

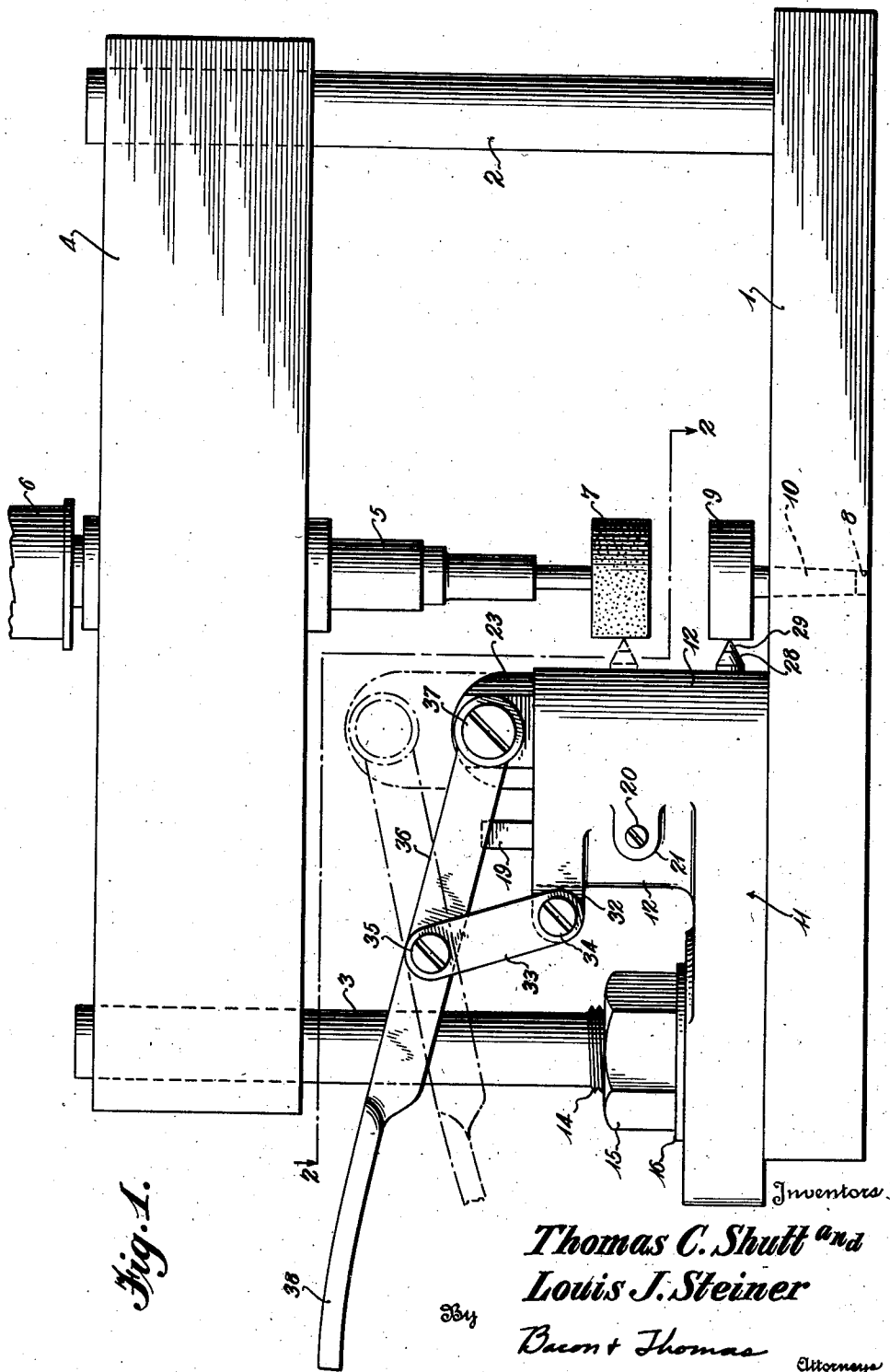
Dec. 19, 1944.

T. C. SHUTT ET AL
GRINDING APPARATUS AND METHOD

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Fig. 2.

