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[21] Appl. No. **792,677**
[22] Filed **Jan. 21, 1969**
[45] Patented **June 1, 1971**
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[56]

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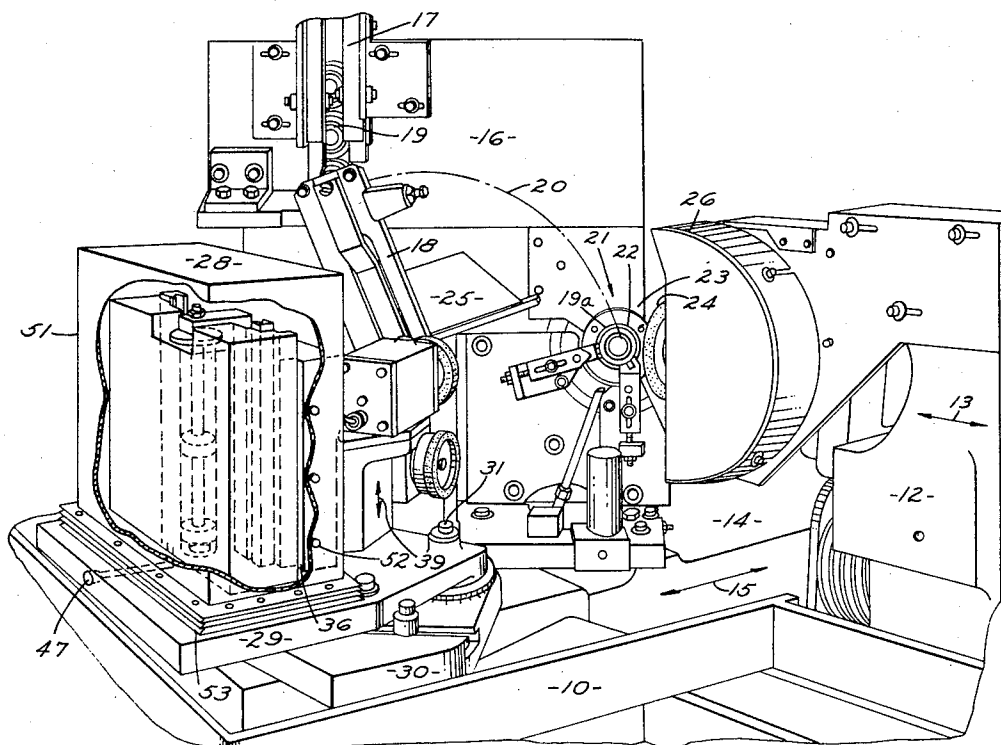
[54] **ROTARY CONJUGATE DRESSER**
2 Claims, 8 Drawing Figs.

