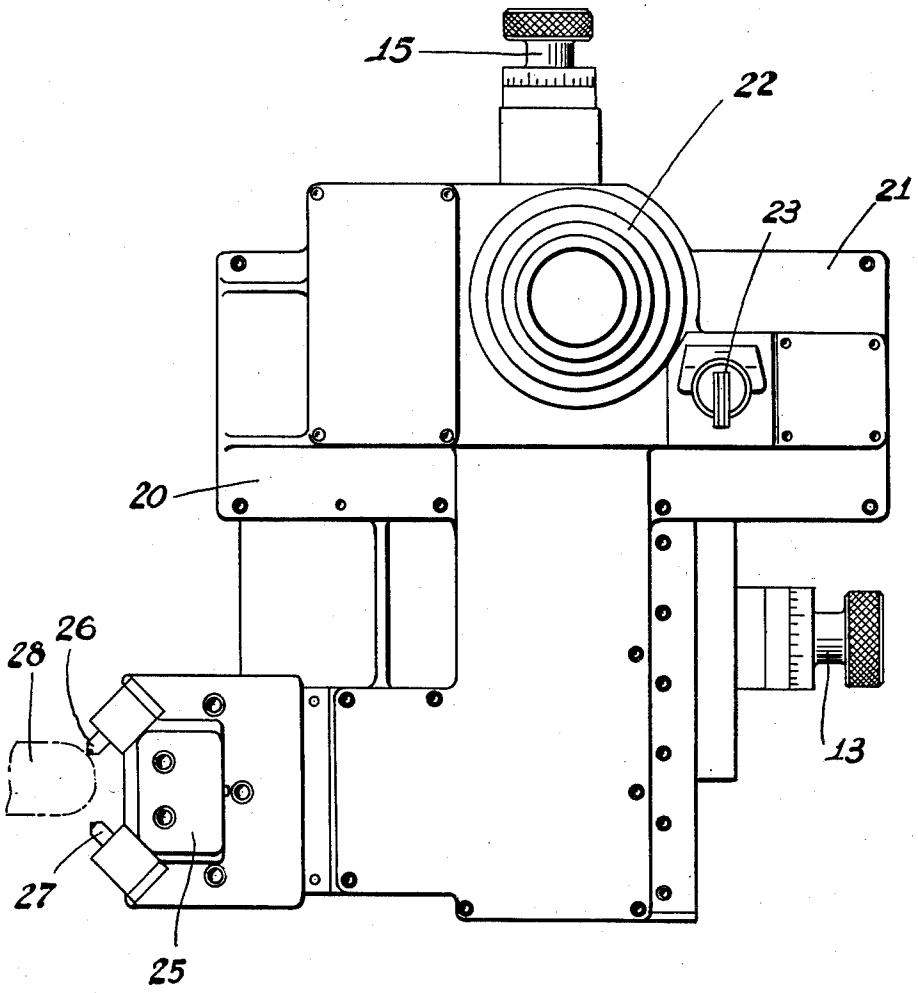
Nov. 10, 1953 N. HOGLUND 2,658,501

GRINDING WHEEL DRESSING APPARATUS

Filed Feb. 12, 1952 5 Sheets-Sheet 1

Fig. 1



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GRINDING WHEEL DRESSING APPARATUS