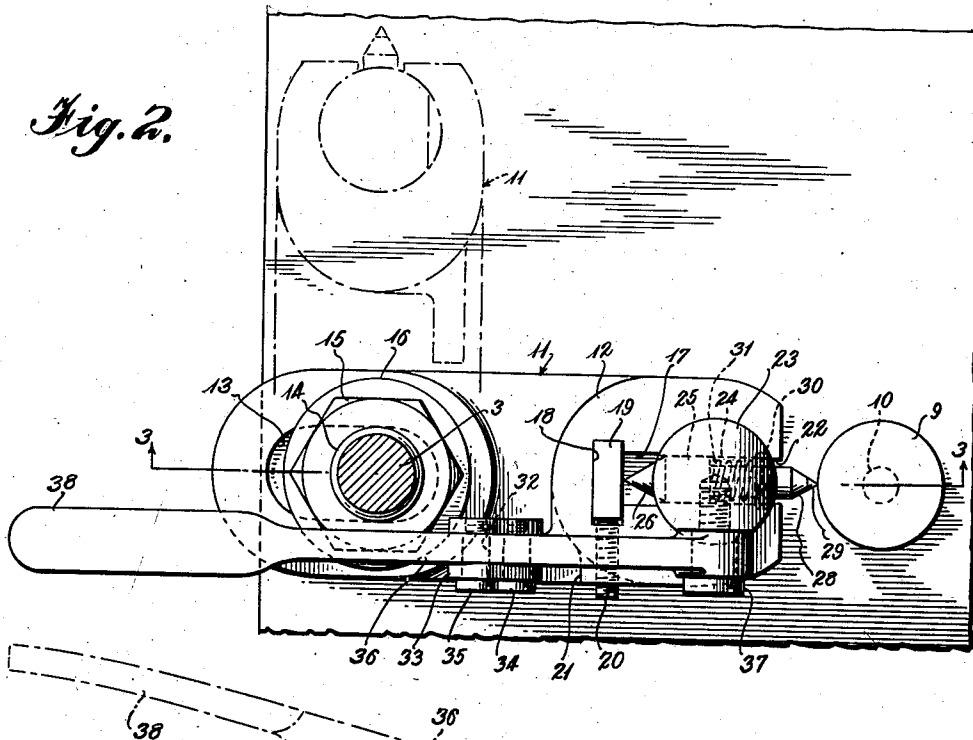
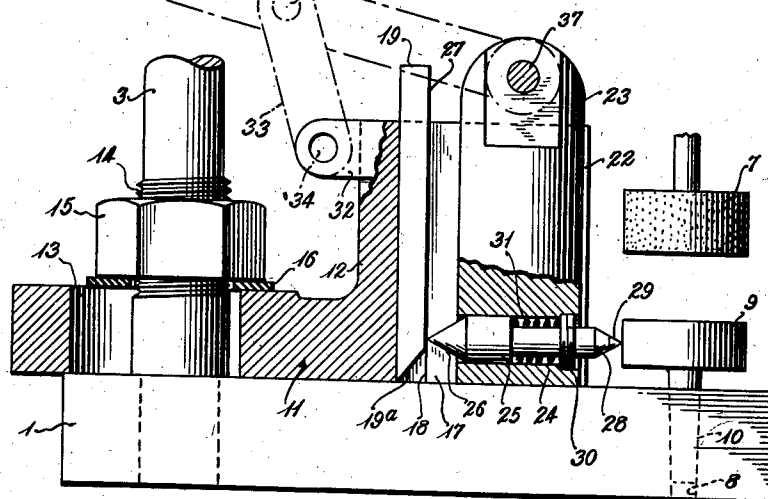


Fig. 3.



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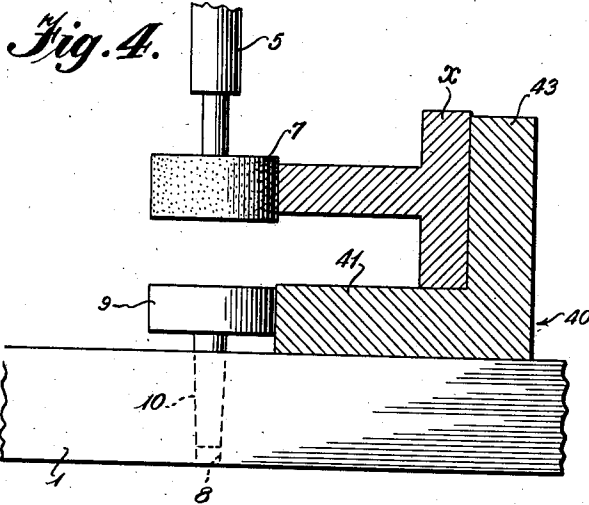
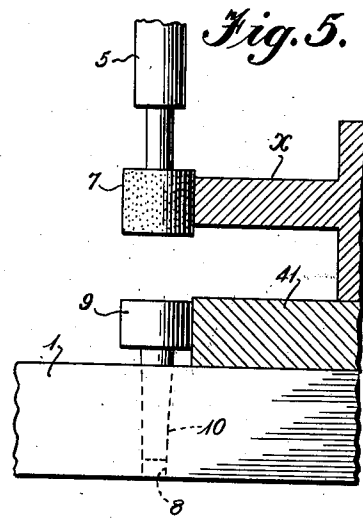


Fig. 6.