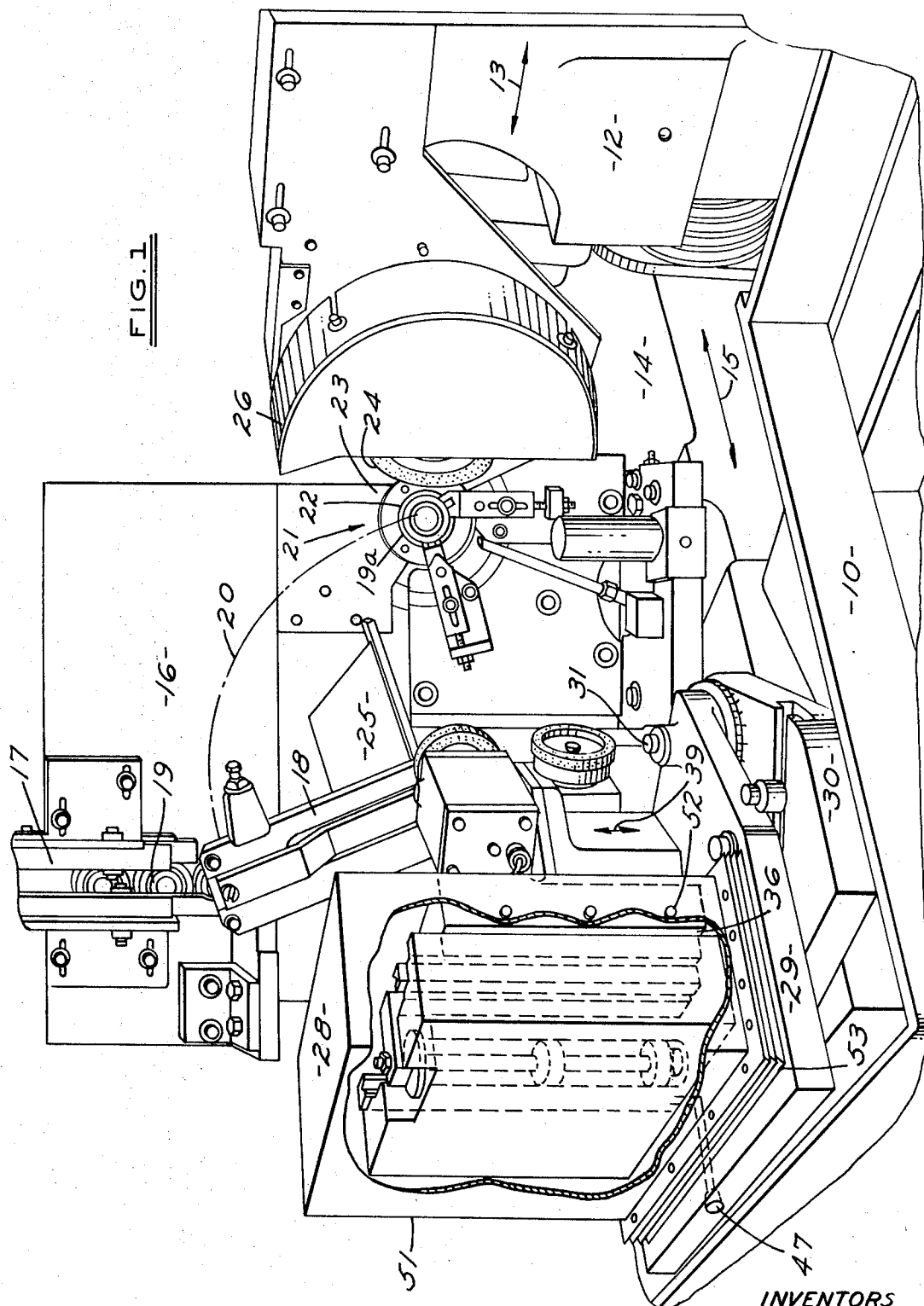
[52] U.S. Cl..... **125/11CD**

[51] Int. Cl..... **B24b 53/14**

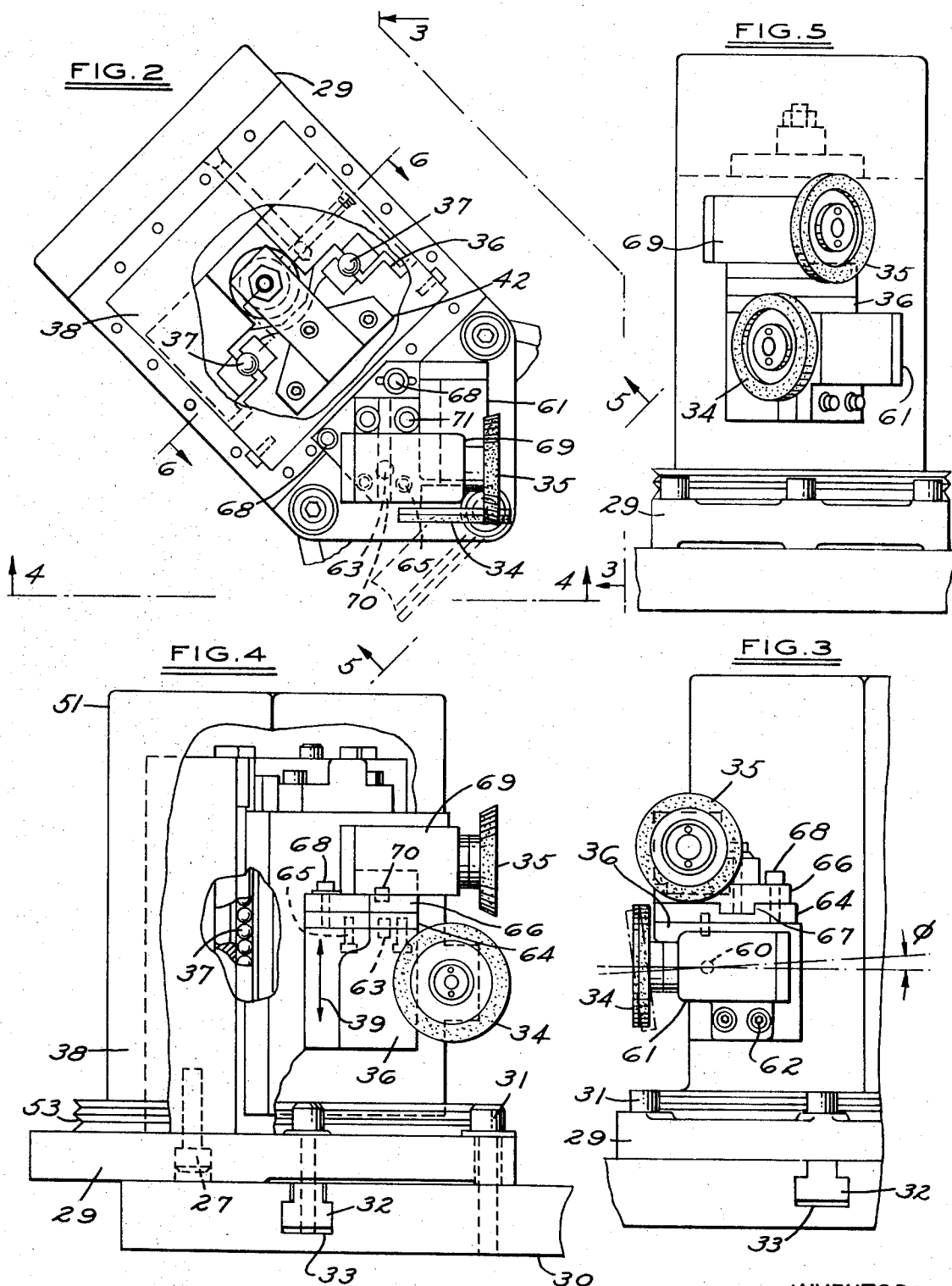
[50] Field of Search..... **125/11**

ABSTRACT: A conjugate wheel dresser for truing a grinding wheel in order to plunge grind surfaces at angles to each other such as the track and rib of the inner race of roller bearings; the mechanism consisting of at least two motor driven dressing cutters, coated with abrasive grits such as diamonds. The dress is accomplished by one pass of the conjugate dresser.





