July 16, 1946. R. A. THOMPSON 2,404,148

GRINDING WHEEL DRESSER

Filed Aug. 5, 1944 3 Sheets-Sheet 1

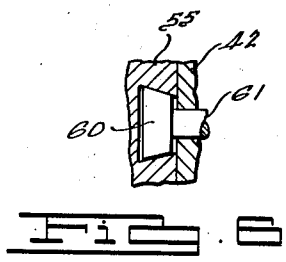


Fig. 2.



Fig. 1.

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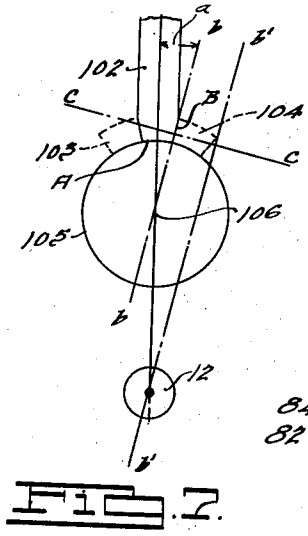



FIG. 1.

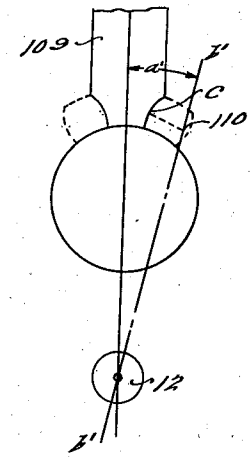



FIG. 3.




FIG. 2.

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Filed Aug. 5, 1944 3 Sheets-Sheet 3

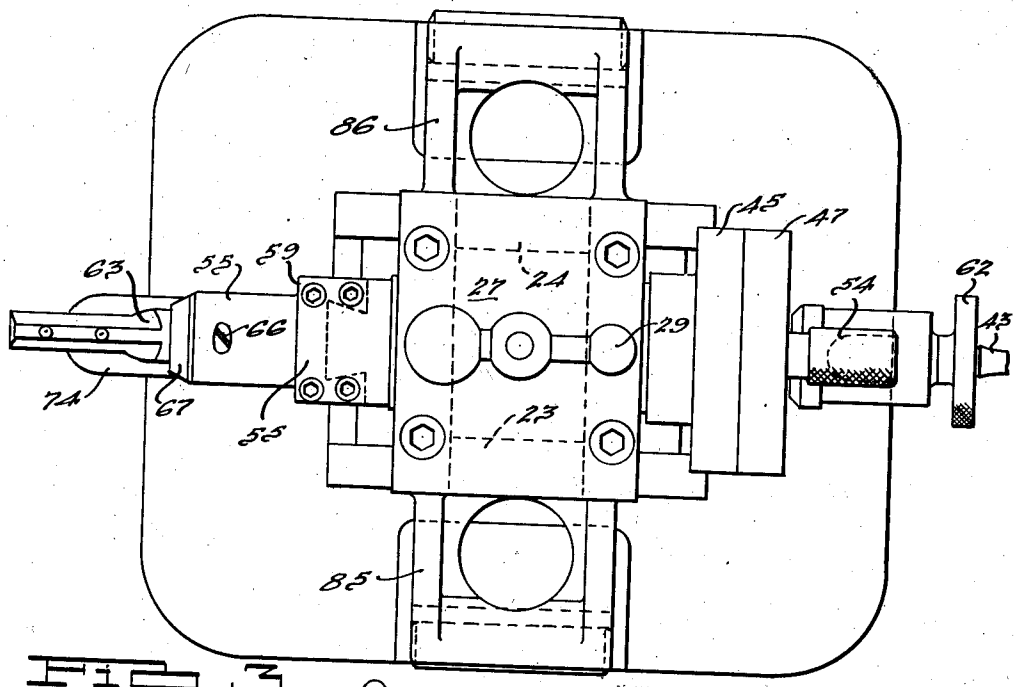



Fig. 3.

