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[54] **MOUNTING ARRANGEMENT FOR A GRINDING WHEEL DRESSING DEVICE**

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[58] **Field of Search** ..... 51/5 D, 126, 109 R, 71, 51/99, 288, 287, 325

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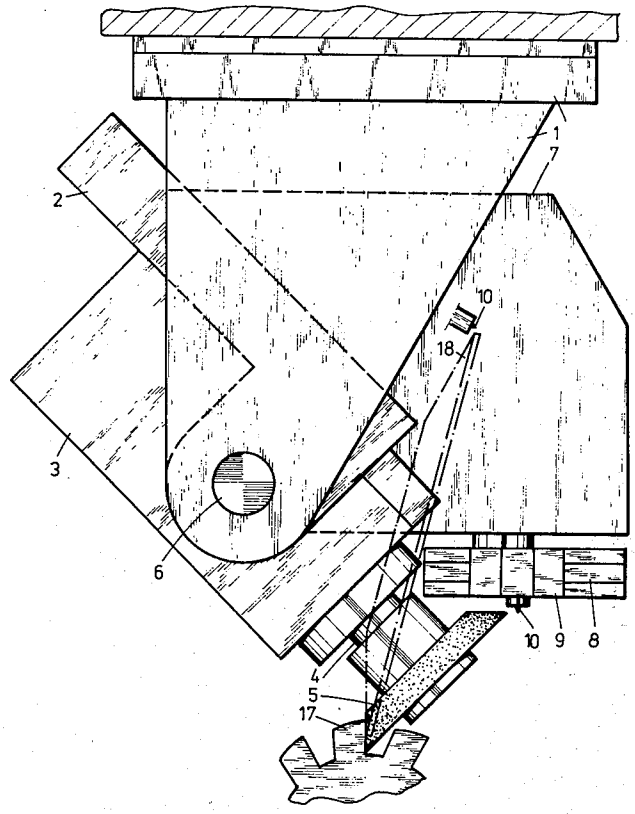
[57] **ABSTRACT**

A grinder for gear cutters with a grinding wheel dressing device attached thereto in which the grinding wheel spindle stock and the dressing device are coaxially pivotable and rotationally interconnected by planetary worm gear drives and spur gears so as to positively set the angular position of the dressing device as a function of the angular position of the grinding spindle.