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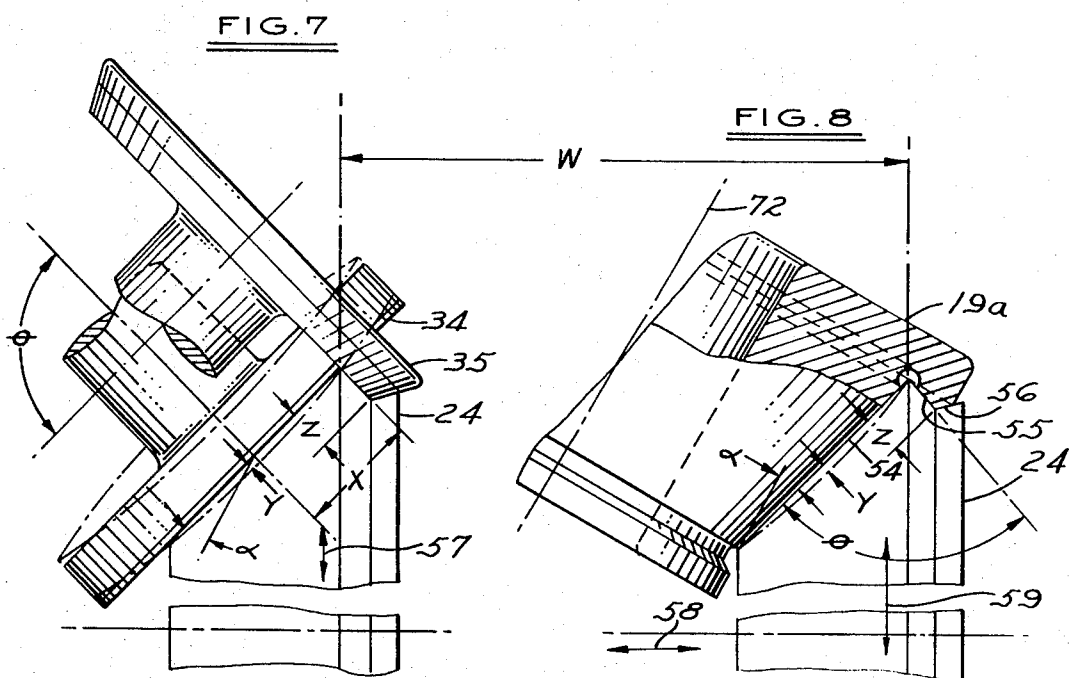
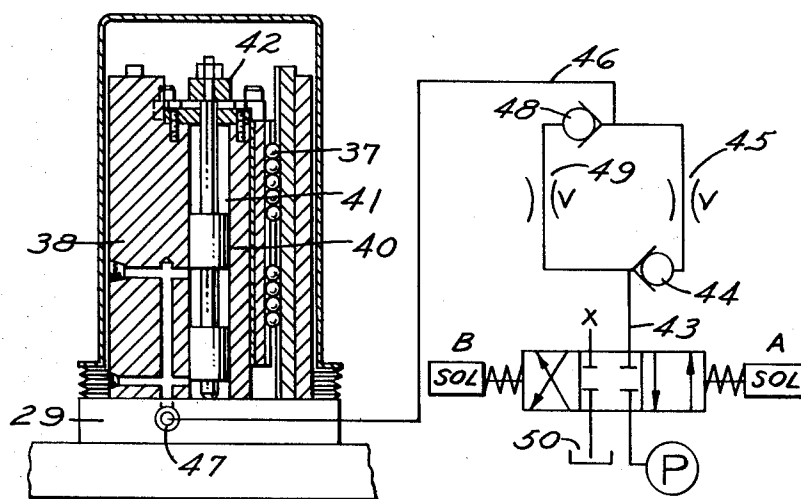


FIG. 6



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ROTARY CONJUGATE DRESSER

BACKGROUND OF THE INVENTION

This invention relates to wheel dressing in general, but more especially dressing the grinding wheel for the conjugate form grinding of workpieces such as the conical race and flat rib of roller bearing tapered cones.

The concept of conjugate grinding of two surfaces is not new per se; this method of accomplishing the dress is. In the past it has been customary to use one diamond point for each element of the wheel surface, each with its own piston or motive device, used alternately. As each diamond must slowly traverse its surface as the wheel turns, understandably, a considerable time must be consumed during each dress cycle, and, since dressing must be done every 1 to 20 parts (considering their size), a saving in time is very desirable.

Further, since all the material dressed from the grinding wheel must be removed by one diamond point, the wear is considerable and consequently the point on the diamond rapidly dulls. Accordingly, once or twice a day, the diamonds must be rotated. This requires much trial and error grinding to keep within the closer tolerances desired, and the time loss further compounds the problem.