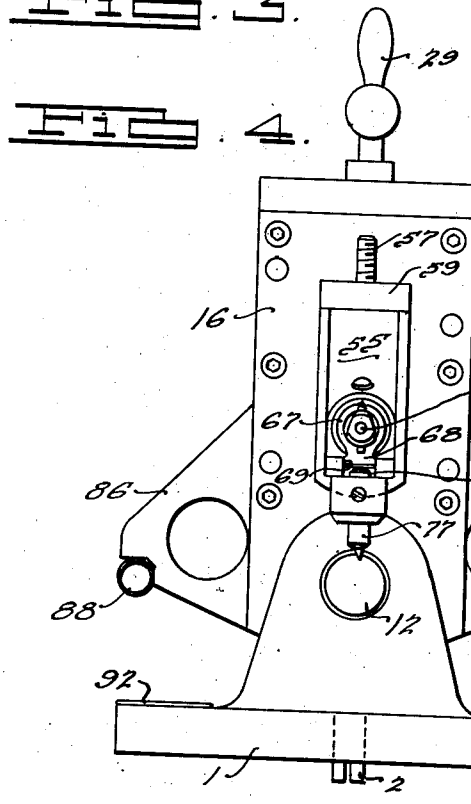



Fig. 4.

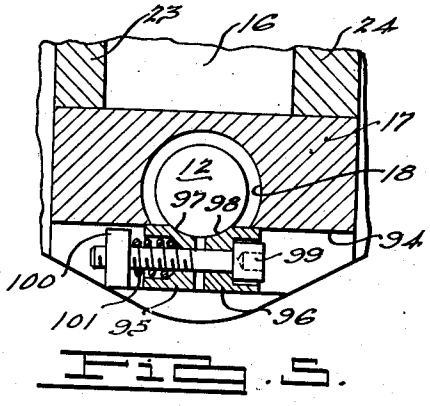



Fig. 5.

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2,404,148

# UNITED STATES PATENT OFFICE

2,404,148

## GRINDING WHEEL DRESSER

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Application August 5, 1944, Serial No. 548,191

4 Claims. (Cl. 125—11)

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The present invention relates to a grinding wheel dresser adapted to dress arcuate surfaces or straight line surfaces at any angle on the periphery of a grinding wheel. It is particularly adapted for use in dressing the wheels employed in grinding splines or spline broaches, but may be employed for other purposes.

The primary object of the invention is to provide a rugged, accurate, and simple dressing fixture adapted to dress a wide variety of wheel forms.

Another object of the invention is to provide a dresser of the type mentioned in which all necessary adjustments may be fixed and determined by means of accurate measuring blocks such as the familiar Johannsen blocks.

Another object of the invention is to provide a machine of the type mentioned in which a minimum number of relatively moving parts are employed and in which, for any given form to be dressed, all relatively movable parts are fixed against relative motion except two parts which move relatively to effect the desired motion of the dressing tool.

Another object of the invention is to provide a dresser of the type mentioned in which means employed to adjust the location of the tool for dressing straight surfaces is employed to effect the necessary movement of the tool in dressing curved forms and vice versa, thus increasing the versatility of the machine without correspondingly increasing its complexity.

Other objects and advantages of the invention will become apparent from the following specification, the accompanying drawings, and the appended claims.

In the drawings:

Figure 1 is a vertical section through the fixture as viewed from the left side.

Figure 2 is a rear elevation of the invention with portions broken away to show the interior.

Figure 3 is a plan view of the invention.

Figure 4 is a front elevation.

Figure 5 is a fragmentary sectional view taken on the line 5—5 of Figure 1.

Figure 6 is a fragmentary section taken on the line 6—6 of Figure 1 showing the means for locking the dressing tool slide relative to the rotary support therefor.

Figure 7 is a diagrammatic illustration of one form of spline grinding wheel which may be dressed by the invention.

Figure 8 is a diagrammatic view of a second form of spline grinding wheel which may be dressed by the present invention.

