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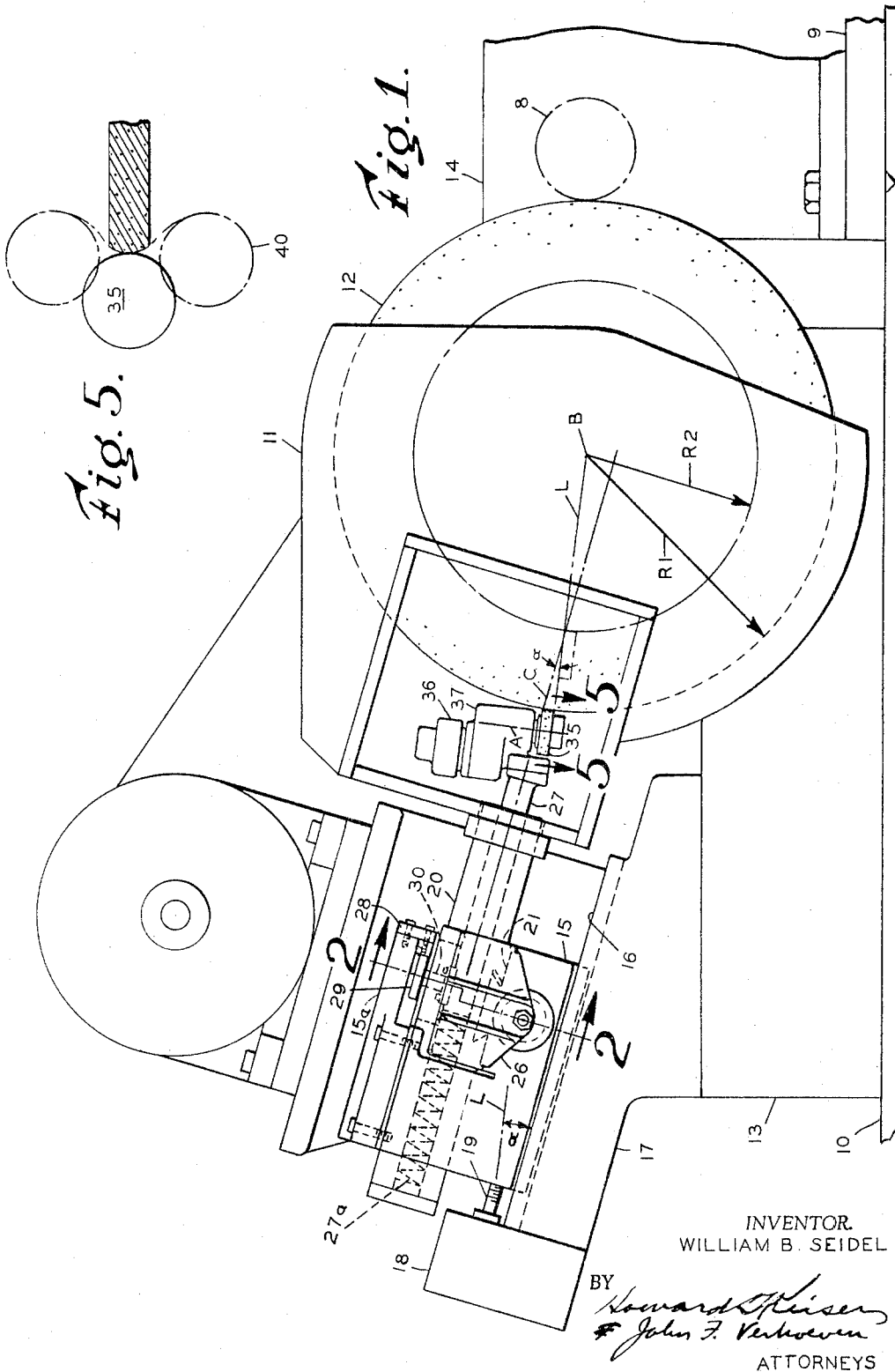
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METHOD AND APPARATUS FOR DISTRIBUTING WEAR OF TRUING ROLLER