10 Claims, 3 Drawing Figures



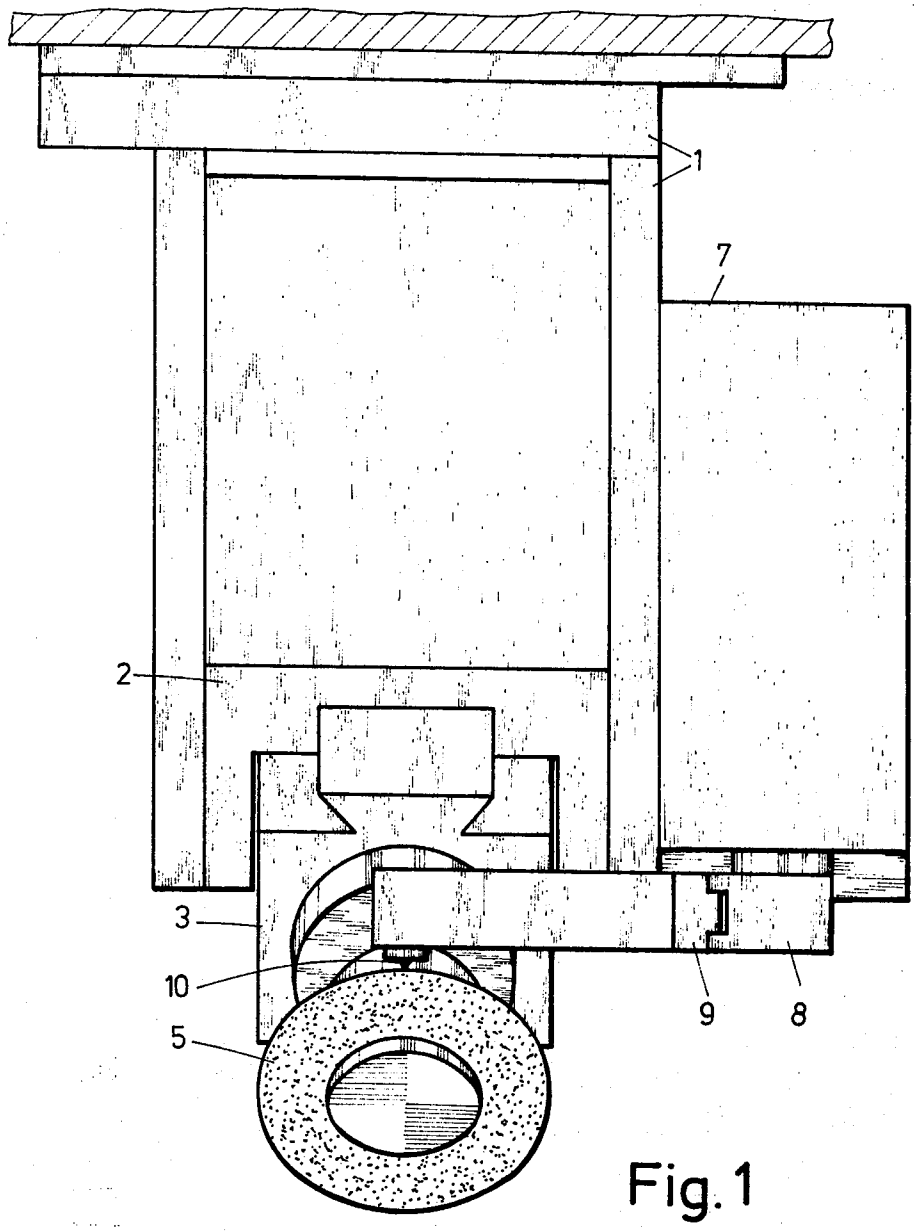


Fig. 1

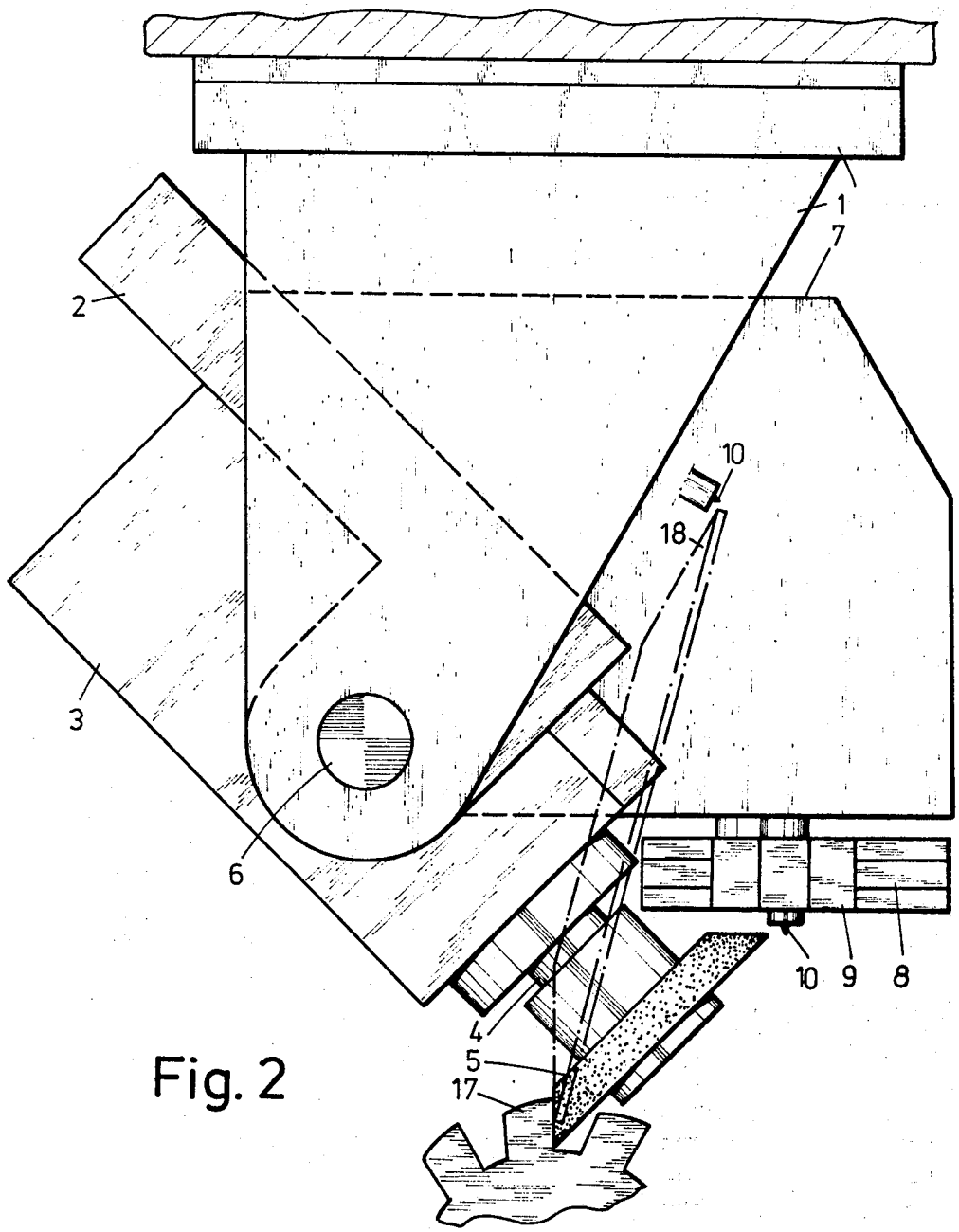


Fig. 2

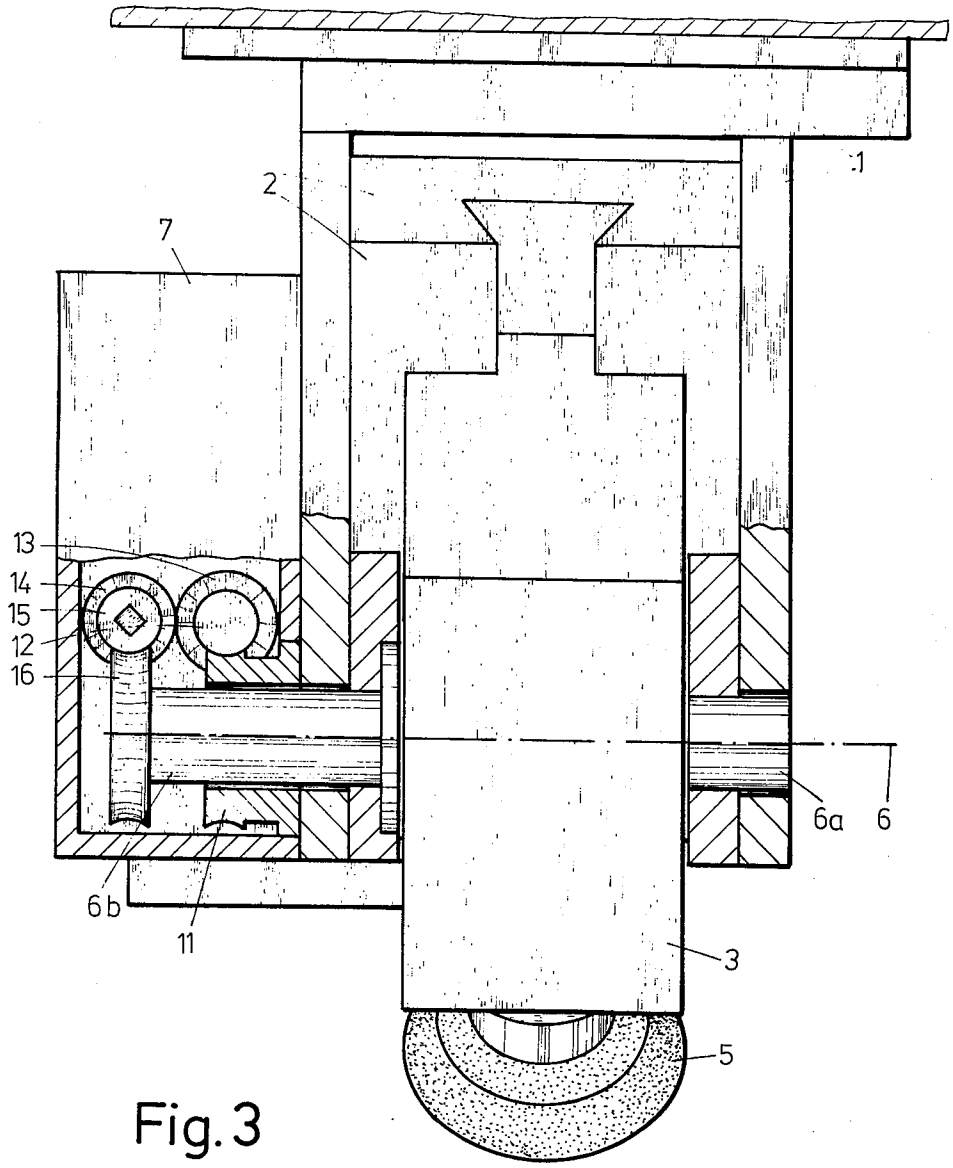


Fig. 3

MOUNTING ARRANGEMENT FOR A GRINDING WHEEL DRESSING DEVICE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to devices for the dressing of grinding wheels, and in particular to dressing devices which are directly attached to grinding wheel spindle stocks, such as those used for the grinding of gear tooth cutters and the like.

2. Description of the Prior Art

In order to retain the true profile of the radially relieved teeth of envolute gear cutters after repeated regrinding of the cutter tooth faces, it is necessary that the orientation of these faces remains unchanged in relation to the center axis of a cutter. This means that for a rake angle of zero degrees the extension of the tooth face direction passes through the cutter axis. In the case of straight-fluted cutters, it is common to grind the tooth faces by means of shallow tapered disk wheels whose straight taper contour is obtained by means of a grinding wheel dressing device which