Filed Feb. 12, 1952 5 Sheets-Sheet 2

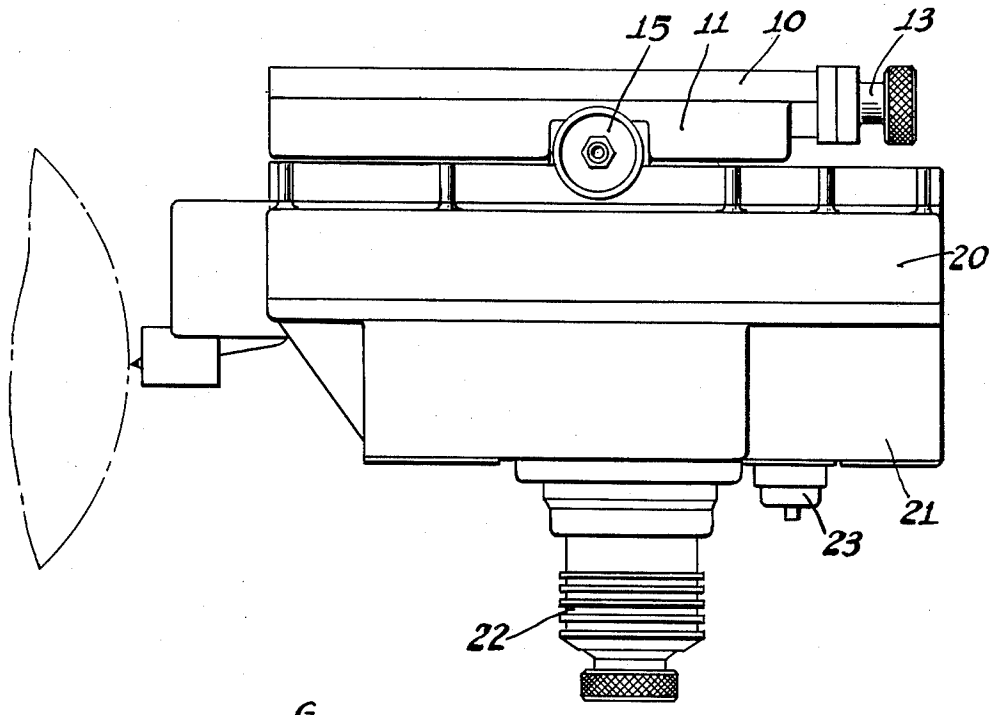


Fig. 2

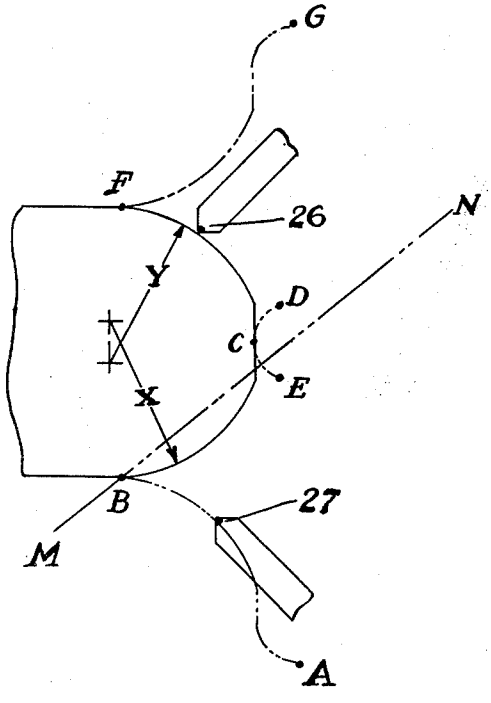


Fig. 7

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GRINDING WHEEL DRESSING APPARATUS