Machine time and man hours being a very significant part of manufacturing cost, it is our object to invent a mechanism which will not only reduce machine down time for replacement or resetting of the dressing tool, but will also speed the actual dressing operation itself.

SUMMARY OF THE INVENTION

According to the present invention, the grinding wheel is dressed by one pass of the conjugate dresser, in which two rotatable abrasive-faced dressing cutters, a track cutter and a rib cutter, dress the grinding wheel. The two cutters are offset relative to each other so as to dress the grinding wheel in order that the grinding wheel will form grind the track and rib of the workpiece in one simultaneous grind.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a general environmental view, partially in section, of the conjugate dresser in place on a grinder;

FIG. 2 is a plan view with a portion of the guard removed.

FIG. 3 is an elevation view looking directly toward the back of the dressing cutter for the rib portion of the grinding wheel;

FIG. 4 is an elevation view looking directly toward the dressing cutter for the track portion of the grinding wheel;

FIG. 5 is an elevation view looking at the conjugate dresser along a line parallel to the axis of the grinding wheel;

FIG. 6 is a section through the elevating mechanism showing the antifriction slides and piston, including the hydraulic circuit;

FIG. 7 is an enlarged plan view of the cutters in dressing position showing the track-forming dressing cutter, the rib-forming dressing cutter, and the grinding wheel; and

FIG. 8 is a plan view of the contact between grinding wheel and workpiece.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In FIG. 1, a conventional type of form grinder is mounted on a bed 10. A wheel slide 12 is mounted for crossfeed movement as indicated by arrow 13.

The workslide 14 is located on the bed 10 and is mounted for movement longitudinally as indicated by arrow 15, between the grinding position as shown and the dressing position as will be explained later on.

Mounted on the workslide 14 is the loader mechanism 16, shown with a magazine 17 containing unground workpieces 19.

Loader arm 18 periodically transfers one workpiece 19a from the magazine 17 along arcuate path 20 to work station 21, and deposits it on a magnetic chuck 22, where it is rotated in a typical "shoe centerless" manner by the workhead hidden

behind splash guard 23. The loader arm 18 is shown raised to better view the work station. Normally the arm remains down during the grinding operation.

Directly in front of the work station 21 is the grinding wheel 24 partially hidden under the wheel guard 26. The wheel 24 is crossed into the workpiece 19a located at the work station 21 until the desired finish size is attained. It is then withdrawn as shown by arrow 13.

The finished workpiece 19 is then automatically removed from the work station 22 and dropped into discharge chute 25 in a manner not part of this invention.

Periodically, a dressing operation is required to sharpen the grinding wheel 24. This is performed by the conjugate wheel dresser 28 mounted on the workslide 14 by attaching baseplate 29 over sub-base 30 which is part of the workslide. Baseplate 29 is swiveled horizontally about pivot 31, and locked in position by tee nuts 32 in slot 33, as seen in FIG. 3 and FIG. 4.

Referring to FIGS. 2-5, we see more detailed views of the conjugate wheel dresser 28 which will now be described more fully. In general, it consists of two abrasive faced dressing cutters—a track cutter 34 and a rib cutter 35—each mounted on a motorized spindle. These two cutters are mounted on an elevator block 36, which moves up and down on antifriction slides 37, separating it from a fixed cylinder block 38. The movement direction is indicated by arrow 39, as seen in FIG. 4.

The cylinder block 38, which is rigidly bolted to baseplate 29 by bolts 27, contains a hydraulic cylinder 41 (FIG. 6) for moving the elevator block 36 carrying motorized dressing cutter spindles 61 and 69. A piston and rod assembly 40 in the cylinder 41 is connected to the elevator block 36 through bracket 42, as is best seen in FIG. 6. The hydraulic circuit will be explained later on.

Looking again at FIG. 1, it will be noted that the internal mechanism particularly the antifriction bearings 27 is well guarded by housing 51. This is attached to the elevator block 36 by screws 52, allowing it to move up and down with the dresser. In order to keep the coolant and grinding swarf out of the mechanism, an accordionlike bellows 53 is attached between the bottom of the housing 51 and the baseplate 29.