is displaced along a straight line. Helically fluted gear cutters, on the other hand, when ground with this type of grinding wheel, have a tooth face which is convex in planar cross section and to which the theoretical tooth face line is a tangent. This undesirable convexity decreases with decreasing grinding wheel diameters and increasing angles of grinding wheel taper. It then becomes necessary to very accurately adjust the dressing device to the selected angle of taper.

Known grinding wheel dressing devices, in order to circumvent the necessary adjustments, provide for the dressing point to move along that taper line of the grinding wheel which is in the grinding position and which, in the case of a zerodegree rake angle is perpendicular to the cutter axis. But, because this taper line is the one which represents the contact line between the grinding wheel and the tooth face, dressing requires that the grinding operation be interrupted. Such interruptions represent costly downtime and are therefore a disadvantage.

Other known dressing devices provide for the dressing point to move along a different taper line, adjustment being made by means of special gauges. These adjustments in turn are timeconsuming and sometimes complicated.

Lastly, there also exist known special cutter grinding units which are adapted for the use of very small and steeply tapered grinding wheels for the purpose of minimizing the tooth face alignment error. The problem with these units is that they frequently require an additional device for the dressing of the grinding wheel.

SUMMARY OF THE INVENTION

It is a primary objective of the present invention to overcome the above shortcomings and to suggest a mounting arrangement for a grinding wheel dressing device in conjunction with gear cutter grinding units which permits the dressing of grinding wheels of both small and large diameters, and with steep and shallow wheel tapers, in a simplified operation and at a minimal cost.

In order to attain the above objective, the invention suggests that the grinding wheel dressing device be pivotally attached to the grinder base, the pivot axis being perpendicular to the axis of the grinder spindle and coincident with the pivot axis of the pivotable spindle stock carrier.