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Referring to the drawings, and particularly to Figures 1 to 4 thereof, the dresser comprises a base plate 1 adapted to rest on the table of a grinding machine. The base plate is provided with a split key formed by two pairs of downward projections, each pair including projections 2 and 3 which are formed as depending flanges on a pair of plates 3 and 4 respectively, slidable toward and from each other in the bottom of plate 1. The position of plates 3 and 4 is controlled by means of a pair of adjusting screws 5 and 6 which are mounted in countersunk openings in the side edges of the plate 1 and are threaded into the members 3 and 4 respectively. A pair of cap screws 7, indicated in dotted lines at the left-hand side of Figure 2, are fitted in suitable slots in the members 3 and 4 to retain them against the bottom surface of the plate 1, with freedom for sliding movement relative to the plate under the influence of the screws 5 and 6. The split key formed by the projections 2 and 3 fits within the keyway on the table of a grinding machine. By adjusting the members 3 and 4 an accurate fit of the key in the keyway may be maintained. In addition, if the keyway becomes worn it may be reground to a slightly greater width by the grinding wheel of the machine, and the split key adjusted to fit the increased width. This assures maintenance of the accurate location of the fixture as a whole with respect to the plane of the grinding wheel.

The base plate 1 is provided with a pair of upstanding apertured ears 8 and 9 fitted respectively with bushings 10 and 11 in which is journaled a shaft 12. The shaft is fixed against rotation by means of a setscrew 13, indicated in dotted lines in Figure 2.

Pivotally mounted upon the shaft 12 is a box-like frame structure indicated generally at 14. This frame comprises a pair of integral front and back walls 15 and 16 joined together at their lower portions by means of a connecting portion 17 in which is formed a transverse bore 18. A pair of flanged bushings 19 and 20 are fitted within the bore 18 and are rotatably journaled on the shaft 12. A pair of spacing discs 21 and 22 form an axial thrust bearing for the assembly, and consequently accurately locate the axial position of the frame 14 on the shaft 12.

Above the connecting portion 17 of the frame 14 the frame is provided with a pair of side wall members 23 and 24 indicated in dotted lines in Figures 1 and 3 and also shown in section in Figure 5. The side wall members 23 and 24 are secured to the front and back of members by means

of countersunk cap screws 25, shown best in Figure 2, to form a rigid structure. The upper ends of the wall members 15, 16, 23, and 24 are secured by similar cap screws 26 to a top plate 27. A generally rectangular block-shaped slide 28 is fitted between the walls 15, 16, 23, and 24, and is slidable vertically therein, such sliding movement being effected by means of a handle 29 fixed to the end of a double screw 30. The screw 30 has an upper portion 31 provided with a left-hand thread and a lower portion 32 with a right-hand thread. The upper portion is threaded through a threaded bushing 33 fixed to the top plate 27, while the lower portion 32 is threaded within a threaded bushing 34 fixed to the slide 28. As a consequence of this arrangement rotation of the handle moves the slide vertically within the frame 14 in either direction.

The slide 28 is provided with a circular opening 35 extending parallel to the axis of the shaft 12 and adapted to receive a tube 36. The tube 36 is keyed to the slide 28 by means of a key 37 which is locked in position by means of a setscrew 38. The rear wall 15 of the frame is provided with a vertical slot 39, and the front wall 16 is provided with a similar slot 40 through which slots the tube 36 projects freely. The slots are of sufficient length to permit the maximum vertical movement of the slide 28 relative to the frame 14 without interference.

The tubular stem 41 of a rotary support 42 is journaled within the tube 36 for rotary movement on an axis parallel to the shaft 12 under the influence of a crank 43 keyed to a reduced extension 44 of the tube stem 41. A disc 45 is fixed to the tube 36 by means of a key 46, and a similar disc 47 is fixed to the tubular stem 41 by means of keyways 48 and a lock nut 49 threaded on the reduced portion 44 of the stem 41. The disc 47 is provided with an accurately formed hole 50, and the disc 45 is provided with four similar holes 51 spaced 90° apart around the disc, the upper and lower holes 51 in the disc 45 being vertically positioned relative to each other and parallel to the path of movement of the slide 28. The holes 50 and 51 are adapted to have a push fit with a bushing 52 fixed on a pin 53, having a handle 54. As a result, it is possible to fix the rotative position of the support 42 relative to the tube 36 in any one of four positions spaced 90° apart. When the pin 53 is removed it will be obvious that the support is freely rotatable relative to the tube 36.