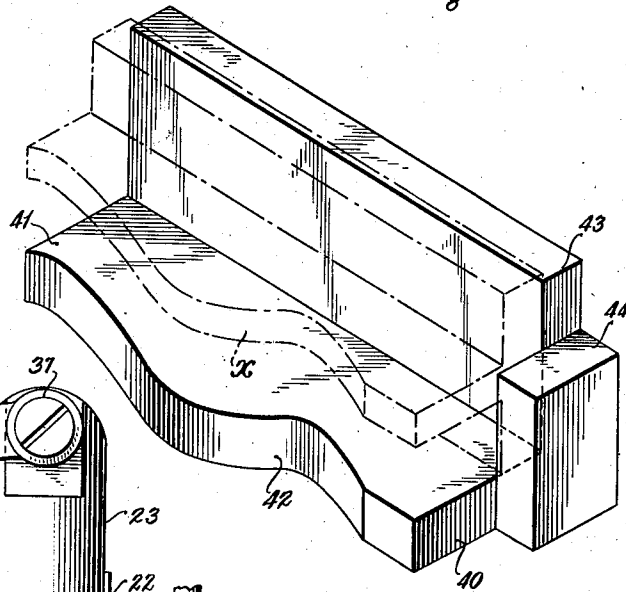
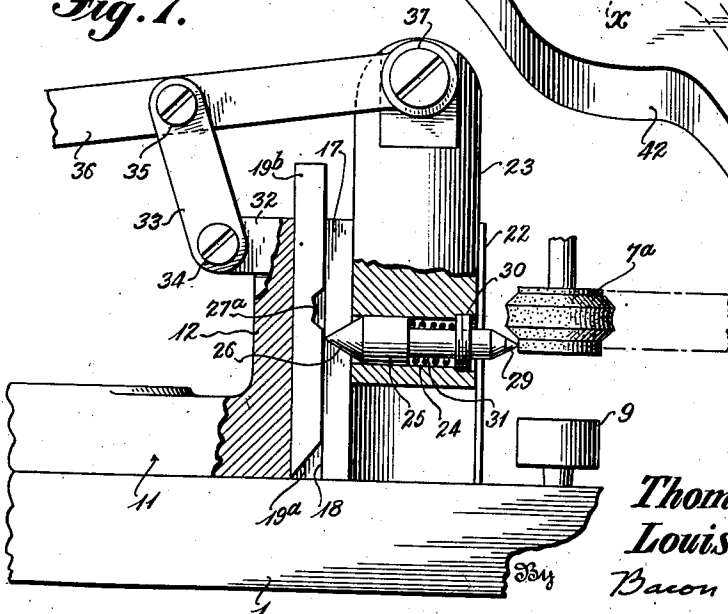


Fig. 7.



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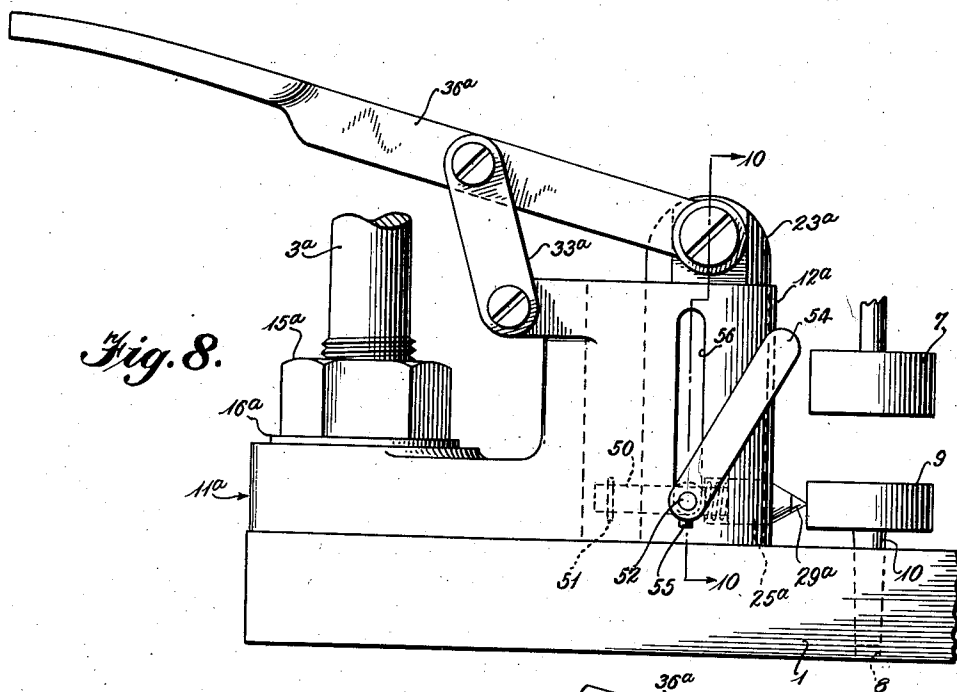
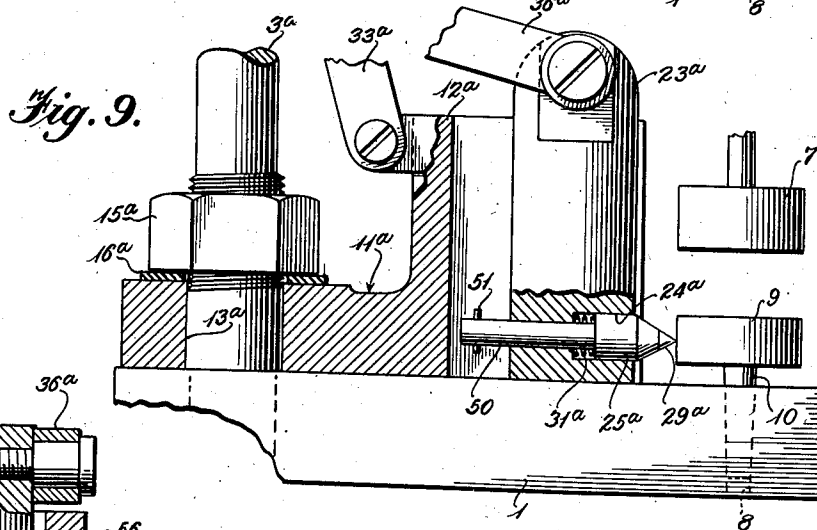
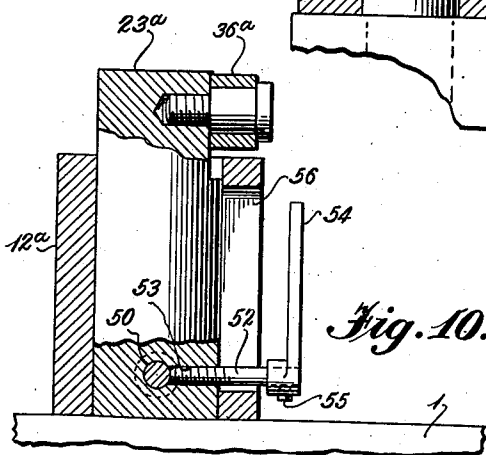
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2,365,302