In a preferred embodiment of the invention is further provided a rotational drive connection between the spindle stock carrier and the wheel dressing device which, when the spindle stock carrier is rotated in relation to the grinder base, executes a proportional angular motion of the wheel dressing device in relation to the spindle stock carrier.

For this purpose, the invention suggests a rotational drive connection including a first gear which is solidary with the grinder base, a second gear which is solidary with the spindle stock carrier, and a train of several gears interconnecting the first and second gears. The overall translation of this rotational drive is such that the rotational angle executed by the wheel dressing device is in each case twice the rotational angle executed by the spindle stock carrier in relation to the fixed grinder base.

An additional feature of the preferred embodiment of the invention suggests a grinder base having an overall shape of an inverted "U", the spindle stock carrier being pivotally supported between the parallel legs of the base. The pivot support preferably consists of two trunnions extending laterally from the spindle stock carrier into journals inside the base legs, one of the trunnions extending into the housing of the wheel dressing device where it carries the earlier-mentioned second gear which, by cooperating with the fixed first gear which is attached to the adjacent leg of the grinder base, angularly positions the wheel dressing device in relation to the spindle stock carrier.

A pivoting adjustment of the grinder around an axis which is perpendicular to the cutter axis, as for example, the adjustment for helical cutter flutes, does not affect the angular adjustment of the wheel dressing device in relation to the grinding wheel. However, when the grinding wheel is to be pivoted around an axis which is perpendicular to the grinder spindle axis, for example, when a more steeply tapered grinding wheel is to be used, the device of the invention automatically provides an accurate resetting of the displacement direction of the dressing point in accordance with the new taper outline. This is achieved by having a common pivot axis for the dressing device and the spindle stock carrier and by providing a rotational drive connecting the grinder base, spindle stock carrier, and dressing device so that the latter executes twice the angular displacement of the spindle stock carrier in relation to the grinder base.

The primary advantage of the novel grinding wheel dressing device of the invention is its versatility of application, without the need for additional adjustment devices, making it suitable for a broad range of grinding wheel diameters and wheel taper angles. Furthermore, the device is extremely simple in construction and therefore inexpensive to manufacture. Additional savings of investment costs are achieved through the fact that the wide range of pivotability of the spindle stock carrier and of the wheel dressing device eliminates the need for a special cutter grinding unit for small, steeply angled grinding wheels.

BRIEF DESCRIPTION OF THE DRAWINGS

Further special features and advantages of the invention will become apparent from the description follow-

ing below, when taken together with the accompanying drawings which illustrate, by way of example, an embodiment of the invention, represented in the various figures as follows:

FIG. 1 is a frontal end view of a grinding unit with a grinding wheel dressing device embodying the invention;

FIG. 2 is an elevational side view of the device of FIG. 1; and

FIG. 3 is a rear end view of the device of FIG. 1, a partial vertical cross section exposing the rotational drive connection.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In FIGS. 1–3 is illustrated a grinding unit which is part of a grinding machine (not shown). It consists essentially of a grinder base with two parallel downwardly extending legs in the form of an inverted "U," which carry between them a pivotable spindle stock carrier **2**, which in turn carries a longitudinally adjustable spindle stock **3** with a grinding spindle **4** and a grinding wheel **5**.

The pivotable support between the grinder base **1** and the spindle stock carrier **2** is provided in the axis **6** (see FIG. 3) in which the spindle stock carrier has attached to it two trunnions **6***a* and **6***b* engaging appropriate journal bearings in the grinder base legs.

On one side of the grinder base **1** is mounted a grinding wheel dressing unit **7** which is likewise pivotable around the earlier-mentioned axis **6**. This dressing unit **7** includes a guide arm **8** along which a dressing head with a dressing point **10**, for example a diamond, is longitudinally movable by means of a carriage **9**.