An auxiliary slide 55 is mounted upon the rotary support 42 by means of the tongue and groove connection shown best in dotted lines in Figure 3, with the result that the auxiliary slide may move radially with respect to the axis of the spindle 41. This movement is accomplished by means of a double screw 56 having a portion 57 at its upper end provided with a left-hand thread and a portion 58 at the lower end provided with a right-hand thread. The portion 57 is threaded in a block 59 fixed to the upper end of the auxiliary slide 55 while the lower end 58 is threaded into the rotary support 42. As a result of this arrangement rotation of the screw 56 shifts the radial position of the auxiliary slide 55 relative to the axis of the tubular spindle 41.

The adjusted position of the auxiliary slide 55 may be fixed by means of a wedge-shaped block 60, shown best in Figures 1 and 6, which corresponds generally to the shape of the dove-tailed tongue on the rotary support 42 and fits within the central portion of the dove-tailed groove in the auxiliary slide 55. The wedge member 60 is fixed to the end of a rod 61, which extends through the tubular spindle 41 and is provided with a projecting threaded extremity carrying a thumb nut 62. As a result of this arrangement tightening of the nut 62 will lock the auxiliary slide 55 against radial movement with respect to the axis of the tubular spindle 41.



The auxiliary slide 55 carries the dressing tool which may be in the form of a pointed diamond. The diamond may be mounted in any suitable manner, but two alternative mountings are illustrated in the drawings. One of the illustrated diamond holders is in the form of a generally cylindrical rod 63 having a stem 64 accurately fitted within a suitable bore within the auxiliary slide 55 and extending parallel to the axis of the tubular spindle 41. The stem 64 is provided with a notch 65 adapted to receive a setscrew 66 for locking the holder in position. The holder is also provided with a flange 67 having a depending portion 68 which, as best shown in Figure 4, fits within a keyway 69 in the auxiliary slide and thus fixes the rotative position of the holder relative to the slide. The diamond point 70, in accordance with conventional practice, is fixed to a cylindrical element 71 which in turn is fitted within a transverse opening in the holder 63 and locked in position by means of a long setscrew 72 shown in dotted lines in Figure 1. The opening in which the element 71 is mounted extends parallel to the dove-tailed tongue and groove connection between the auxiliary slide 55 and the rotary support 42. If desired, a second diamond 73 may be similarly mounted further out on the holder 63 for use in connection with grinding wheels of larger diameter. It will be understood that only one diamond will be employed at one time.

In order to increase the effective range of adjustment of the diamond point by the auxiliary slide 55 and screw 56, a second diamond holder is provided which positions a diamond at a greater distance from the axis of the tubular spindle 41 than does the holder 63. This holder, as shown in Figure 1, comprises a bracket 74 fixed to the auxiliary slide 55 by means of a key 75 and cap screws 76. It carries a diamond holding element 77 provided with a diamond point 78. The element 77 is locked in position by means of a set screw 79. It will be observed that by rotating the spindle 41 through an angle of 180° that the diamond 78 may be swung into the angular position occupied by the diamonds 70 and 73, but will be spaced at a greater distance than the latter from the axis of the tubular spindle 41.

The diamond holder 63 is so positioned on the slide 55 and the diamonds 70 and 73 are so positioned relative to the holder, that when the surface 80 of the block 59 contacts the surface 81 of the rotary support 42 the point of the diamond will be exactly on the axis of spindle 41. As a result, the radius of movement of the diamond point effected by swinging the crank handle 43 may be exactly determined by inserting measuring blocks between the surfaces 80 and 81 and thereafter fixing the auxiliary slide relative to the rotary support 42 by means of the wedge 60. The distance between the diamond point 78 and the axes of the tubular spindle 41 is preferably such that when the surfaces 80 and 81 are in contact, the distance between the point 78 and the axis of the spindle 41 equals the maximum distance to which the diamond point 70 may be shifted from that axis by means of the screw 56. Thus, the two

diamond mountings double the effective range of movement of the auxiliary slide 55.

As best shown in the broken-away portion of Figure 2, the side wall 23 of the frame 14 is provided with an opening 82 through which may be inserted measuring blocks of known dimensions in order to determine the vertical position of the slide 28 relative to the frame 14. A pin 83 is fixed in the threaded bushing 34 of the slide 28, and a pin 84 is fixed to the cover plate 27. These pins are so constructed that for a known distance between them, which may be determined by the measuring blocks, the distance between the axes of the shaft 12 and the tubular spindle 41 is known. Consequently the opening 82 and the pins 83 and 84 provide a means for accurately determining the distance between those axes.