Filed Feb. 12, 1952 5 Sheets-Sheet 3

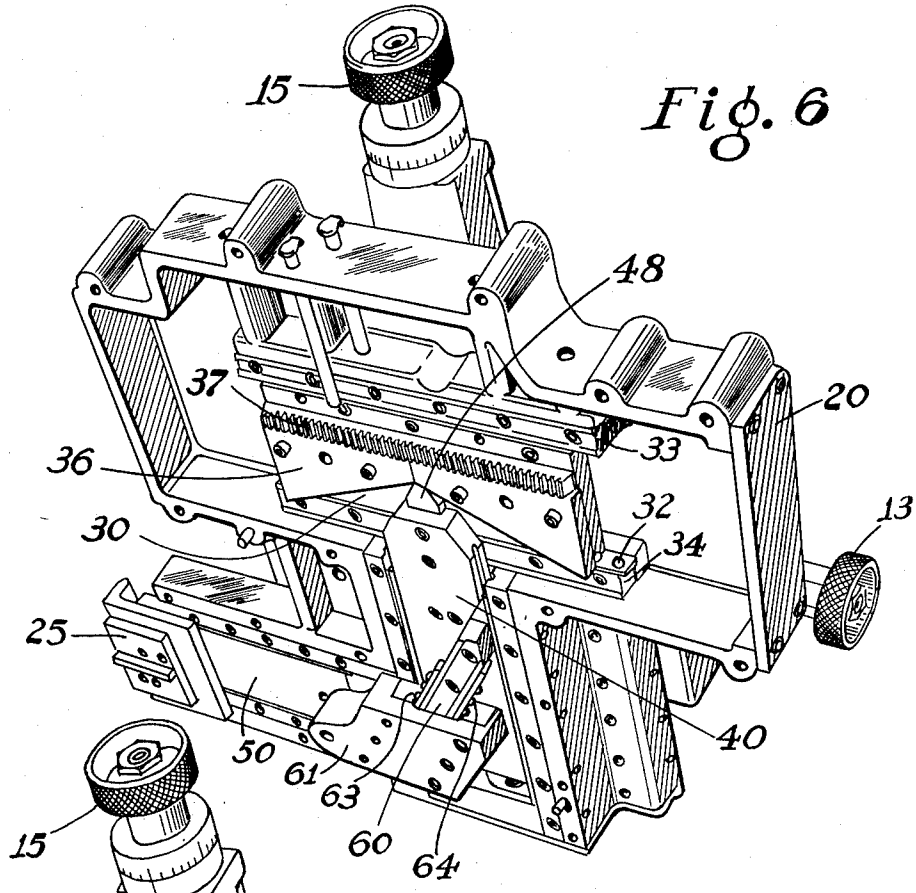


Fig. 6

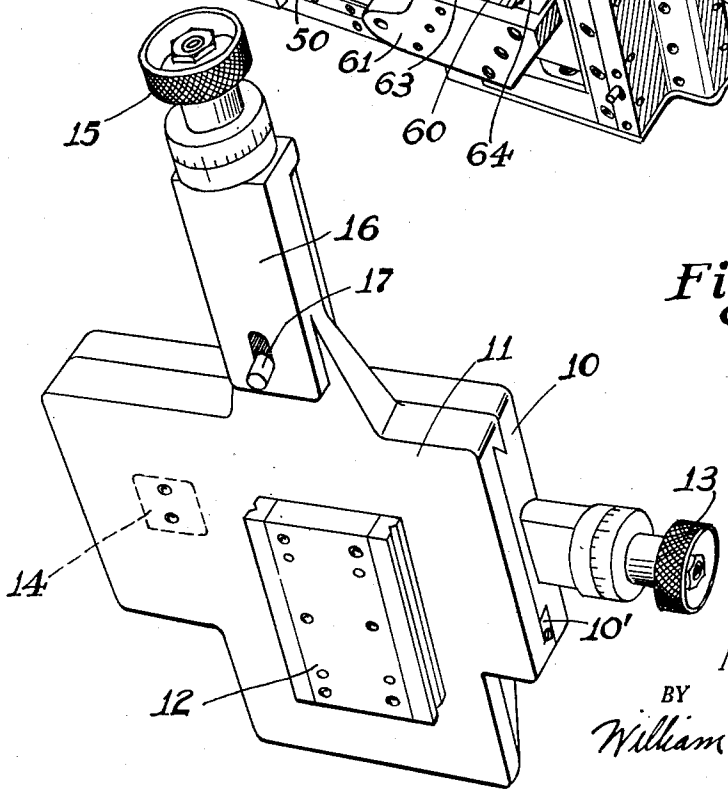


Fig. 3

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GRINDING WHEEL DRESSING APPARATUS