GRINDING APPARATUS AND METHOD

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Application May 28, 1943, Serial No. 488,900

11 Claims. (Cl. 51—100)

The present invention relates to metal grinding apparatus, and more particularly to a novel method and apparatus for grinding a contour on a work-piece corresponding identically with that on a master template.

More specifically, the invention comprises grinding apparatus including a grinding machine having a rotatable spindle carrying a grinding wheel and means for dressing said grinding wheel to corresponding with the diameter of a circular guide or element mounted on the table of the grinding machine in axial alignment with the grinding wheel. In one embodiment of the invention, the guide means consists of circular plugs of progressively varying diameter removably mounted in an opening in the table axially aligned with the axis of the grinding wheel. These removable plugs serve a dual purpose in the present invention. First, they serve as a guide means for positioning a wheel dressing device in such manner that upon operation of said device it will dress the grinding wheel to a diameter corresponding exactly to that of the plug. Secondly, the cylindrical plug serves as a guide for a combined master template and jig which holds the work while it is being ground to shape by the grinding wheel.

One of the important advantages of the invention over prior devices is that inaccuracies in grinding due to wear of the grinding wheel are wholly eliminated. This is achieved by the successive manual replacement of one plug by a slightly smaller plug and the dressing of the grinding wheel to correspond to the diameter of said smaller plug. By virtue of this arrangement, highly accurate grinding can be done and in actual practice it is easy to maintain a tolerance as low as 0.0005 of an inch.

The principal object of the invention is to provide a metal grinding apparatus which will duplicate or reproduce curved and/or straight contours upon metal work-pieces rapidly and with great accuracy.

Another object of the invention is to provide a grinding apparatus in which the customary inaccuracies due to wear of the grinding wheel are eliminated and high precision grinding is made possible.

Another object of the invention is to provide means for accurately dressing the periphery of a grinding wheel to make it conform to a given surface contour on a master tracer block.

Still another object of the invention is to provide conveniently arranged means on the table of a grinding machine for quickly and accurately

dressing a grinding wheel, and which means can be readily swung out of the way about its mounting means so as not to interfere with the manipulation of the work during the grinding operation.

Other objects and advantages of the invention will be apparent from the following description taken in conjunction with the accompanying drawings in which:

Fig. 1 is a front elevation of a grinding machine and a grinding wheel dressing device embodying the principles of the invention;

Fig. 2 is a sectional plan view taken on the line 2—2 of Fig. 1 and showing the inactive position of the wheel dressing device in dot-and-dash lines;

Fig. 3 is a vertical sectional view through the wheel dressing device taken on the line 3—3 of Fig. 2;

Fig. 4 is a fragmentary view partly in section illustrating the manner in which the work is carried by the master template and guided to reproduce the contour of the template on said work-piece;

Fig. 5 is a view similar to Fig. 4, but showing a guide plug of smaller size and a grinding wheel of like size, whereby the relationship between the template and grinding wheel is unchanged regardless of wear and repeated dressing of the grinding wheel;

Fig. 6 is a perspective view of the combined master template and work holder;

Fig. 7 is a view similar to Fig. 3, but showing a modified tracer block for the wheel dressing device, whereby the grinding wheel may be given a desired predetermined irregular surface configuration;

Fig. 8 is a view of a modified form of wheel dressing device in which the wheel dressing bit is spring-pressed toward a circular guide plug instead of having the body of the wheel dressing device adjustable with respect to said plug;

Fig. 9 is a view partially in section of the wheel dressing device shown in Fig. 8; and

Fig. 10 is a sectional view taken on the line 10—10 of Fig. 8.