As best shown in Figure 2 the frame 14 is provided with a pair of triangular boxlike projecting ears 85 and 86, to each of which is secured a cylindrical roll 87 and 88, respectively. The rolls are secured by cap screws 89 in position against a pair of accurately located surfaces 90 and 91 formed on the ears 85, which surfaces extend at right angles to each other. The rolls 87 and 88 are made with great accuracy, and by the means just described are exactly located so that the common plane of their axes contains the axis of shaft 12.

The base plate 1 is provided at each side beneath the rolls 87 and 88 with a pair of blocks 92 and 93 having accurately formed top surfaces positioned in a common plane at an accurately known distance from the axis of the shaft 12. As best shown in Figure 1, the top surfaces of the blocks 92 and 93 are provided with dust collecting grooves in order to insure that measurements made from the surfaces will not be impaired by any grinding dust which might fall on them. The rolls 87 and 88 in combination with the locating blocks 92 and 93 provide a means by which the angular position of adjustment of the frame 14 about the axis of the shaft 12 may be accurately determined. For any given angle the distance between one of the rolls and its corresponding locating block may be readily determined or calculated, and measuring blocks of the proper dimensions inserted between the rolls and the locating block to accurately locate the angular position.

In order to fix the frame 14 in any adjusted angular position a clamping means is provided as best shown in Figure 5. As there shown, the lower portion 17 of frame 14 is provided with a transverse bore 94 in which are slidably fitted a pair of plugs 95 and 96. The bore 94 intersects the bore 18, and the plugs 95 and 96 are provided with cylindrical surface portions 97 and 98, respectively, adapted to fit against the shaft 12. A socket head screw 99 extends through and is freely rotatable with respect to the plug 96, and is threaded through the plug 95 with the result that upon tightening of the screw the plugs will be drawn together and clamped against the fixed shaft 12, thus preventing rotation of the frame relative to the shaft. In order to prevent free movement of the frame about the shaft 12 when the screw 99 is loosened, the screw is provided with a nut 100 which is fixed thereto in any desired manner, and a spring 101 surrounds the screw and is located between the nut and the plug 95. Consequently, when the screw is loosened the spring maintains sufficient clamping action tending to draw the plugs together to prevent the frame from moving by gravity.



The operation of the mechanism may best be understood by reference to diagrammatic Figures 7 and 8. In Figure 7 is illustrated a fragment of a grinding wheel 102 adapted to grind the space between a pair of teeth, indicated in dotted lines at 103 and 104, of a straight-sided spline or splined broach having a root radius represented by the circle 105. In such a case, the portion A of the face of the grinding wheel must be dressed to an arc equal to the radius of the circle 105. For such dressing operations the frame 14 is fixed in a vertical position in which the rolls 87 and 88 are equal distances from the locating blocks 92 and 93, respectively. This is accomplished by the use of an accurate measuring block equal to the known distance between the plane of the upper surfaces of the blocks 93 and the axis of shaft 12 less the radius of the rolls 87 and 88. The main slide 28 is then elevated or lowered by means of the handle 29 until the axis of the spindle 41 is on the center 106 of the circle 105. This is accomplished by inserting appropriate measuring blocks between the pins 83 and 84 shown in Figure 2 and adjusting the slide until the proper distance between those pins is achieved. This distance may be calculated from the known distance between the end of pin 84 and the axis of the shaft 12, the known distance between the end of pin 83 and the axis of spindle 41, and the known distance between the axis of shaft 12 and the axis 106 of the workpiece. The auxiliary slide is then adjusted until the distance between the surfaces 80 and 81 is equal to the radius of the circle 105. Then with the slides 28 and 55 clamped, the rotary support 42 is oscillated by means of crank 43 to dress the wheel. It will be understood in this connection that the axis of the shaft 12 and the tubular spindle 41 are at all times parallel to the plane of the grinding wheel, and that in the dressing of a surface corresponding with surface A in Figure 7 that they are preferably located in the central plane of the wheel. Pin 53 will be removed during this dressing operation in order that spindle 41 may rotate freely.