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2 Sheets-Sheet 1



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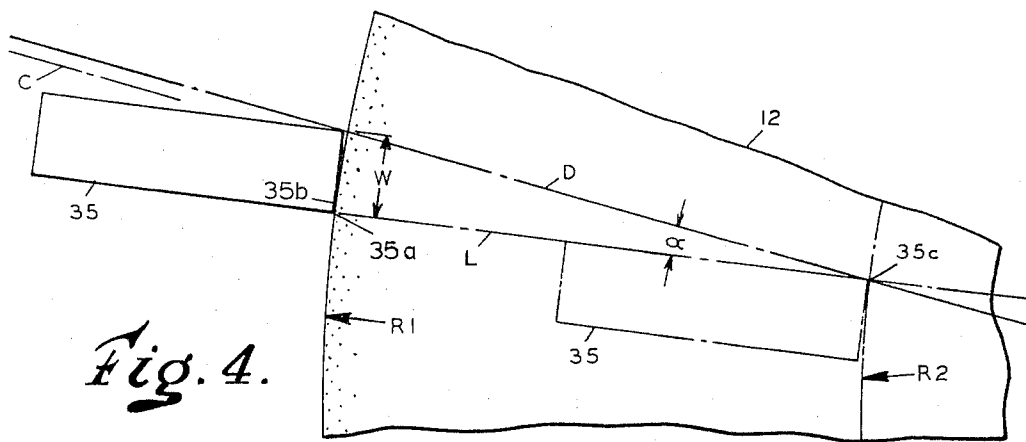
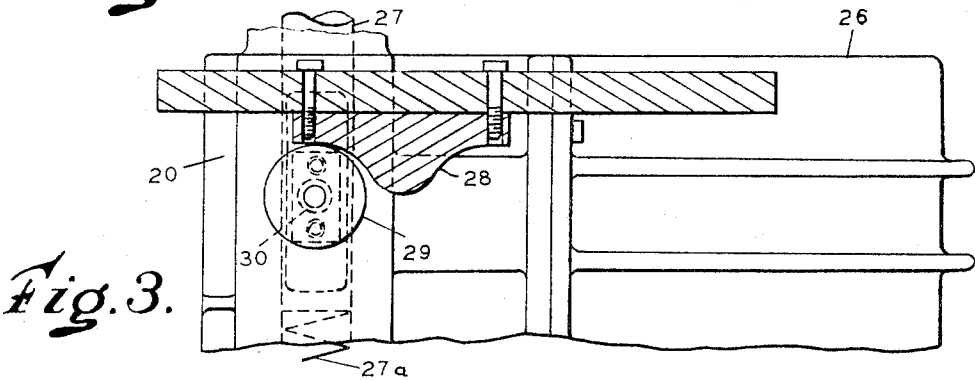
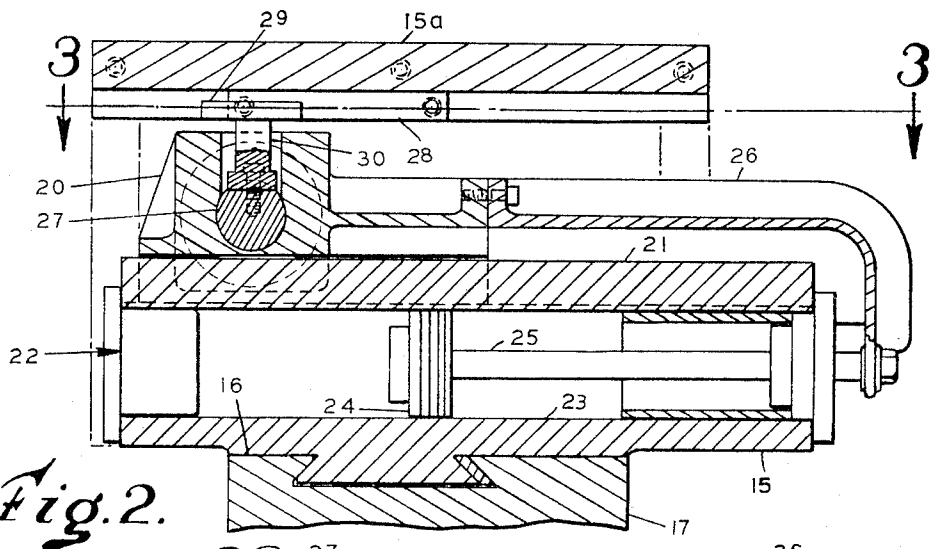
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METHOD AND APPARATUS FOR DISTRIBUTING WEAR OF TRUING ROLLER

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9 Claims. (Cl. 125—11)

The present invention relates to the truing of a grinding wheel with a truing roller.