Filed Feb. 12, 1952 5 Sheets-Sheet 4

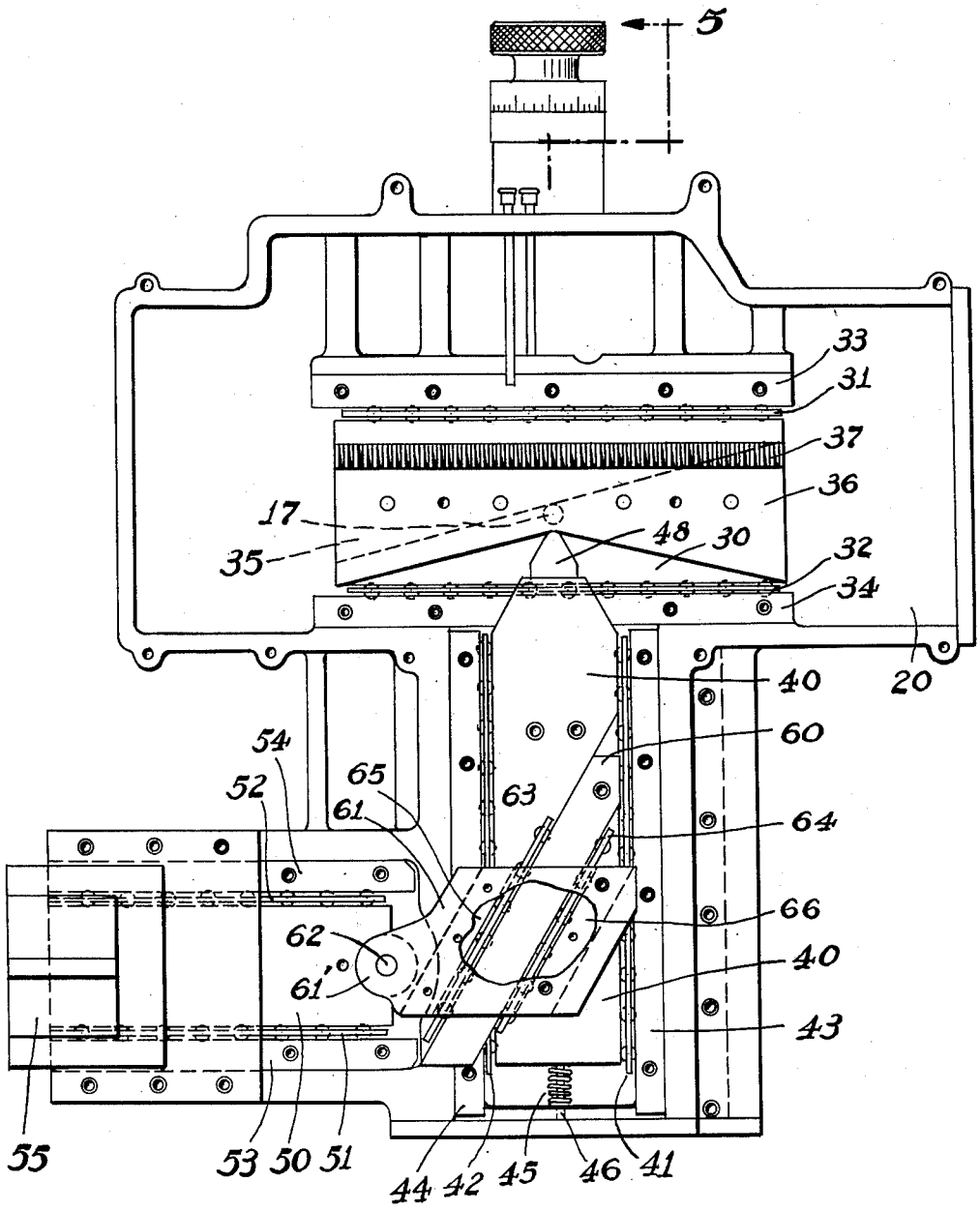


Fig. 4

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GRINDING WHEEL DRESSING APPARATUS

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5 Sheets-Sheet 5

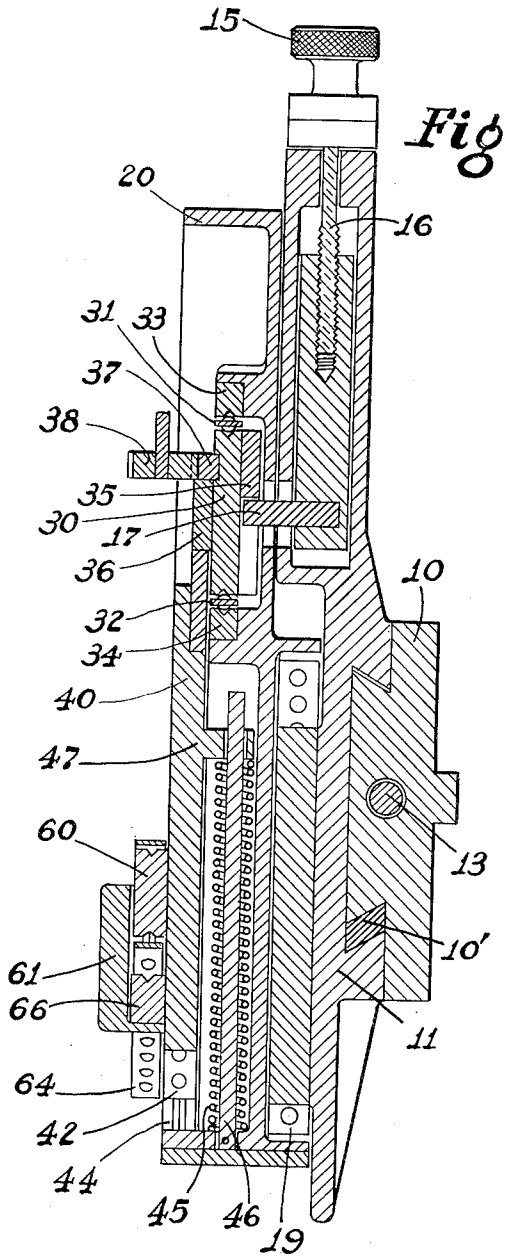


Fig. 5

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UNITED STATES PATENT OFFICE

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GRINDING WHEEL DRESSING APPARATUS

Nils Hoglund, Summit, N. J.

Application February 12, 1952, Serial No. 271,255

9 Claims. (Cl. 125—11)

1

My invention relates to grinding wheel dressing apparatus, more particularly to apparatus for automatically dressing, turning and forming precise contours on grinding wheels. The present invention relates particularly to a dresser for use with grinding wheels having vertically mounted spindles and useful on boring mill grinders.

Prior apparatus for forming contours have employed different methods, one such being the conventional crushing method where a preshaped crushing roller is used for forming the contour on the grinding wheel. Another employs a diamond tracing device which uses a templet usually having a one-to-one ratio which is contacted by a follower to guide the diamond cutting or dressing tool across the surface of the wheel being dressed. A modification of the last is a dressing device operating from a templet with a one-to-one radial ratio and a two-to-one axial ratio so designed that a follower and templet are travelling at a two-to-one ratio in the same direction, causing the diamond to produce the one-to-one ratio contour on the wheel in both coordinates. Other devices of this kind have also utilized a pantograph arrangement which supports the cutting diamond. Many dressing devices of previous apparatus have employed as their prime movers complicated hydraulic mechanisms which are comparatively costly.

Further, due to the small ratio employed on some of the contour cams and followers associated therewith error is introduced in the contour being formed unless the cam is extremely accurate. This requires careful, arduous and long preparation in the manufacture of the cam.

Previous devices of this kind have also been complicated requiring much space. In many cases the devices are not automatically controlled for successively passing the cutting diamond across the face of the wheel being dressed. Manual control of this operation induces further error.