As a general rule grinding machines for spline grinding maintain the work on a fixed axis and consequently it is not necessary to change the adjustment of the slide 28 to dress arcs of different radii. It is contemplated that the shop prints for the particular workpiece to be made will bear a notation of the measuring block settings for the distance between the pins 83 and 84, distance between the surfaces 80 and 81, and the distance between the rolls 87 or 88 and the blocks 92 or 93. Consequently, no calculations need to be made by the operator of the machine.

In order to dress the straight sides B of the wheel 102 the main frame 14 is swung about the axis of the shaft 12 until it extends at an angle from the vertical equal to the angle $a$ between the profile B and the central plane of the wheel. The center line of the frame 14 then occupies the line $b'b'$ shown in Figure 7, which is parallel to the line $b$—$b$ lying in the surface B to be dressed. The spindle 41 is then rotated 90° in a counterclockwise direction from the position illustrated in the drawings and fixed in that position by means of pin 53. This results in an inclination of the dovetailed ways of slide 55 in a direction along the line $c$—$c$ of Figure 7, with the diamond point directed to the left along that line as viewed in Figure 7. The small slide is thereupon adjusted by screw 56 until the diamond point lies in the line $b$—$b$. The small slide is then clamped

by means of the thumb nut 62, and the wheel is dressed by rotating the handle 29 to shift the main slide back and forth along the line $b'b'$.

It will be understood that the setting of the main frame on the angle $a$ may be determined with great accuracy by means of measuring blocks inserted between the roll 88 and the block 93. The thickness of the measuring blocks may be readily calculated or determined from ordinary trigonometric tables and the known dimensions of the dresser. Likewise the setting of the auxiliary slide 55 may be accurately calculated to determine the accurate thicknesses of the measuring blocks to insert between the surfaces 80 and 81 in order to insure that the diamond point will be upon the line $b$—$b$ of Figure 7 during the dressing operation. It will be understood that the angular position of the frame 14 will be fixed by tightening the clamping blocks 95 and 96 of Figure 5 prior to the dressing operation.

It will be appreciated that in order to dress the straight surface on the opposite side of the wheel it will only be necessary to rotate the spindle 41 through an angle of 180° from the position it occupies in dressing the surface B, and to swing the main frame 14 over to the opposite side of the plane of the wheel at the same, but opposite, angle.

The dresser is also adapted to dress arcuate side areas such as the area C on the wheel 109 indicated diagrammatically in Figure 8. Any desired arrangement of arcuate side surfaces may be dressed, but, in the particular example illustrated, C is an arcuate grinding profile which is intended to approximate the involute form required to dress the sides of involute splined teeth indicated in dotted lines. In this connection it may be noted that on small splines it is possible to approximate the involute curve with great accuracy by a true circular arc or, in some cases, a combination of two tangent arcs of different radii. The center or centers of such arcs and their radii may be determined by mathematical calculation or by laying out the true involute on a greatly enlarged scale, such as fifty to one hundred or one hundred to one, and determining the center location and radius of the proper circular arc or arcs graphically. In either event, in accordance with the present invention, the location of the center of such arc, indicated at 110 in Figure 8, is determined with respect to the axis of the shaft 12 and, in addition, a determination is made of the angle $a$ between the central plane of the wheel and the line $b'b'$ of Figure 8, which extends through the center 110 of the arc and the axis of the shaft 12.

Once this information is determined graphically or by calculation, the frame 14 is pivoted with respect to the vertical by the angle $a'$, which angular position, as previously mentioned, is determined by measuring blocks inserted between the roll 88 and the block 93. Thereupon the main slide 28 is adjusted along the line $b'b'$ until the center of the spindle 41 coincides with the center 110 of the arc of the radius to be dressed. The small slide 55 is then adjusted by screw 56 until the distance between the surfaces 80—81 equals the radius of the arc C, which is to be dressed. This position of the small slide 55 is fixed by means of the thumb nut 62 and the wheel is then dressed by swinging the diamond point about the axis of the spindle 41 by manipulation of the handle 43. The opposite side of the wheel may be dressed in the same manner without any adjustment except a shift of the main frame 14 to the proper angular position on the opposite side of the frame of the wheel. This position may be determined by the same measuring blocks required to locate the angular position employed at the right side of the wheel as viewed in Figure 8.