Rollers, such as costly diamond impregnated rollers, have been used heretofore to true grinding wheels. It is important, particularly with the more expensive rollers, to minimize the wear of the truing roller resulting from successive truing cuts on the grinding wheel. Generally, the smaller the area of the roller engaged with the grinding wheel at any instant, the greater the wear the roller will undergo. For that reason, truing an arcuate profile on a grinding wheel with a roller which makes only point contact with the grinding wheel produces rapid wear on the roller and it is to this type of truing operation that the present invention is directed.

In the present invention, as in the prior art, the roller makes point contact with an arcuate profile on a grinding machine, but, unlike the prior art, the wear is distributed over the periphery of the roller as successive truing cuts are taken. More specifically, in the preferred form of the invention, a cylindrical roller is oriented transverse to the grinding wheel and, for the first truing cut on the grinding wheel, the roller is positioned relative to the grinding wheel so that one edge of the periphery of the roller makes point contact with the grinding wheel during the initial truing cut. The roller is fed into the grinding wheel in discrete increments, and, between each incremental feed movement, the roller is moved across the grinding wheel in a truing cut. As successive truing cuts are made, the relative positioning between the roller and the wheel is changed so that, on successive truing cuts, the point of contact of the roller with the grinding wheel moves across the periphery of the roller. In this manner, wear of the roller is distributed evenly across the entire face of the truing roller.

It is therefore one object of the present invention to minimize wear on a truing roller. It is another object of the present invention to distribute the wear on a truing roller. It is yet another object of the present invention to distribute the wear of a cylindrical truing roller across the entire periphery thereof.

Other objects and advantages of the present invention should be readily apparent by reference to the following specification, considered in conjunction with the accompanying drawings forming a part thereof, and it is to be understood that any modifications may be made in the exact structural details there shown and described, within the scope of the appended claims, without departing from or exceeding the spirit of the invention,

In the drawings:

FIG. 1 is a fragmentary side view, in elevation, of a grinding machine incorporating the present invention;

FIG. 2 is an enlarged view taken on the line 2—2 of FIG. 1;

FIG. 3 is a view taken on the line 3—3 of FIG. 2;

FIG. 4 is schematic diagram, taken as the view of FIG. 1, showing the position of the truing roller relative to the grinding wheel during an initial truing cut in solid lines, and showing the position of the truing roller relative to the grinding wheel during the final truing cut in phantom lines; and

FIG. 5 is an enlarged view taken on the line 5—5 of FIG. 1.

There is shown in FIG. 1 a portion of the base 10 of

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a center-type grinding machine. A wheelhead 11, having a rotatable grinding wheel 12 therein, is secured on a lower support 13 mounted on base 10. A table 9 is mounted on the base 10 and carries a headstock 14 and tailstock (not shown). A workpiece 8 is received between the headstock and tailstock and rotated for a grind thereon. For purposes of illustration, the operation on the workpiece may be considered as a plunge grind operation in which the table 9 is held fixed on the base 10. Relative movement between the grinding wheel and the workpiece, for producing the plunge grind on the workpiece and for compensating for the diminution of the grinding wheel as successive truing cuts are taken thereon, is effected by moving the lower support 13 on the base 10 by a motor (not shown).

In order periodically to true the grinding wheel, a truing feed member, or feed slide 15, is mounted on ways 16 of an upper support 17 which is secured to the lower support 13. A step motor 18 connected to upper support 17 drives a screw 19 which is threadably engaged with truing feed member 15. Momentary energization of step motor 18 produces a predetermined incremental rotation of screw 19 which advances feed member 15 a predetermined incremental amount toward the grinding wheel 12.

A cross slide, or carriage, 20 is mounted on ways 21 of feed member 15 which extend in a direction perpendicular to the direction of movement of feed member 15. A motor 22 comprises a cylindrical chamber 23 in feed member 15 and a piston 24 slidably received in the chamber. A piston rod 25 is connected to piston 24 and extends from the chamber 23. A bracket 26 secured to piston rod 25 is connected to cross slide 20 for reciprocation thereof when fluid pressure is introduced to chamber 23 alternately on one side and then the other of piston 24 by means not shown.