FIG. 7 and FIG. 8 show the plan view of the grinding wheel at the dressing station and at the grinding station respectively. FIG. 7 shows the relative positions of the track cutter 34, the rib cutter 35, and the wheel 24. The corresponding position of wheel and workpiece is shown in FIG. 8.

The procedure of setting the dressing cutters will now be described.

In order to achieve the exact profile specified for the workpiece, it is necessary to very carefully position the track and rib cutters 34 and 35 relative to each other, as seen in FIG. 7, so as to dress the grinding wheel to form grind the workpiece shown in FIG. 8.

To perform this, the following steps should be taken in order:

- set the angle alpha (α), or cone angle, of the workpiece drawing;
- set the crown dimension "Y" (usually between 0 and 0.0001 inches) to specification;
- set the angle theta (θ), the rib face to track angle, (usually specified at about $89\frac{1}{2}^\circ$);
- set the distance "X" from rib cutter 35 to the centerline of track cutter 34, in order to locate the crown at the center of the track;
- set the height "Z" of the rib face above the track;
- The chamfer angle between rib face 55 and chamfer 56 is built into the rib cutter itself, and is not adjustable. Alternatively a radius might be used. These settings as outlined above are accomplished as follows:

- The cone angle alpha (α) (seen in FIG. 7 and FIG. 8), is the angle between the axis 72 of the workpiece and the face of the track cutter 34. The correct angle is set by swiveling the wheel dresser baseplate 29 about pivot 31

and locking the position by means of tee nuts 32 in slot 33 (FIG. 4).

- b. Setting the crown dimension "Y" to specification (FIG. 7 and 8) is accomplished by tilting the face of the track cutter 34 slightly toward the wheel from the vertical. The angle (Φ) is very small and is changed by swiveling the track-dressing cutter spindle 61 about the pivot 60 (seen in FIG. 3), and locking it using clamp screws 62. The method of calculating "0" and "Y" is described in our copending application Ser. No. 594,460, filed Nov. 15, 1966 and issued as U.S. Pat. No. 3,481,319 on Dec. 2, 1969.
- c. The angle theta (θ) (FIG. 7 and 8) is set by rotating the swivel plate 64 about its pivot 63 and locking it in position from below with clamp screws 65 (seen in FIG. 4).
- d. The distance "X" (FIG. 7) is adjusted by sliding the gib plate 66 (FIG. 3 and 4) with rib dressing cutter spindle 69 attached, along the guideway 67 milled in swivel plate 64. (A gib for this purpose is machined on the bottom of gib plate 66). The adjustment is then clamped by screws 68 (seen in FIG. 2).
- e. Dimension "Z" is set by sliding rib dressing cutter spindle 69 along a square key 70 set into the top of gib plate 66 and clamping it with screws 71. This completes the setting of the cutters relative to each other.

Before grinding, the position of the conjugate wheel dresser 28 must be set as a unit so that the grinding wheel 24 will be directly in front of the dresser at the dress position, and the workpiece will be directly in front of the grinding wheel at the grinding position. The method of doing this would be different for each type of form grinder on which it is installed. In this embodiment, workslide 14 is traversed as indicated by arrow 15 between adjustable stops (not shown) at each end of travel.

On the typical form grinder illustrated in FIG. 1 the grinding wheel 24 is shown in the grind position at work station 21, about to feed into a workpiece 19a shown on the magnetic chuck 22. (An enlarged view of this is shown in FIG. 8. Grinding wheel 24 is fed into the workpiece along arrow 59 until the finished size stop (not shown) is reached, and then backed off along arrow 59 in the reverse direction.

When the grinding wheel is clear of the work station, the workslide 14 (which also carries the wheel dresser 28 seen in FIG. 1) is shifted through the distance "W" (shown in FIG. 7 and FIG. 8) as indicated by arrow 58. This brings the wheel dresser 28 carrying the dressing cutters 34 and 35 into the position formerly occupied by workpiece 19a.