It will be observed that there is provided, in accordance with the present invention, a relatively simple dressing device of rugged construction in which all adjustments may be determined with great accuracy by means of measuring blocks. In addition, it will be noted that the device is flexible in its capacity to dress various arrangements of straight or arcuate profiles, but that such flexibility is not achieved by additional complication of the mechanism. Thus, the rotary movement of the diamond provided by the pivotal mounting of spindle 41 is employed to perform the dressing operation in the case of arcuate profiles and is employed to adjust the diamond into a position at right angles to the surface to be dressed when dressing straight profiles. The sliding movement of the small slide 55 is utilized to fix the radius in dressing arcuate profiles and is employed to feed the diamond point into contact with the wheel in preparation for the dressing of straight profiles. The main slide is employed to position the spindle 41 on the center of an arcuate profile and is employed to effect the rectilinear dressing movement in dressing a straight profile. Finally, the swinging movement of the frame 14 is employed to locate the axis of the spindle 41 on the center of an arcuate profile to be dressed, and is employed to adjust the plane of movement of the diamond to correspond to the angular position of a straight profile to be dressed. Thus, each of the relative movements or adjustments provided in the machine is employed in dressing both types of profiles and no additional adjusting means are necessary for either type.

What is claimed is:

1. A grinding wheel dresser comprising a base, a frame pivotally connected to the base, a slide movable on the frame in a path at right angles to the axis of said pivotal connection, a support rotatably mounted on said slide on an axis parallel to said first mentioned axis, a second slide movable on said support in a path at right angles to the axis of movement of the support relative to the first slide, and a dressing tool carried by said second slide with its point projecting in a direction parallel to the path of movement of the second slide relative to the support, said base having a flat reference surface extending parallel to the axis of said frame, and means on said frame offset from its axis defining a curved surface adapted to remain tangent to planes parallel to said reference surface, in all pivotal positions of said frame, said reference surface and said means being in juxtaposition to receive between them measuring blocks for determining the angle of adjustment of the frame relative to the base.

2. A grinding wheel dresser comprising a base, a frame pivotally connected to the base, a slide movable on the frame in a path at right angles to the axis of said pivotal connection, a support rotatably mounted on said slide on an axis parallel to said first mentioned axis, a second slide movable on said support in a path at right angles to the axis of movement of the support relative to the first slide, and a dressing tool carried by said second slide with its point projecting in a direction parallel to the path of movement of the second slide relative to the support, said support and second slide having surface portions which

move toward and from each other and remain in alignment during movements of the second slide relative to the support and between which measuring blocks may be inserted to determine the adjustment of the dressing tool relative to the axis of the support.

3. A grinding wheel dresser comprising a base, a frame pivotally connected to the base, a slide movable on the frame in a path at right angles to the axis of said pivotal connection, a support rotatably mounted on said slide on an axis parallel to said first mentioned axis, a second slide movable on said support in a path at right angles to the axis of movement of the support relative to the first slide, and a dressing tool carried by said second slide with its point projecting in a direction parallel to the path of movement of the second slide relative to the support, said support and second slide having surface portions which move toward and from each other and remain in alignment during movements of the second slide relative to the support and between which measuring blocks may be inserted to determine the adjustment of the dressing tool relative to the



axis of the support, and said dressing tool being so positioned on said second slide that its wheel engaging point is located on the axis of the support when said surface portions contact each other.

4. A grinding wheel dresser comprising a base, a frame pivotally connected to the base, a slide movable on the frame in a path at right angles to the axis of said pivotal connection, a support rotatably mounted on said slide on an axis parallel to said first mentioned axis, a second slide movable on said support in a path at right angles to the axis of movement of the support relative to the first slide, a dressing tool carried by said second slide with its point projecting in a direction parallel to the path of movement of the second slide relative to the support, and means for fixing the support relative to the first slide in either of two rotative positions 180° apart, in both of which positions the point of the dressing tool projects in a plane at right angles to the direction of movement of the first slide relative to the frame.

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