The cross slide 20 has a truing bar 27 slidably received therein which extends in a direction perpendicular to the direction of movement of cross slide 20 and parallel to the direction of movement of feed member 15. The feed member 15 has an upper plate 15a extending over the cross slide 20. Plate 15a has a cam 28 secured thereto which is engaged by a roller 29 mounted on a stud 30 secured to the truing bar 27. Spring 27a urges bar 27 toward wheel 12. A cylindrical truing roller 35 and a motor 36 for the rotation thereof are mounted on a truing roller support 37 at the forward end of the truing bar. The truing roller 35 is oriented transversely to the grinding wheel 12.

Assume that a large group of workpieces 8 are to be successively ground, and a new grinding wheel 12, having an initial radius R1, is mounted in the machine. A cylindrical truing roller which is oriented transverse to the grinding wheel will make only point contact with the grinding wheel as it moves across the grinding wheel to true the periphery thereof (see FIGS. 1 and 4). The truing roller 35 is positioned relative to the truing bar with one edge 35a of the periphery of the roller 35 in a plane L through the center of the grinding wheel as the cross slide 20 moves across the feed member 15 for the initial truing cut on the grinding wheel 12. The cam 28 has an arcuate shape, as shown in FIG. 3, to move the truing bar axially in cross carriage 20 and cause the roller 35 to follow an arcuate path (as shown in FIG. 5) as it moves across the wheel to put an arcuate profile on the grinding wheel. The alignment of the roller 35 with respect to the grinding wheel 12 remains unchanged as the roller moves across the grinding wheel for a truing cut, and it is only the lower edge 35a of the roller which makes contact with the grinding wheel during this initial truing cut.

After completion of the initial truing cut, the piston 24 is held at one extreme limit of its movement in cham-

ber 23, and the truing roller 35 is held to one side of the grinding wheel out of engagement therewith as indicated, for example, at 40 in FIG. 5. Usually, several workpieces are ground before a second truing cut is deemed necessary. To effect the second truing cut, the step motor 18 is momentarily energized to advance the feed member 15 an incremental amount. The ways 16 are parallel to the central longitudinal axis C of the truing bar but are inclined at an angle α to the plane L which contains the axis B of the grinding wheel. Thus, when the feed member 15 is advanced an incremental amount along ways 16, the roller is displaced laterally with respect to the plane L. Since the roller remains parallel to plane L, the roller is positioned with respect to the grinding wheel 12 for point contact at a point 35b (displaced on the periphery of the roller from the point of contact on the initial truing cut) when the motor 22 is subsequently operated to move the roller 35 across the grinding wheel. Because the roller 35 always lies in a plane which is not parallel to the direction of incremental advance of the roller into the grinding wheel for successive truing cuts, a different point on the roller 35 makes contact with the grinding wheel during successive truing cuts. In the specific embodiment of the invention shown, the roller 35 is maintained parallel to the plane L through the central axis of rotation of the grinding wheel, and the discrete feed movement of the roller 35 into the wheel are parallel to the line C inclined at the angle α to the plane L.

Stated another way, the cylindrical roller 35 may be considered as having a plurality of equally spaced planes extending therethrough normal to the axis A (parallel to plane L) and equal in number to the number of truing cuts which will be taken to reduce the size of the grinding wheel from an initial radius R1 to a final radius R2. The plane L may be considered as a radial plane of the grinding wheel which is fixed in space and not rotating with the grinding wheel. With axis A of the roller 35 normal to the radial plane L of the grinding wheel (which it is at all times), and the roller 35 positioned for intersection by the radial plane L, the point of contact of the periphery of the roller 35 with the grinding wheel (or, more accurately, the circle of contact of the periphery of the roller 35 with the grinding wheel, since the roller 35 is rotated by motor 36) is the point (or circle) on the roller plane which is aligned with the radial plane L. If, after each successive truing cut, the roller 35 has, in addition to a radial component of movement toward the grinding wheel, an axial component of movement transverse to the stationary plane L (maintaining axis A normal to plane L), a different roller plane will be aligned with plane L for each truing cut, and thus a different point (or circle) on the roller will engage the grinding wheel. This is accomplished by the incremental movement of the feed member 15, between each truing cut, parallel to the line C (inclined at some angle α to the plane L), which results in a radial component of movement of roller 35 parallel to plane L and an axial component of movement of roller 35 transverse to plane L while the axis A of the roller is held normal to the plane L. It will be noted that since there is movement of the roller not only along plane L but also transverse thereto, the roller is repositioned with respect to the grinding wheel on each incremental advance of feed member 15.

