 76 and 77 on a collar 78 which is keyed, or otherwise secured non-rotatably, on the shaft 24 close beside the gear. A strap 79 passes from a point of anchorage 80 with the collar 78 over the upper side thereof and supports a weight 81. The arrangement of strap and weight is such that the shoulder 76 normally bears against pin 75, and the direction of the torque which causes such bearing is the same as that which causes rotation of the holder 2 from the position shown in Fig. 15 to that shown in Fig. 16. Hence, when torque is applied to the quill to rotate it, by means of the worm and wheel gearing in the direction indicated, the weight 81 causes the shaft 24, and the dressing tool holder, to be rotated in the same direction at the same speed, whatever that speed may be.

A stop abutment 82 is secured to a portion of the housing 18 adjacent to the carrier 2, and lies in the path of a stop pin 83 which projects from the carrier. These parts are arranged to arrest rotation of the carrier when it arrives in the position indicated by Fig. 16, or, in other words, when the dressing tool comes to the locality on the grinding wheel which has been ordained as the limit of the curved face *c*. The cam is arranged so that the beginning point 16 of its receding surface reaches the support 15 at the same time. Then the carrier is prevented from rotating further, but continued rotation of the quill carries the receding cam surface 16—17 across the support 15, allowing the housing 18 to descend, under the action of gravity, as to its portion next to the grinding wheel. It should be noted that the axis of the trunnions 19, about which the dressing tool then moves, is parallel to the axis on which the grinding wheel is set to rotate while being dressed. Hence, although the path of the dressing tool then deviates imperceptibly from a straight line, yet such deviation is of no importance, (and would still be of no importance even if much greater in degree), because the path of the dressing tool lies in the plane of rotation of the wheel. A guide element 84 projects from the housing 18 between two guide rolls 85 and 86 mounted with their axes

parallel on a bracket 87 which is secured to the base 21. The sides of the guide element 84 against which these rolls bear are in parallel planes perpendicular to the axis of trunnions 19. This guide means is located near to the working location of the dressing tool, at least much nearer thereto than the trunnions 19, and it accurately establishes the plane in which the dressing tool travels when making a zone of straight line profile in the grinding wheel.

The member 15, previously described as being the support on which the cam 14 rests, is here shown as a rod movable freely endwise through the guide element 84 and supported in its turn by a stud 88 set into the base portion of bracket 87. The abutting faces of rod 15 and stud 88 are convex, and so is the end face of the rod which supports the cam. Thus, when the receding cam face permits descent of the housing, the guide element 84 passes downward along the rod, and the latter is free to slip across the face of stud 88 to the extent necessitated by the arcuate movement of the element 84 around the trunnion axis.

The principles of the apparatus last described are operable to form conical zones as well as plane zones in grinding wheels and the like. This may be done by locating the axis of trunnions 19 and the plane of the grinding wheel at an oblique angle of any desired degree to one another. In either case the profile of that part of the wheel dressed while the housing turns about the trunnion axis is composed of straight lines.

What I claim and desire to secure by Letters Patent is:

1. A dressing apparatus for creating a prescribed profile in a cutting tool, comprising an angularly movable carriage holder, a carriage mounted on said holder with provision for movement in a path crosswise of the axis of angular movement of the holder, a dressing instrument on said carriage, a relatively stationary former having a cam surface which is a curve generated from a base circle concentric with said axis, an abutment carried by said carriage holder in engagement with said cam surface and being movable on the holder in a path tangent to said concentric circle, and a lever pivotally coupled with said abutment, carriage and holder.

2. A dressing apparatus for creating a prescribed profile in a cutting tool, comprising an angularly movable carriage holder, a carriage mounted on said holder with provision for movement in a path crosswise of the axis of angular movement of the holder, a dressing instrument on said carriage, a relatively stationary former having a cam surface which is a curve generated from a base circle concentric with said axis, an abutment carried by said carriage holder in engagement with said cam surface and being movable on the holder in a path tangent to said concentric circle, and a lever pivotally coupled with said abutment, carriage and holder, the carriage being adjustable on the holder to alter the distance of its path from the axis, and the pivot coupling of the carriage with the lever being adjustable at the same time and in proportional degree.