Referring now to Fig. 1 of the drawings, the grinding machine comprises a table 1 carrying spaced, vertical posts 2 and 3. A transverse member 4 is mounted on the posts 2 and 3 in vertically spaced relation to the table 1. The transverse member 4 carries a conventional or suitable spindle 5 adapted to be driven by a pulley 6. A grinding wheel 7 is suitably mounted in the spindle 5. It will be understood that the spindle 5 may be raised or lowered by any con-

ventional or suitable means (not shown) to position the grinding wheel 7 to suit the work or the wheel dressing device described later.

The table 1 is provided with a tapered opening 8 having its axis vertically aligned with the axis of the spindle 5. A circular guide plug 9 having a tapered shank 10 is mounted in the tapered opening 8. Figure 1 shows the grinding wheel 7 dressed to exactly the same diameter as the plug 9. A series of plugs 9 of progressively varying diameter is provided so that as the grinding wheel wears in use a slightly smaller plug is substituted and the grinding wheel is then dressed to correspond to the diameter of the substituted plug.

The grinding wheel dressing device is generally indicated by the numeral 11 and comprises a body 12, the base of which rests flush upon the upper surface of the table 1. The wheel dressing device 11 is made so that it can be bodily moved toward and away from the grinding wheel 7 to facilitate wheel dressing and to be swung out of the way about the post 3 when not in use. To this end, the body 12 is provided with an elongated slot 13 (Fig. 3). The post 3 is threaded as indicated at 14 and a nut 15 and cooperating washer 16 serve to clamp the body 12 in any desired position relative to the grinding wheel 7, or to clamp the same in its inactive out-of-the-way position, as indicated by the dot-and-dash lines in Fig. 2. While a conventional nut, washer and thread have been shown as a locking means for the wheel dressing device 11, it will be understood that any other suitable clamping means may be employed.

The body 12 is provided with a generally T-shaped slot 17, (Fig. 2), the head portion 18 of which is adapted to receive a master tracer block 19 which is rectangular in cross-section. The block 19 is held in place in the slot portion 18 by a screw 20 threaded into a boss 21 formed on the body 12. The block 19 preferably extends above the upper surface of the body 12 so that it can be easily grasped for removal. The stem portion 22 of the T-shaped slot 17 is enlarged medially of its length to receive a cylindrical slide member 23. The lower end of the slide member 23 has a transverse bore 24 (Fig. 3) in which a combined tracer and dressing bit 25 is freely mounted for reciprocation. The tracer-bit 25 has an enlarged pointed end 26 which is adapted to engage a surface 27 on the block 19. The tracer-bit 25 also has a reduced and pointed end 28 upon which is preferably mounted a diamond 29 for dressing the grinding wheel 7. A threaded closure plug 30 slidably receives the reduced portion of the tracer-bit 25 and is mounted in the slide 23 at one end of the bore 24. A spring 31 surrounds the reduced portion of the tracer-bit 25 and engages the inner side of the closure plug at one end thereof and the enlarged portion of said tracer-bit at the opposite end and constantly urges the pointed end 26 into engagement with the master surface 27. The lower end of the block 19 is tapered as indicated at 19^a (Fig. 3) so that it can readily displace the tracer-bit 25 during insertion of said block.

The body 12 carries an integral lug 32 which serves as a support for one end of a pair of links 33, a pin 34 extending through the lug 32 and pivotally supporting the lower ends of said links. The upper ends of the links 33 are pivotally connected by a pin 35 to an intermediate portion of an operating lever 36. One end of the operating lever engages a flat surface on the upper end of

the slide 23 and is pivotally connected to said slide by a screw 37. The opposite end of said operating lever is flattened to provide a handle portion 38.

It will be particularly noted from Fig. 2 that the tracer-bit 25 rides in the stem portion 22 of the slot 17 as the slide 23 is raised or lowered by manipulation of the operating lever 36.

In using the wheel dressing device 11, the clamping nut 15 is released and the body 12 is adjusted relative to the plug 9 so that the diamond point 29 engages the plug and lies along a line drawn through the center of the post 3 and the center of said plug, the elongated slot 13 permitting any shifting of the body 12 that may be necessary. The clamping nut 15 is then tightened to lock the body 12, against movement relative to the table 1. It will be apparent from the arrangement of the links 33 and the operating lever 36 that when the handle portion 38 is pulled down, the slide 23 will be raised, carrying the tracer-bit 25 with it. The pointed end 26 of the tracer-bit 25 is engaged with the plain surface 27 of the block 19 under the influence of the spring 31. The spindle 5 is rotated at this time so that as the diamond point 29 engages the grinding wheel 7, it will true up said wheel and form a peripheral surface thereon in parallel with the surface 27 of the master tracer block 19. After the wheel 7 has been dressed, the wheel dressing device 11 may be moved out of the way by loosening the nut 15 and turning the body 12 about the post 3. Tightening of the nut 15 will then lock the device 11 in its inactive position.