If the grinding wheel 12 is to be discarded when it has diminished to a final radius R2, the angle α is preferably the angle the tangent of which is equal to the width W of the roller 35 divided by the difference between the initial radius R1 of the grinding wheel and the final radius R2 of the grinding wheel. This is shown best in FIG. 4 where a line D, parallel to the line C and the ways 16, passes through the edge 35c opposite edge 35a of the truing roller 35 and intersects the plane L at radius R2 with the angle α between plane L and line D. With the angle α equal to the angle whose tangent equals

$$W/(R1-R2)$$

the edge 35c will make point contact with the grinding wheel during the final truing cut, as shown in phantom lines in FIG. 4. Thus the point of contact on the periphery of the roller which makes contact with the grinding wheel will have progressively moved across the periphery of the roller as successive truing cuts were made on the grinding wheel. In this manner, the wear on the roller 35 is distributed evenly across the periphery of the roller despite the fact that the roller only makes point contact with the grinding wheel on each truing cut.

What is claimed is:

1. A method of truing an arcuate profile on a grinding wheel with a cylindrical truing roller comprising,
 - (a) aligning the roller with the axis thereof perpendicular to a radial plane containing the axis of the grinding wheel,
 - (b) positioning the roller for point contact of one edge of the periphery of the roller with the periphery of the grinding wheel on said radial plane,
 - (c) moving the roller around the periphery of the grinding wheel and maintaining said one edge of the periphery of the roller in point contact with the periphery of the grinding wheel for an initial truing cut,
 - (d) advancing the roller in discrete increments for successive truing cuts on the grinding wheel along a line inclined with respect to said radial plane to move the point of contact of the roller with the grinding wheel across the roller as successive truing cuts are taken, and
 - (e) maintaining the axis of the roller perpendicular to said radial plane as the roller is advanced in discrete increments to maintain the point of contact between the periphery of the roller and the periphery of the grinding wheel in said radial plane.
2. In a grinding machine having a support, the combination comprising,
 - (a) a grinding wheel mounted on the support,
 - (b) a feed slide,
 - (c) a roller mounted for movement with the feed slide and having an axis fixed relative to the feed slide, said axis perpendicular to a radial plane containing the axis of the grinding wheel, said roller positioned for point contact of one edge of the periphery with the periphery of the grinding wheel in said radial plane when the feed slide is in a predetermined position for an initial truing cut on the grinding wheel,
 - (d) and ways on the support to receive the feed member for incremental movement in a straight line toward the grinding wheel from said predetermined position for successive truing cuts on the grinding wheel in said radial plane, said ways inclined at an angle to said radial plane to shift the point on the periphery of the roller which makes point contact with the periphery of the grinding wheel on each successive truing cut.
3. A method of truing an arcuate profile on a grinding wheel with a cylindrical truing roller comprising,
 - (a) aligning the roller with the axis thereof perpendicular to a radial plane containing the axis of the grinding wheel,
 - (b) positioning the roller for point contact of one edge of the periphery of the roller with the periphery of the grinding wheel,
 - (c) moving the roller around the periphery of the grinding wheel and maintaining said one edge of the periphery of the roller in point contact with the periphery of the grinding wheel for an initial truing cut,
 - (d) advancing the roller in discrete increments for successive truing cuts on the grinding wheel along a line inclined with respect to said radial plane to move the point of contact of the roller with the

grinding wheel across the roller as successive truing cuts are taken.

4. A method of taking successive truing cuts with a cylindrical truing roller to true an arcuate profile on a grinding wheel which diminishes in size from an initial radius to a final radius comprising,

- (a) aligning the roller with the axis thereof perpendicular to a radial plane containing the axis of the grinding wheel,
- (b) positioning the roller with one edge of the periphery in said radial plane for point contact of said one edge of the periphery of the roller with the periphery of the grinding wheel,
- (c) moving the roller around the periphery of the grinding wheel and maintaining said one edge of the periphery of the roller in point contact with the periphery of the grinding wheel for an initial truing cut,
- (d) advancing the roller in discrete increments for successive truing cuts on the grinding wheel along a line inclined relative to said radial plane at an angle having a tangent equal to the width of the periphery of the roller divided by the difference between the initial and final radius of the grinding wheel.