3. An apparatus of the character set forth, comprising a dressing tool, an angularly movable holder, a guide member on which said dressing tool is supported movably and constrained to move in a given path transverse to the axis about which said holder is movable, which guide member is mounted on the holder adjustably with provision for displacement in directions transverse to both said axis and said path, whereby to vary the distance of the path from the axis, a relatively stationary cam, a cam follower supported movably on the holder in engagement with the cam, and proportional motion mechanism operatively engaged with the holder, dressing tool and cam follower arranged to transmit motion from said cam follower to the dressing tool.

4. A wheel dressing apparatus comprising a cam and a holder, one of which is stationary and the other is movable angularly about an axis, a cam follower supported movably on said holder in engagement with the cam to be displaced thereby relatively to the holder in consequence of relative rotation between the holder and cam, an adjustable guide on the holder, a dressing tool carrier movable along said guide, the paths of the carrier and cam follower being parallel to each other and transverse to said axis, and the adjustability of the guide being transverse to both paths and the axis, a lever pivotally connected to the holder and cam follower, and a shiftable pivotal engagement between said lever and the dressing tool carrier.

5. A wheel dressing apparatus comprising a cam and a holder, one of which is stationary and the other is movable angularly about an axis, a cam follower supported movably on said holder in engagement with the cam to be displaced thereby relatively to the holder in consequence of relative rotation between the holder and cam, an adjustable guide on the holder, a dressing tool carrier movable along said guide, the paths of the carrier and cam follower being parallel to each other and transverse to said axis, and the adjustability of the guide being transverse to both paths and the axis, a lever having fulcrum connection with the holder on a line radial to the axis and parallel to the before-mentioned paths, said lever being also pivotally connected with the cam follower on an axis lying in the path of the follower, and a pivot carried by the dressing tool carrier in shiftable engagement with the lever.

6. A dressing or truing apparatus for the purpose set forth, comprising a housing, a holder rotatably mounted on said housing for movement about an axis, said housing being displaceable in a direction transverse to said axis, a guide member mounted on the holder, a dressing tool carriage mounted on said guide with provision for movement in a line tangential to a circle centered on said axis, a former secured to the housing having a cam face formed as a curve generated from a base circle concentric with said axis, a cam follower or abutment slidingly mounted on said holder for movement in a path parallel to that of the dressing tool carriage, a lever pivotally connected with said abutment and having fulcrum connection with the holder, said pivotal and fulcrum connections being in a line transverse to the paths of movement of the carriage and abutment with changing angularity relative thereto when the abutment traverses said cam surface in consequence of angular movement of the holder, said carriage guide being shiftable on the holder in directions transverse to the path of the carriage, and the carriage having simultaneously shiftable engagement with said lever centered in the path of movement of the carriage, means for swinging said holder through a limited arc, and means for causing displacement of the housing in the before stated direction when the holder has arrived at the prescribed limit of its swinging movement.

7. A dressing or truing apparatus comprising a pivotally supported housing, a quill rotatably

mounted in said housing on an axis transverse to the pivotal axis thereof, a cam secured to the quill, a support on which the cam rests and, by cooperation of which with the surface of the cam, the position of the housing angularly about its pivot axis is controlled, a shaft coaxial with said quill rotatably contained therein, a holder secured to the shaft, a dressing tool carriage mounted on said holder, mechanism cooperating between the housing and said carriage for imparting a translative component of movement to the carriage when the shaft and holder are rotated, means for rotating the quill, yielding means for imparting rotation to the shaft simultaneously with the quill, and a stop for arresting rotation of the shaft at a prescribed point and permitting continued rotation of the quill, the surface of said cam being concentric with the axis of the quill throughout the arc of rotation in which the shaft approaches said stop, and being eccentric to the axis through a further angle throughout which the quill is rotated after arresting of the shaft.

8. A dressing apparatus comprising a holder supported with provision for angular movement about an axis, a dressing tool carriage mounted on said holder with provision for displacement thereon in a path tangent to a circle concentric with said axis, means for swinging the holder about said axis, means actuated by the holder in its angular movement about said axis for simultaneously imparting a component of translation to the carriage for causing the dressing tool to trace a curve other than concentric with the axis, and means for causing displacement of the holder, carriage and pivot axis of the holder together in a substantially straight line, whereby to cause movement of the dressing tool in a substantially straight line tangent to said curve.

9. A dressing apparatus for generating surfaces of involute profile in grinding wheels comprising a stationary former having an involute face curve, a holder supported for angular movement about the center of the base circle of said face curve, a follower supported and guide on said holder for movement in a path tangent to said base circle and being arranged to bear on the curved face of the former, a dressing tool carrier mounted on the holder with provision for guided movement thereon in a path parallel to that of said follower, and a ratio lever pivotally connected with the follower and having a fulcrum engagement with the holder and a pivotal engagement with the dressing tool carrier for imparting to the latter translative movements proportional to the translative movements of the follower.