The pivot trunnion **6***b* on the side of the dressing unit extends laterally through the grinder base leg into the housing of the dressing device **7**. Surrounding the trunnion **6***b* and nonrotatably attached to the grinder base leg is provided a first worm gear, or base worm gear **11** which is engaged by a cooperating worm **12** journalled in said housing. A second worm gear, or trunnion worm gear **16** is attached to the far end of trunnion **6***b* and cooperates with a worm **15** which is similarly journalled in the housing. The worms **12** and **15**, in turn, are interconnected by means of spur gears **13** and **14** in the manner of a planetary gear train. The housing of the dressing unit **7** is arranged for rotation in relation to the grinder base **1** by being supported on a shoulder of the worm gear **11**, its angular position being determined by the angular position of the trunnion worm gear **16** in relation to the fixed based worm gear **11**.

Referring to FIG. **2**, it can be seen that the grinding of the cutting faces of a gear cutter teeth **17** requires a pivoting adjustment of the spindle stock carrier **2** and a longitudinal adjustment of the spindle stock **3** so that the taper line of the grinding wheel **5** is properly oriented in relation to the cutter axis (not shown). The grinding wheel dressing device **7** of the invention is so arranged that it can dress the grinding wheel **5** on the grinding locus, i.e. the taper line which is diametrically opposite to the taper line engaging the tooth face. Thus, when the angular orientation of the grinding spindle **4** is readjusted for a different grinding wheel taper, the orientation of the dressing point guide arm **8** must accordingly be adjusted by twice the angular displacement of the spindle stock carrier in relation to the grinder base **1**.

This relationship is illustrated in FIG. **2**, where the spindle stock carrier **2** with the spindle stock **3** and grinding wheel **5** is inclined at approximately 45° from the vertical direction so that a grinding wheel **5** with a 45° taper angle defines a vertically oriented tangential grinding plane, producing a vertical cutting face on the gear cutter tooth **17**. In this case the dressing device **7** is oriented for a dressing point movement which is at an angle of 90° in relation to the vertical direction of the grinding plane. Thus, the angular deviation of the dressing point movement from the vertical grinding plane is twice the angular deviation of the spindle axis from said grinding plane. Accordingly, when a larger diameter grinding wheel **18** with a smaller angle of taper (indicated in FIG. **2** by thin lines) is used, the spindle axis may have to be inclined at an angle of 75° from the grinding plane. In this case the corresponding displacement path of the dressing point **10** is rotated from the grinding plane by an angle of 150°.

The angular adjustment motion of the spindle stock carrier **2** in relation to the grinder base **1** and the consequent angular motion of the wheel dressing unit **7**, which is of equal angle in relation to the spindle stock carrier **2** and therefore twice that angle in relation to the grinder base **1**, is obtained as a continuous adjustment motion through rotation of the worm **15**. For this purpose, the shaft carrying worm **15** may include suitable cranking means. The two spur gears **13** and **14** which interconnect the worms **12** and **15** are preferably identical in size, and the two worm gear drives **11, 12** and **15, 16** are preferably likewise identical in diameter. However, in order to obtain the necessary translation for the double angular displacement of the wheel dressing unit **7**, the worms **12** and **15** have opposite helices, the helix angle of the base worm gear drive **11, 12** being larger than that of trunnion worm gear drive **15, 16** so that the translation ratio of the former is double that of the latter. At least the smaller helix angle of gears **15, 16** is preferably selflocking, i.e. small enough to make the drive non-reversing, under a force acting on the trunnion worm gear **16**.

The angular adjustment of the orientation of the dressing guide arm **8** is thus obtained automatically and positively for each size and taper angle of the grinding wheel **5**. Of course, the displacement path of the dressing point **10** need not always be a straight line, as in the case with the straight-line guide of arm **8**. This displacement path could for instance also be made curved for the dressing of a convexly corrected grinding contour, in order to compensate for the earlier mentioned distortion in connection with helically fluted gear cutters.

It should be understood, of course, that the foregoing disclosure describes only a preferred embodiment of the invention and that it is intended to cover all changes and modifications of this example of the invention which fall within the scope of the appended claims.