In some types of apparatus it is necessary to vertically support large revolving turrets in bearings. In order to insure free rotation ball-bearing assemblies of large diameter are used. It has been found, however, when these turrets are subjected to large transverse forces the bearings cause Brinell effects, that is, indentations in the ball races. This has made it necessary to harden the bearing surfaces by various heat treatments. However, in spite of all care taken in the heat treating, the distortion is so large in the ball races that a great deal of work in hand polishing and hand grinding is necessary to correct the

2

errors caused by distortion. Such a process is extremely slow and very unsatisfactory. It has been proposed to grind these races after hardening. This, however, required grinding wheels mounted on vertical spindles. Such grinders have been associated with boring mills in which the grinding spindles are attached to a ram in vertical position. In the industry these machines have been called tank grinding mills.

One of the most difficult problems introduced with this type of machine is that of dressing the contours of the grinding wheels when supported on vertically mounted spindles. Hand dressing usually required about forty-five minutes but still failed to produce the accurate contours required for accurately grinding the ball races.

It is, therefore, an object of my invention to provide an improved and simplified form of grinding wheel dressing apparatus.

A further object of my invention is to provide such an improved apparatus which insures accurate contours by eliminating the need for pantograph operation, which pantograph operation induces accumulated errors during operation.

A further object of my invention is to eliminate hydraulic drive and utilize electric driving means of simple form.

Another object of my invention is to provide apparatus utilizing cams enlarged many times over the contour being dressed and of the order of, for example, ten times the controlled movement of the cutting tool whereby error is eliminated and accuracy is assured.

A still further object of my invention is to provide cams having a sufficiently large ratio so that the contour on the cams can be easily changed to correct any inaccuracy shown on the finished contour.

A further object of my invention is to provide such an apparatus which is compact and which is automatic, and which eliminates the skill required for dressing when manual operation or semi-manual operation is employed.

A further specific object of my invention is to provide an improved apparatus for forming contours or dressing the grinding surfaces, particularly on grinding wheels mounted on vertically positioned shafts.

A still further object of my invention is to provide such a dressing mechanism which while insuring accuracy reduces time of dressing to a minimum and which is of simplified construction.

Briefly in accordance with my invention I provide a base for supporting in a vertical plane a

slide movable horizontally toward and from the grinding wheel being dressed. A housing is slidably mounted on the slide for movement in a vertical plane. The housing is supported on an adjustable pin carried by the slide. The housing by means of mechanism to be described and mounted on the housing is caused to reciprocate in a vertical plane when the apparatus is in operation, the housing and all of the other mechanism therein being supported entirely by the pin.

The housing supports at its lower end a dressing tool having a pair of oppositely disposed cutting or dressing diamonds. This tool is slidably supported on a slide within the housing and is movable toward and from the wheel being dressed in a direction normal to the movement of the housing. Only one diamond engages the grinding wheel surface at a time.

Within the upper part of the housing is mounted a slide upon which are supported a pair of cams and which is driven in a reciprocating movement by an electric motor mounted on the housing. One of the cams engages the pin and causes reciprocating movement in a vertical plane of the housing. The other cam or templet is engaged by a cam follower which is caused to move in accordance with the contour of the cam as the cam slide moves back and forth. Connected between the follower and the slide supporting the tool is a ratio cam assembly which positively couples the tool slide and the cam follower and its slide so that the surface on the contour cam or templet is reproduced on the grinding wheel surface on a reduced scale.

Referring to the drawings, Figure 1 is a front elevation of a grinding wheel dressing apparatus made according to my invention, Figure 2 is a top view of Figure 1, Figure 3 is a perspective of the base and the main or in-feed slide assembly, Figure 4 is a plan view with the cover removed of the apparatus shown in Figures 1 and 2 and disassociated from the base and main slide, Figure 5 is a section taken along line 5—5 of Figure 4, Figure 6 is a perspective view of the structure shown in Figure 4, and Figure 7 shows the details of one of the surfaces which can be ground by apparatus made according to my invention.

General

Referring particularly to Figures 1, 2 and 3, an apparatus made according to my invention includes a base 10 which may be fixed to a mounting pad of the machine employing the grinding wheel to be dressed. This base 10 slidably supports thereon the main or in-feed slide 11 upon which is supported the slide guide 12 for the main frame and housing. This main slide 11 may be adjusted horizontally, that is radially toward and from the grinding wheel 28 to be dressed by means of the adjusting screw 13 mounted in base 10 and having nut 14 shown in dotted outline in Fig. 3, which is secured to the bottom of the slide 11. A gib 10' varying minutely in width along its length can be adjusted longitudinally to fit slide 11 and base 10. This is a conventional structure for controlling movement of slides in apparatus of this kind. At the upper end of the slide 11 is the vertical adjusting screw 15 threaded into the nut 16 which supports the pin 17. As will be described, the entire main frame housing, dressing tool and operating mechanism are supported by pin 17 which cooperates with mechanism to be described for controlling the vertical reciprocating movement of the housing and tool. The main frame 20, which is mounted on the slide guide 12 in a manner to be described, is provided with cover 21 which supports the electric driving motor 22 and the switch 23. The tool 25 having the cutting diamonds 26 and 27 is mounted on a slide within the main frame and to be described and moves radially toward and from the grinding wheel being dressed as the frame and housing are moved in a vertical direction to dress the grinding wheel 28.