Prior to this movement "W," the conjugate wheel dresser 28 must be raised hydraulically to allow the dressing cutters 34 and 35 to clear the grinding wheel during traverse.

When the translation movement "W" is complete, the grinding wheel again cross feeds into the dress stop along arrow 57, and the conjugate wheel dresser 28 is lowered. First the rotating track-dressing cutter 34 contacts the rotating grinding wheel 24, and passes by, removing a small amount of the wheel to expose a new surface thereon.

Next the rib cutter 35 contacts and passes by the wheel, removing a small portion and exposing a new surface thereon.

After both dressing cutters have passed the wheel 24, the elevator block 36 reaches bottom, and remains there in preparation for the next dress cycle.

When the elevator block 36 is down, the work slide 14 is again moved back through the distance "W" (arrow 58) and a new workpiece is ground by infeed along arrow 59.

The dressing cycle is not necessarily called for each time a workpiece is ground. It varies with the size of the workpiece

and the amount of stock removal. "Skip dress," as it is called, might be anywhere between 1 and 20 workpieces of the type shown.

- 5 A description of the hydraulic circuit controlling the operation of the elevator will now be given with reference to FIG. 6. Essentially, it consists of a solenoid operated, spring centered, four-way valve and a throttled flow control for speed adjustment in both "up" and "down" directions.

Prior to dressing, solenoid "A" is energized, shifting the valve to the left and permitting the pressurized oil from pump "P" to flow through the valve and hydraulic line 43, check valve 44, variable restrictor 45, and line 46, to orifice 47 in baseplate 29. There is no flow through restrictor 49 because of check valve 48.

- 15 Through the internal passes in block 38, the pressurized oil is led to the piston and rod assembly 40, causing it to rise at a rate controlled by the setting of variable restrictor 45.

When the solenoid is released, the valve returns to center as shown in the diagram, trapping the oil in the cylinder and holding the elevator up, where it will stay until released by solenoid "B."

When it is desired to lower the conjugate wheel dresser 28, solenoid "B" is energized, which opens line 43 to sump 50 through the valve. The weight of the elevator block 36 and the units mounted on it, force the oil out of cylinder 41 back through the orifice 47, line 46, check valve 48, variable restrictor 49, and line 43. The rate of fall of the elevator block 36 is controlled by setting variable restrictor 49, since check valve 44 prevents flow through restrictor 45.

- 25 It might be pointed out that the piston 40 is formed in two parts for reasons not essential to this invention.

An oil entrapment cushion to reduce the shock when the bottom is reached, is provided at the lower end of the cylinder in a manner well known to the art.

- 35 The rate of rise and fall are controlled by adjustment of the variable restrictors 45 and 49, and need not be identical.

We have here disclosed only one embodiment of our mechanism, but it should be understood that this design is not so limited, and other useful applications might be adopted well within the purview of the invention.

We therefore claim:

1. A wheel-dressing apparatus for dressing a grinding wheel, said grinding wheel adapted to simultaneously grind a plurality of surfaces on a workpiece, said wheel-dressing apparatus comprising:

- a. a baseplate;
- b. an elevating block;
- c. means for elevating said block;
- d. a first dressing cutter mounted on a motor driven spindle on said elevating block;
- e. a second dressing cutter mounted on a second motor driven spindle on said elevating block;
- f. said second dressing cutter mounted above and offset substantially normal from said first dressing cutter;

Whereby said first dressing cutter contacts said grinding wheel on its front surface thereof, and said second dressing cutter contacts said grinding wheel on its back and edge surfaces as said block is elevated past said grinding wheel.

2. A wheel dressing apparatus as defined in claim 1, wherein said first dressing cutter is defined as a track cutter and is tilted vertically, defined by the angle α , so as to provide a crowned surface on said workpiece by means of forming a minimal concave surface on said grinding wheel, defined by the dimension Y.