10. A dressing apparatus for generating surfaces of involute profile in grinding wheels comprising a stationary former having an involute face curve, a holder supported for angular movement about the center of the base circle of said face curve, a follower supported and guided on said holder for movement in a path tangent to said base circle and being arranged to bear on the curved face of the former, a plate mounted on the holder with provisions for adjustment thereon in a path transverse to the path of said follower, a dressing tool carrier mounted movably on said plate and guided to move in a path parallel to that of the cam follower, a ratio lever having pivotal and fulcrum connections with the follower and holder and a contact surface extending in the same direction as the line of centers of said pivot and fulcrum connections, and a stud on the dressing tool carrier overlapping and engaging said contact surface for moving said carrier in consequence of angular movements of the lever, said stud being movable to different positions along said contact surface in consequence of adjustments of said plate.

11. A dressing apparatus for generating surfaces of involute profile in grinding wheels comprising a stationary former having an involute face curve, a holder supported for angular movement about the center of the base circle of said face curve, a follower supported and guided on said holder for movement in a path tangent to said base circle and being arranged to bear on the curved face of the former, a dressing tool carrier mounted on the holder with provision for guided movement thereon in a path parallel to that of said follower, a ratio lever pivotally connected with the follower and having a fulcrum engagement with the holder and a pivotal engagement with the dressing tool carrier for imparting to the latter translative movements proportional to the translative movements of the follower, and means for shifting said holder in a manner to cause displacement of its axis of angular motion in a plane substantially radial to said base circle.

12. A dressing apparatus for generating surfaces of involute profile in grinding wheels comprising a stationary former having an involute face curve, a holder supported for angular movement about the center of the base circle of said face curve, a follower supported and guided on said holder for movement in a path tangent to said base circle and being arranged to bear on the curved face of the former, a plate mounted on the holder with provisions for adjustment thereon in a path transverse to the path of said follower, a dressing tool carrier mounted movably on said plate and guided to move in a path parallel to that of the cam follower, a ratio lever having pivotal and fulcrum connections with the follower and holder and a contact surface extending in the same direction as the line of centers of said pivot and fulcrum connections, a stud on the dressing tool carrier overlapping and engaging said contact surface for moving said carrier in consequence of angular movements of the lever, said stud being movable to different positions along said contact surface in consequence of adjustments of said plate, and means for shifting said holder in a manner to cause displacement of its axis of angular motion in a plane substantially radial to said base circle.

13. An apparatus for dressing grinding wheels, comprising a dressing tool, a holder on which said tool is supported with provision for linear movement relatively to the holder, said holder being mounted pivotally to turn about an axis at one side of the path thereon in which the dressing tool has its linear movement, mechanism correlated with said holder and tool to cause the tool to move relatively to the holder in its path of linear movement when said holder is turned about said axis, and provisions whereby the distance between said axis and path may be altered.

14. A dressing apparatus as set forth in claim 13, combined with correlated means for turning the holder and then causing the pivotal support of said holder, and therewith the holder and the dressing tool, to be shifted after the holder has arrived at a predetermined position in its angular movement.

15. A dressing apparatus for generating a prescribed profile in the active portion of a cutting

tool, comprising a dressing instrument, a carriage on which said dressing instrument is mounted, a holder for said carriage mounted to be angularly movable about an axis, having guide means for the carriage whereon the latter is translatively movable in a path transverse to said axis, means for causing the carriage to be so moved relatively to the holder when the holder is turned about said axis, and means for altering the position of said guide means on the holder so as to locate the path of translative movement of the carriage at different distances from said axis.

16. An apparatus of the character set forth, comprising an angularly movable holder, a dressing tool carriage mounted on said holder with provision for translative movement relatively thereto in a path tangent to a base circle concentric with the axis of angular movement of the holder, a dressing tool secured to said carriage, means controlled by the holder in the course of its angular movement for causing the carriage to be moved relatively to the holder in said tangent path at a rate such that the dressing tool traces a curve developed from such base circle, and means for shifting said carriage relatively to the holder and to the means by which the carriage is moved translatively so that the distance from such axis of the path in which the carriage moves and the rate of its translative movement are altered, whereby the dressing tool is enabled to generate the characteristic curve from a different base circle.

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