When the motor 22 is energized, through mechanism to be described, the housing, the frame 20 and all of the parts supported thereon are caused to move in a reciprocating fashion in a vertical direction carrying dressing tools 26 and 27 axially of or across the grinding wheel being dressed. At the same time the cutting diamonds are caused to move in and out radially of the grinding wheel being dressed through connections within the housing. The movements of the diamonds are controlled by a system of cams and slides in accordance with a predetermined contour.

Main frame and drive

Reference is now made to Figures 4, 5, 6 and 7. In the upper part of the main frame and housing 20 a slide and cam assembly is mounted in ball bearing supports to move normally of or perpendicularly of the movement of the housing. On the back or undersurface of the slide there is carried an elongated triangularly shaped ratio cam, the surface of which contacts the pin 17 previously referred to. On the front or upper surface of the slide there is mounted a contour cam of predetermined design having a reproduction of the contour to be dressed which in some cases may be distorted. This second cam or templet is contacted by a follower or stylus to be described. A rack mounted on the slide cooperates with a pinion driven by a reversible electric motor for causing a reciprocating movement of the slide and cams transversely of the vertical axis of the assembly.

Specifically a slide 30 is supported by means of ball bearing assemblies 31 and 32 and ball bearing race members 33 and 34. Mounted on one side of the slide is the elongated triangularly shaped ratio cam 35 which contacts and rests on the pin 17. Mounted on the opposite surface of the slide is the templet or contour cam 36. The rack 37 is also mounted on the templet side of the slide and is engaged by the pinion 38 driven by the electric motor 22.

It will be observed that as the slide 30 is moved back and forth that the cam 35 will ride up and down on the pin and since the main frame and housing and all of the enclosed mechanism are supported by the pin, the entire housing will be raised as the slide moves from left to right. Also in this operation the cam follower 48, which is to be discussed in further detail below, will follow the surface of the contour of the cam 36 to control movement of the tool slide in a manner to be described. The initial position of the entire assembly is controlled by position of the pin 17, which in turn can be adjusted vertically by the screw 15 operably associated with the slidable nut 16 which supports the pin. This assembly is slidably mounted on slide guide 12 by ball bearing assemblies 18 and 19.

Contour slide assembly

The contour slide assembly which supports the

follower is also mounted with ball bearing assemblies and is urged into contact with the contour cam 36 by a compression spring so that the follower is constantly in contact with the cam surface.

More specifically the follower slide 40 which supports the follower 48 is mounted in the ball bearing assemblies 41 and 42, which in turn are supported in the races 43 and 44 mounted in the frame. A compression spring 45 is mounted on the spring support rod 46 which is secured in the frame 20 at one end and is engaged by the boss 47 mounted on the slide 40. The boss 47 is provided with an aperture through which the spring support rod 46 extends, the rod and boss having relative movement. The stress stored in the compression spring 45 constantly urges slide 40 and follower 48 upwardly against the templet 36.

Thus as the cam templet 36 reciprocates the slide 40 reciprocates in a vertical plane parallel to the movement of the main frame and housing.

Tool slide and support

The tool slide 50 is mounted with the ball bearing assemblies 51 and 52 positioned between the slide and the races 53 and 54. It is free to move radially toward and from the grinding wheel and normally to the movement of the main frame and housing. It supports at its outer end a tool support member 55 upon which are mounted the diamonds 26 and 27.

Ratio slide

To transfer movement of the follower slide 40 to the tool slide 50 and to cause movement of the tool in accordance with the contour to be dressed, I provide between these two slides a ratio slide assembly so that as the follower slide 40 moves in a vertical direction the tool slide will move in a horizontal direction or a direction normal to the vertical.

Mounted on the slide 40 is the slide guide 60, the guide 60 being mounted at an angle to the movement of the slide determined by the various factors required for converting the relative movement of the cam 36 and follower 48 into movement of the slide 50 for reproducing the contour desired. Positioned over and engaging the slide guide 60 is the yoke-shaped slide 61, the slide being supported on the slide guide 60 by means of the ball bearing assemblies 63 and 64 and ball bearing race members 65 and 66. The slide 61 is provided with a boss 61' provided with an aperture through which the pin 62 extends, the pin 62 being secured to the tool slide 50.

As the slide 40 moves down, the yoke engaged by the slide guide 60 will cause the slide 61 to move to the right positively causing slide 50 to move to the right or away from the axis of the wheel being ground. Upward movement of the slide 40 produces opposite movement of the tool slide 50 toward the wheel being dressed.

It will be observed that the contour on the templet 36 is the same as the contour being formed on the grinding wheel, each half controlling only one diamond during cutting or dressing. It will also be observed that the contour on the cam 36 is much wider than that on the grinding wheel being dressed. By means of the mechanism described the transverse movement of the cutting tool is much reduced from that of the surface of templet 36 and movement of the tools. By means of this arrangement it is possible to very accurately cut or dress the surfaces on the grinding wheel while at the same time making it comparatively easy to make the cam contours.