5. In a grinding machine having a support, the combination comprising,

- (a) a grinding wheel mounted on the support,
- (b) a feed slide,
- (c) a roller mounted for movement with the feed slide and oriented transverse to the grinding wheel, said roller having a point on the periphery lying on a radial plane through the axis of the grinding wheel when the feed slide is in a predetermined position,
- (d) and means to advance said feed slide toward the grinding wheel along a line inclined with respect to said radial plane.

6. In a grinding machine having a support, the combination comprising,

- (a) a grinding wheel mounted on the support,
- (b) a feed slide,
- (c) a roller mounted for movement with the feed slide and oriented transverse to the grinding wheel, said roller positioned for point contact of one edge of the periphery with the periphery of the grinding wheel as said carriage moves the roller across the axis of the grinding wheel when the feed slide is in a predetermined position for an initial truing cut on the grinding wheel,
- (d) and ways on the support to receive the feed member for incremental movement toward the grinding wheel from said predetermined position for successive truing cuts on the grinding wheel, said ways inclined at an angle to said radial plane to shift the point on the periphery of the roller which makes point contact with the periphery of the grinding wheel on each successive truing cut.

7. In a grinding machine having a support, the combination comprising,

- (a) a grinding wheel mounted on the support,
- (b) a feed slide movable from a predetermined position towards the grinding wheel in discrete increments,
- (c) a truing roller,
- (d) a carriage mounted on the feed slide to carry the truing roller across the grinding wheel for truing cuts between incremental movements of the feed slide, the truing roller positioned on the carriage for point contact of one edge of the periphery of the roller with the periphery of the grinding wheel on a radial plane through the axis of the grinding wheel as said carriage moves the roller across the periphery of the grinding wheel when the feed slide is in said predetermined position,

(e) and ways on the support to receive the feed member for movement thereof, said ways inclined at an angle to said radial plane to shift the point on the periphery of the roller which makes point contact with the periphery of the grinding wheel on each successive truing cut.

8. In a grinding machine having a support, the combination comprising,

- (a) a grinding wheel mounted on the support, said grinding wheel diminishing in size from an initial to a final radius,
- (b) a feed slide movable from a predetermined position towards the grinding wheel in discrete increments,
- (c) a truing roller,
- (d) a cross carriage mounted on the feed slide and movable thereon transversely to the direction of movement of the feed slide to carry the truing roller across the grinding wheel for truing cuts between incremental movements of the feed slide, the truing roller positioned on the carriage for point contact of one edge of the periphery with the periphery of the grinding wheel on a radial plane through the axis of the grinding wheel as said cross carriage moves the grinding wheel when the feed slide is in said predetermined position,
- (e) and ways on the support to receive the feed member for said incremental movement thereof toward the grinding wheel from said predetermined position, said ways inclined at an angle to said radial plane, said angle having a tangent equal to the width of the periphery of the roller divided by the difference between the initial and final radius of the grinding wheel.

9. In a grinding machine having a support, the combination comprising,

- (a) a grinding wheel mounted on the support, said grinding wheel diminishing in size from an initial to a final radius,
- (b) a feed slide movable towards the grinding wheel,
- (c) a cross carriage mounted on the feed slide and movable thereon transversely to the direction of movement of the feed slide,
- (d) a template mounted on the feed slide,
- (e) a truing bar mounted in the cross carriage and engaged with said template for movement in the cross slide parallel to the direction of movement of the feed slide,
- (f) a cylindrical truing roller mounted on the truing bar and positioned thereon for point contact of one edge of the periphery with the periphery of the grinding wheel on a radial plane through the axis of the grinding wheel as said cross carriage moves the roller across the periphery of the grinding wheel when the feed slide is in said predetermined position,
- (g) ways on the support to receive the feed member for said incremental movement, said ways inclined at an angle to said radial plane, said angle having a tangent equal to the width of the periphery of the roller divided by the difference between the initial and final radius of the grinding wheel,
- (h) means to move said feed slide on said ways from said predetermined position towards the grinding wheel in discrete increments of movement,
- (i) and means to move said carriage across the wheel between incremental movements of the feed slide.

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