It will be understood that as the grinding wheel 7 wears, and progressively smaller plugs 9 are mounted in the opening 8 in the table 1, the elongated slot 13 in the body 12 will permit the wheel dressing device 11 to be successively locked in position closer to the axis of the spindle. In this way, the wheel dressing device 11 can be readily adjusted to dress the grinding wheel from the time that it is initially used until it has been worn to such degree as to require discarding.

The circular guide plug 9, in addition to serving as a means for positioning the wheel dressing device 11 to dress the grinding wheel 7, also serves as a guide for a combined master template and work holder 40 shown in Fig. 6. This template includes a base portion 41 which is adapted to rest flush upon the upper surface of the table 1. The longitudinal edge 42 of the base portion 41 is provided with a contour or configuration which it is desired to reproduce upon a suitable work-piece X indicated in dot-and-dash lines. As shown, the work piece X is adapted to rest against the base 41 and a wall 43 extending upwardly from said base. One end of the work-piece X is also adapted to be engaged with a transverse abutment 44 formed on the end of the template 40. The work-piece X is clamped to the master template 40 by any suitable clamping means (not shown).

In use, the master template 40, with the work-piece X attached, is manually moved upon the table 1 with the contoured edge 42 disposed toward the guide plug 9. The work-piece X, of course, is engaged with the grinding wheel 7. As the work-piece X is ground away, the edge 42 of the template 40 engages the periphery of the guide plug 9 and upon movement of the edge 42 along said plug, the material of the work-piece X will be ground away to a configuration conforming to the contour of said edge. Any wear on the grinding wheel can be compensated for, as

previously explained, by substituting a smaller plug 9 in the opening 8 and then dressing the grinding wheel 7 so that its diameter will correspond exactly to that of the substituted plug. By maintaining this identity of diameters, it is possible to duplicate various contours with unusually high accuracy. If desired, the work-piece X may be rough ground to the approximate shape of the template 40 and then accurately ground to final form on the template 40.

Fig. 5 illustrates the manner in which the relationship between the grinding wheel 7, the work X and the master template 40 is maintained by the use of the plug means 9 even after the wheel 7 has worn considerably.

Fig. 7 illustrates the manner in which a tracer block 19^b may have a configured surface 27^a provided thereon when it is desired to alter the cross-sectional configuration of the work-piece. This figure illustrates the tracer-bit 25 and diamond point 29 elevated to a position where the diamond is in engagement with a grinding wheel 7^a to dress the same to a contour conforming to the shape of the surface 27^a. It will be understood that as the slide 23 is raised and lowered by operation of the lever 36, the spring 31 will urge the tracer point 26 into intimate contact with the surface 27^a so that an accurate duplication thereof will be effected on the periphery of the wheel 7^a.

It will be apparent from the foregoing that by using the circular guide plugs 9 as a means for positioning the wheel dressing device 11 to dress the grinding wheel 7 to the same diameter as said plug, and by using the same plug as a guide for the master template 40, extremely accurate grinding can be done upon the work-piece. It will also be apparent that by virtue of the use of the circular guide plugs 9, the edge 42 of the master template 40 can be engaged with the plug 9 at any portion of its periphery and the work manipulated upon the table in any convenient manner without resulting in inferior grinding.

Referring to the modified embodiment of the invention shown in Figures 8 to 10, the wheel dressing device 11^a comprises a body 12^a provided with a circular opening 13^a (Fig. 9), instead of an elongated opening as in Figure 3. Thus, the body 12^a is mounted for simple rotation about the post 3^a and is not adjustable in a direction transversely of said post. However, the wheel dressing device 11^a may be held in any desired radial position of adjustment about the post 3 by any suitable clamping means, for example the nut 15^a and the washer 16^a.

A slightly modified form of slide 23^a is mounted in the body 12^a and is adapted to be raised or lowered by links 33^a and an operating lever 36^a similar to that previously described.

The wheel dressing device 11^a shown in Figures 8 to 10 is particularly adapted for dressing grinding wheels having plain peripheral surfaces and is simplified in the respect that it is so constructed that the necessity for a tracer block, such as the block 19 or 19^b, is eliminated. This is accomplished by having the dressing bit 25^a slidably mounted in a bore 24^a in the lower portion of the slide 23^a so that the working point 29^a thereof is urged toward the circular guide plug 9 by a spring 31^a, as best shown in Figure 9. The dressing bit 25^a has a reduced shank 50 carrying a pin 51 which limits the outward movement of the dressing bit 25^a and also maintains the same in assembled relation with the slide 23^a.