Operation

When a grinding wheel is to be dressed, screw 13 is adjusted to bring the slide 11 into proper radial position so that the dressing diamonds 26 and 27 are in proper position with respect to the grinding wheel. Screw 15 is adjusted to bring the apparatus in proper vertical adjustment by raising or lowering the pin 17 on which the main frame and its associated assembly are gravity supported.

Driving motor 22 is then turned on and through its connection with rack 37 by means of pinion gear 38 causes the slide 30 to move back and forth normal to the vertical axis of the assembly.

The entire weight of the main frame and its assembly is supported on pin 17 by means of the triangularly shaped ratio slide cam 35 and as the cam moves back and forth across pin 17 the main frame and its assembly including the tool support 55 move up and down. The degree of movement of course is determined by the angle or slope of the cam surface with respect to the horizontal, the greater the slope the greater the vertical movement.

As contour cam 36 moves from left to right the follower 48 moves in or up as the center of cam 36 passes by the follower and then out or down as the cam 36 continues to move to the right, the reverse action taking place when the cam moves from the right to left. Spring 45 constantly urges follower 48 and its supporting slide 40 against cam 36.

Transfer of the movement of slide 40 to tool slide 50 is accomplished by means of the slide guide 60 and slide 61 as described above. Movement of slide 60 up moves tool slide 50 toward the axis of the grinding wheel or inwardly of the surface being dressed. The reverse action takes place when slide 40 moves down. The movements of all slides are such that the distorted contour on the contour cam 36 is reproduced in the desired cam surface to be dressed.

Referring to Figure 7, as diamond 26 travels from E through C to F diamond 27 travels from A to B. Diamond 26 travels in open space from F to G when diamond 27 dresses the wheel from B to C and leaves the wheel to point D. The general direction of dressing movement of diamond 27 is along line M—N which deviates very little from radius X. This method of dressing gives longer life to diamonds than with single diamond dressing.

My invention provides an automatic dresser of simple construction which produces extremely accurately produced contours from contour cams which can be easily produced. Errors due to complicated link mechanisms and wear are reduced to a minimum. Experienced operators are made unnecessary with dressers made according to my invention. It is now possible to easily and quickly dress grinding wheels mounted on vertical spindles, cutting dressing time from 45 minutes to a cycle requiring less than one minute and making it possible to use such grinding wheels which have cut grinding time from one to two weeks to a matter of three to five hours.

What I claim as new is:

1. A grinding wheel dressing apparatus having a support, a main frame mounted for vertical movement on said support, a pin fixed to said support, a first slide mounted on said main frame and movable parallel thereto in a vertical direc-

tion, a second slide on said main frame movable normally to said first slide and carrying a tool for dressing a grinding wheel, and a ratio slide and slide guide connected between said first and second slides for transferring movement of said first slide to said second slide, a third slide mounted on said main frame and movable transversely of the direction of movement of said main frame, a cam supported on said third slide engaging said pin, said pin supporting said main frame and all of the elements supported thereon and connections between said third slide and said first slide for causing movement of the second slide.

2. A grinding wheel dressing apparatus having a support, a main frame mounted for vertical movement on said support, a first slide mounted on said main frame and movable parallel thereto in a vertical direction, a second slide on said main frame movable normally to said first slide and carrying a tool for dressing a grinding wheel positioned in a horizontal plane and mounted on a vertical spindle, and a ratio slide and slide guide connected between said first and second slides for transferring movement of said first slide to said second slide, said main frame and said slides moving in parallel vertical planes, fixed means on said support and a slide on said main frame contacting said fixed means and causing movement of said main frame when said last slide is moved, and connections between said last slide and said first slide for causing movement of said first and second slides.

3. A grinding wheel dressing apparatus having a base, a slide guide mounted vertically on said base, a slidable support mounted on said slide guide and having supported thereon a first slide supporting a contour cam, a second slide mounted on said slidable support and having a follower engaging said contour cam, a third slide mounted on said slidable support and movable normally to said second slide, a dressing tool supported on said third slide, a ratio slide mechanism comprising a slide guide and a slide connected between said second and third slides, and electrical means mounted on slidable support for moving said first slide carrying said contour cam for causing and controlling movement of said slidable support and tool slide.

4. A grinding wheel dressing apparatus having a supporting means, a slide guide mounted on said supporting means, a slidable support mounted on said slide guide and having supported thereon a first slide supporting a contour cam, a second slide mounted on said slidable support and having a follower engaging said contour cam, a third slide mounted on said slidable support and movable normally to said second slide, a dressing tool supported on said third slide, a ratio slide mechanism comprising a slide guide and a slide connected between said second and third slides, a fixed pin on said supporting means extending toward said slidable support, a second cam mounted on said first slide and having a surface engaging said pin, said movable support and all of the elements thereon being supported entirely by said pin, means connected to said first slide for moving said first slide and causing movement of said movable support and all of the elements supported thereon.