I claim:

1. In a milling cutter grinding machine equipped with means for holding and rotationally indexing milling cutters, and adapted especially for the grinding and regrinding of the cutting faces of profile cutters, such as envolute gear cutters and the like, a grinding and grinding wheel dressing device comprising in combination:

a grinder base;

a spindle stock assembly supported by the grinder base, said assembly including a grinder spindle carrying a grinding wheel mounted on one end

thereof; the grinding wheel having a frustum-shaped outline, with a tapered peripheral grinding face oriented radially outwardly and axially toward the spindle stock, a tangent plane to said grinding face being the grinding plane;

means for pivotally adjusting the spindle stock assembly in relation to the grinder base about a pivot axis which perpendicularly intersects the spindle axis at a distance from the grinding wheel, and which also extends parallel to said grinding plane;

a grinding wheel dressing head carrying a dressing point;

means for guiding the dressing head for displacement of the dressing point along a path which determines the outline of said grinding face taper at a place on the grinding face that is located diametrically opposite the grinding locus, i.e. that place which is common to the grinding face and the tangential grinding plane; and

means for pivotingly reorienting the dressing head path, by way of pivotally adjusting the dressing head guide means, about the axis of pivotal adjustment of the spindle stock assembly.

2. A device as defined in claim **1,** further comprising:

mechanical translation means between said spindle stock assembly pivoting means and said dressing head path reorienting means for creating a positive interdependence between the angular positions of the grinder spindle and of the dressing head guide means in reference to the grinder base.

3. A device as defined in claim **2,** wherein:

said mechanical translation means interconnects the spindle stock assembly pivoting means and the dressing head path reorienting means in such a way that a given angular displacement of the former requires twice that angular displacement of the latter in reference to the grinder base.

4. A device as defined in claim **3,** wherein:

said mechanical translation means is a gear drive which rotationally interconnects the dressing head path reorienting means with the grinder base on the one hand and with the spindle stock assembly pivoting means on the other hand.

5. A device as defined in claim **1,** wherein:

the spindle is journalled to the spindle stock assembly, and the spindle stock assembly pivoting means includes a first pivot connection between the spindle stock assembly and the grinder base;

the dressing head guide means is part of a dressing unit; and

the dressing head path reorienting means includes a second pivot connection between the dressing unit and the grinder base which is coaxial with said first pivot connection.

6. A device as defined in claim **5,** wherein:

the grinder base is generally U-shaped, having two parallel spaced legs as part of said shape;

the spindle stock assembly is arranged between the base legs and includes a spindle stock and a spindle stock carrier relative to which the spindle stock is longitudinally adjustable; and

the first pivot connection is defined between the spindle stock carrier and the two base legs and includes oppositely extending trunnions attached to the spindle stock carrier and journalled in said legs.

7. A device as defined in claim **6,** wherein:

one of the trunnions of the first pivot connection is elongated to extend laterally beyond the respective base leg and includes a trunnion gear attached thereto;

said grinder base leg has a base gear nonrotatably attached thereto in concentric relationship with the elongated trunnion; and

the dressing unit encloses the elongated trunnion by forming said coaxial second pivot connection with the grinder base while further including: a planetary gear train mounted in the dressing unit, the gear train engaging said trunnion gear with one end of the train and said base gear with the other end of the train, whereby a given angular displacement of the trunnion gear in relation to the base gear determines twice that angular displacement of the planetary gear train in relation to the base gear.

8. A device as defined in claim **7,** wherein:

the trunnion gear and the base gear are worm gears and the ends of the gear train are cooperating worms, the gear train further including two shafts mounted in the dressing unit and carrying said worms, and two cooperating spur gears on the two shafts connected to the worms, respectively.

9. A device as defined in claim **8,** wherein:

the two spur gears of the gear train are identical; and

the two worms and cooperating worm gears on the trunnion and base leg, respectively, are substantially identical in diameter, but have opposite helix angles, the helix angle of the trunnion worm gear being greater than the helix angle of the base worm gear for a gearing ratio which is twice that of the latter.

10. A device as defined in claim **8,** wherein:

the helix angle of at least one worm gear is small enough to render it self-locking, i.e. non-reversible; and

the gear train further includes means for manually cranking it.

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