The wheel dressing bit 25^a can be locked in any desired position of adjustment relative to the slide

block 23^a by a locking screw 52 (Fig. 10) which may have a multiple pitch thread so that it can be moved axially rapidly upon turning through a small angle. The locking screw 52 is received in a threaded opening 53 in the slide 23^a and its inner end engages the shank 50 of the dressing tool 25^a to clamp it in place on said slide. An arm 54 is fastened to the outer end of the locking screw 52 by a small set screw 55, which enables the arm 54^a to be so adjusted on the locking screw 52 that it can turn through the necessary angle to lock and unlock the wheel dressing bit 25^a without hindrance by the table 1.

The locking screw 52 extends through an elongated vertical slot 56 in the body 12^a so that as the slide 23^a is elevated to bring the cutting point 29^a into engagement with the grinding wheel 7, said locking screw will rise vertically in said slot.

In using the wheel dressing device shown in Figures 8 to 10, the bit 25^a may be manually pressed inwardly against the action of the spring 31^a so that it will clear the plug 9 while the body 12^a is being positioned so that the point 29^a of said bit falls upon a line passing through the center of the post 3 and the center of the plug 9. The dressing bit 25^a may then be released and the spring 31 will automatically urge it into snug engagement with the peripheral surface of the plug 9. Tightening of the nut 15^a will securely clamp the body 12^a against the table 1. The arm 54 is then rotated and the screw 52 connected therewith locks the shank 50 of the bit 25^a against axial movement relative to the slide 23^a. With the dressing bit 25^a locked in position, the slide 23^a can then be elevated by the operating lever 36^a to raise the point 29^a of said bit into engagement with the grinding wheel 7 to dress it to the same diameter as the circular guide plug 9. After the wheel has been dressed, the nut 15^a is loosened and the wheel dressing device 11^a swung about the post 3 so that it will be out of the way and not interfere with the manipulation of the work during the grinding operation.

It will be understood that various changes may be made in the details of construction of the wheel dressing devices and in the clamping means therefor shown herein without departing from the spirit of the invention or the scope of the annexed claims:

What we claim is:

1. Grinding apparatus comprising: a table; a rotatable spindle; means supporting said spindle for rotation relative to said table; a grinding wheel carried by said spindle; a circular guide mounted upon said table below said grinding wheel in axial alignment with said grinding wheel; a wheel dresser mounted upon said table including a dressing tool engageable with the periphery of said circular guide; and means for elevating said dressing tool into engagement with said grinding wheel to dress the same to a diameter corresponding to that of said circular guide.

2. Grinding apparatus comprising: a table; a rotatable spindle; means supporting said spindle for rotation relative to said table; a grinding wheel carried by said spindle; a removable, circular guide plug mounted upon said table below said grinding wheel in axial alignment with said grinding wheel; a wheel dresser mounted upon said table including a dressing tool, said wheel dresser being adjustable radially with respect to said circular guide plug to engage the point of said dressing tool with the periphery of said circular guide plug; and means for elevating said dressing tool into engagement with said grinding

wheel to dress the same to a diameter corresponding to that of said circular guide plug.

3. Grinding apparatus comprising: a table; a rotatable grinding wheel; means supporting said grinding wheel for rotation relative to said table; a circular guide mounted upon said table below said grinding wheel in axial alignment with said grinding wheel; and a grinding wheel dresser including a body, a slide mounted in said body, a wheel dressing bit carried by said slide and adapted to have the working point thereof brought into engagement with said circular guide, and means for elevating said slide to raise said wheel dressing bit to a position in engagement with said grinding wheel, whereby to dress said grinding wheel to the same diameter as said circular guide.

4. Grinding apparatus comprising: a table; a pair of spaced posts mounted upon said table; a transverse member supported by said posts in vertically spaced relation to said table; a rotatable spindle carried by said transverse member; a grinding wheel carried by said spindle; a circular guide mounted upon said table below said grinding wheel in axial alignment with said grinding wheel; a wheel dresser mounted upon said table for swinging movement about one of said posts; and a wheel dressing bit carried by said wheel dresser for dressing said grinding wheel to the same diameter as said circular guide.

5. Grinding apparatus comprising: a table; a pair of spaced posts mounted upon said table; a transverse member supported by said posts in vertically spaced relation to said table; a rotatable spindle carried by said transverse member; a grinding wheel carried by said spindle; a circular guide mounted upon said table below said grinding wheel in axial alignment with said grinding wheel; a wheel dressing device mounted upon said table for swinging movement about one of said posts and including a wheel dressing bit for dressing said grinding wheel to the same diameter as said circular guide; and means for clamping said wheel dressing device against said table.