5. A grinding wheel dressing apparatus including a base, a main slide vertically mounted on said base and horizontally movable thereon, an adjustable pin supported on said slide, said main slide having a slide guide mounted thereon, a main frame and housing mounted on said slide guide for vertical movement on said main slide, a first slide mounted in said main frame and housing and movable transversely of the movement of said housing, a cam mounted on one surface of said first slide and engaging said pin for controlling vertical movement of said frame and housing when said first slide is reciprocated, a templet mounted on the opposite surface of said slide, and a rack mounted on said first slide, and an electric motor having a pinion engaging said rack and carried by said frame and housing, a second slide mounted in said main frame and housing and movable parallel to the movement of said main frame and housing, a templet follower mounted on said second slide and contacting said templet, and a compression spring mounted between said second slide and said main frame and housing for urging said second slide and follower against said templet, a third slide movable transversely of said second slide, a dressing tool mounted on said third slide, a ratio slide assembly connected between said second and third slides and comprising a slide guide, and a yoke shaped slide connected therewith for transferring movement between said second and third slides, said main frame and housing and said slides being supported by said pin, said housing reciprocating in a vertical direction and said tool slide and tool being reciprocated in a direction normal thereto when the electric motor is energized.

6. A grinding wheel dressing apparatus including a base, a main slide mounted on said base and movable thereon, a pin supported on said slide, said main slide having a slide guide mounted thereon, a main frame and housing mounted on said slide guide for movement on said main slide, a first slide mounted in said main frame and housing and movable transversely of the movement of said housing, a cam mounted on one surface of said first slide and engaging said pin for controlling movement of said frame and housing when said first slide is reciprocated, a templet mounted on the opposite surface of said slide, and a rack mounted on said first slide, and a motor mounted on said housing and having a pinion engaging said rack, a second slide mounted in said main frame and housing and movable parallel to the movement of said main frame and housing, a templet follower mounted on said second slide and contacting said templet, and a compression spring mounted between said second slide and said main frame and housing for urging said second slide and follower against said templet, a third slide movable transversely of said second slide, a dressing tool mounted on said third slide, a ratio slide assembly connected between said second and third slides and comprising a slide guide, and a yoke shaped slide connected therewith for transferring movement between said second and third slides, all of said slides moving in parallel planes.

7. A grinding wheel dressing apparatus having a base, a vertically mounted main slide mounted on said base for movement in a direction normal to the vertical mounting, a slidable support mounted on said main slide and having supported thereon a first slide supporting a templet, a second slide mounted on said slidable support and having a follower engaging said templet, a third slide mounted on said slidable support and movable normally to said second slide, and a dressing tool supported on said third slide, and a ratio slide mechanism comprising a slide guide

and a slide connected between said second and third slides and means for moving said first slide carrying said contour templet for causing and controlling movement of said tool slide, said main slide having a pin thereon extending toward said slidable support, a cam mounted on said first slide and having a surface engaging said pin, said movable support and all of the elements thereon being supported by said pin, movement of said first slide causing vertical movement of said movable support and all of the elements supported thereon.

8. A grinding wheel dressing apparatus including a base, a main slide vertically mounted on said base and horizontally movable thereon, an adjustable pin supported on said slide, said main slide having a slide guide mounted thereon, a main frame and housing mounted on said slide guide for vertical movement on said main slide, a first slide mounted in said main frame and housing and movable transversely of the movement of said housing, an elongated triangularly shaped cam mounted on one surface of said first slide and engaging said pin for controlling vertical movement of said frame and housing when said first slide is reciprocated, a templet mounted on the opposite surface of said slide, a second slide mounted in said main frame and housing and movable parallel to the movement of said main frame and housing, a templet follower mounted on said second slide and contacting said templet, a third slide movable transversely of said second slide, a dressing tool mounted on said third slide, a ratio cam connected between said second and third slides and comprising a slide guide, and a yoke shaped slide connected therewith for transferring movement between said second and third slides, said last slide guide being positioned at an angle to the longitudinal axes of the second and third slides, said main

frame and housing and said slides being supported by said pin, said housing moving in a vertical direction and said tool slide and tool being moved in a direction normal thereto when said first slide is moved.

9. A grinding wheel dressing apparatus having a base, a vertically mounted main slide mounted on said base, a slidable support mounted on said slide and having supported thereon a first slide supporting a cam, and movable normally to the vertical a second slide mounted on said slidable support and movable parallel to said first slide, and a dressing tool supported on said second slide, and mechanism including a ratio slide mechanism comprising a slide guide and a slide connected between said first and second slides and means for moving said first slide for causing and controlling movement of said second slide, said main slide having a pin thereon extending toward said slidable support, said cam mounted on said first slide having a surface engaging said pin, said movable support and all of the elements thereon being supported by said pin, movement of said first slide causing vertical movement of said movable support and all of the elements supported thereon.

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