6. Grinding apparatus comprising: a table; a pair of spaced posts mounted upon said table; a transverse member supported by said posts in vertically spaced relation to said table; a rotatable spindle carried by said transverse member; a grinding wheel carried by said spindle; a circular guide mounted upon said table below said grinding wheel in axial alignment with said grinding wheel; and a wheel dresser mounted upon said table for swinging movement about one of said posts including a slide, a wheel dressing bit carried by said slide, a spring for yieldably urging the working point of said wheel dressing bit into engagement with the periphery of said circular guide, means for locking said spring-urged wheel dressing bit against movement relative to said slide, and means for elevating said slide to raise said locked wheel dressing bit out of engagement with said circular guide and into engagement with said grinding wheel to dress said grinding wheel to the same diameter as said removable plug.

7. Grinding apparatus comprising: a table; a rotatable grinding wheel; means supporting said grinding wheel for rotation relative to said table; a circular guide mounted upon said table below said grinding wheel in axial alignment with said grinding wheel; and a wheel dressing device mounted on said table including a body, a slide mounted in said body, a wheel dressing bit mounted in said slide, means carried by said slide yieldably urging the working point of said dressing bit into engagement with said circular guide,

means for locking said dressing bit against movement relative to said slide, and means for elevating said slide to raise said dressing bit to a position in engagement with said grinding wheel, whereby to dress said grinding wheel to the same diameter as said circular guide.

8. Grinding apparatus comprising: a table; a rotatable spindle; means supporting said spindle for rotation relative to said table; a grinding wheel carried by said spindle; a removable, circular guide plug carried by said table below said grinding wheel in axial alignment with said grinding wheel; and grinding wheel dressing means mounted upon said table including a body having a tracer block fixedly mounted therein; a slide movable vertically relative to said block; a combined tracer and wheel dressing bit mounted in said slide, said tracer-bit having one end thereof engageable with said tracer block and its other end provided with a diamond point engageable with said circular plug, means constantly urging said tracer-bit into engagement with said tracer block, and means for elevating said slide to a position to engage said diamond point with said grinding wheel to dress at least a portion of the periphery of said grinding wheel to the same diameter as said circular guide plug and to shape the remainder of said periphery to a contour corresponding to that of the surface of the tracer block engaged by said one end of said tracer-bit.

9. Grinding apparatus comprising: a table; a rotatable spindle; means supporting said spindle for rotation relative to said table; a grinding wheel carried by said spindle; a removable, circular guide plug mounted upon said table below said grinding wheel in axial alignment with said grinding wheel; and wheel dressing means adjustably mounted upon said table and including a body having a tracer block fixedly mounted therein, a slide mounted in said body, a wheel dressing bit carried by said slide, means urging one end of said wheel dressing bit toward said tracer block, said end of said bit being pointed to enable the same to accurately follow the configuration of said tracer block, the opposite end of said wheel dressing bit carrying a cutting element adapted to be engaged with the outer periphery of said circular guide plug to determine the position of said body upon said table for performing a wheel dressing operation, means for clamping said body to said table, and means for actuating said slide to raise said wheel dressing bit out of engagement with said circular guide plug and into engagement with said grinding wheel, whereby to impart a peripheral shape to said grinding wheel corresponding to that of the surface of the tracer block engaged by said pointed end of said wheel dressing bit.

10. Grinding apparatus comprising: a table; a rotatable spindle; means supporting said spindle for rotation relative to said table; a grinding wheel carried by said spindle; a removable circular guide plug mounted upon said table below said grinding wheel in axial alignment with said grinding wheel; and wheel dressing means adjustably mounted upon said table and including a body having a tracer block fixedly mounted therein, a slide mounted in said body, a wheel dressing bit carried by said slide; means urging one end of said wheel dressing bit toward said tracer block, said end of said bit being pointed to enable the same to accurately follow the configuration of said tracer block, the opposite end of said wheel dressing bit carrying a cutting element adapted to be engaged with the outer periphery of said

circular guide plug to determine the position of said body upon said table for performing a wheel dressing operation, means for clamping said body to said table, an operating lever pivotally connected with said slide, and a pair of links pivotally mounted at one end upon said body and pivotally connected at their opposite end to the medial portion of said operating lever, so that upon actuation of said operating lever said slide will be elevated to raise said wheel dressing bit out of engagement with said circular guide plug and into engagement with said grinding wheel, whereby to impart a peripheral shape to said grinding wheel corresponding to that of the surface of the tracer block engaged by said pointed end of said wheel dressing bit.

11. Grinding apparatus comprising: a table; a

rotatable spindle; means supporting said spindle for rotation relative to said table; a grinding wheel carried by said spindle; a circular guide mounted upon said table below said grinding wheel in axial alignment with said grinding wheel; a wheel dresser mounted upon said table including a dressing tool engageable with the periphery of said circular guide; a spring for yieldably urging the working point of said dressing tool into engagement with the periphery of said circular guide; means for locking said spring-urged dressing tool in adjusted position; and means for elevating said dressing tool into engagement with said grinding wheel to dress the same to a diameter corresponding to that of said circular guide.

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