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W. J. FANT ET AL

3,157,969

COMPENSATOR

Filed Dec. 4, 1962

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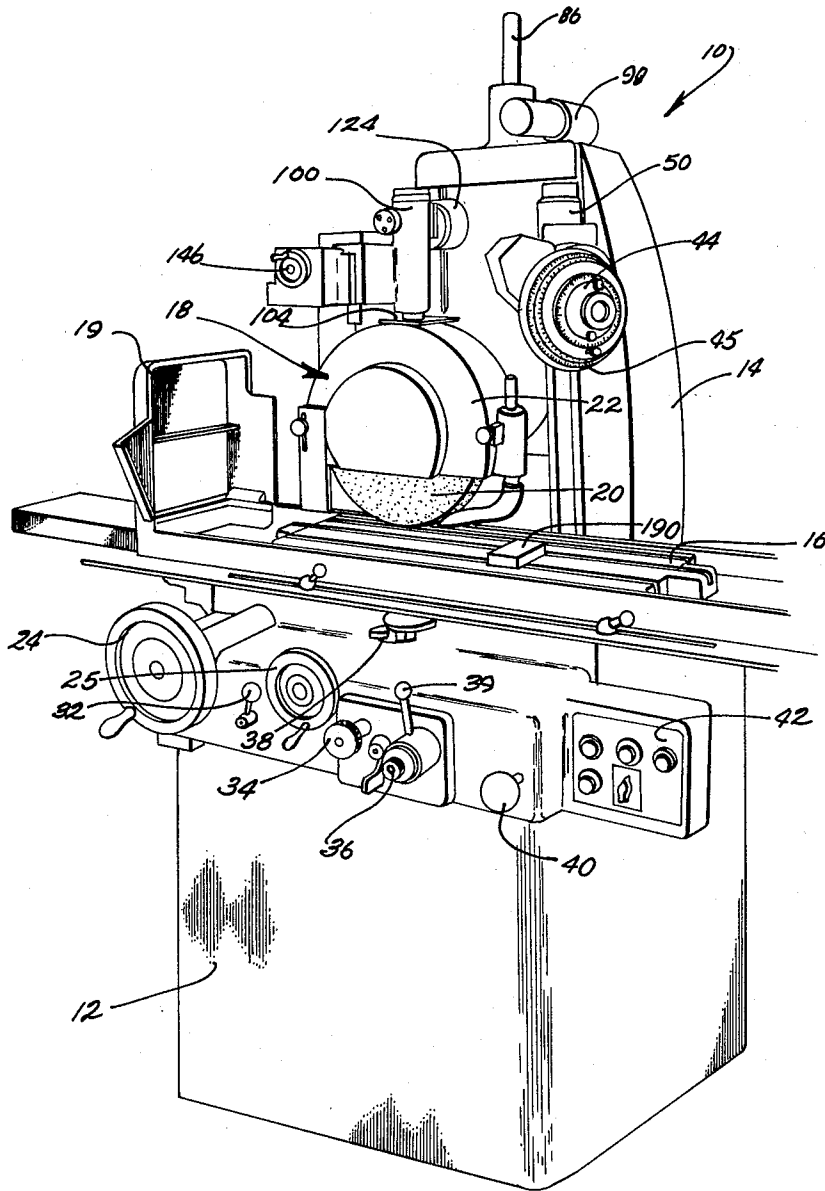


Fig. 1.

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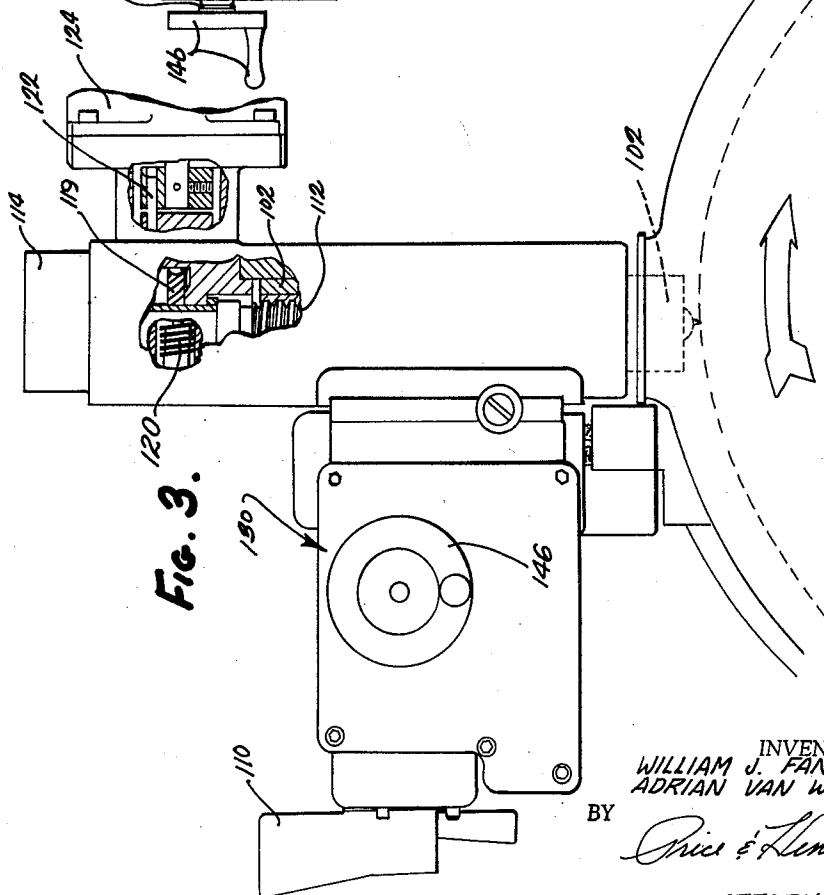
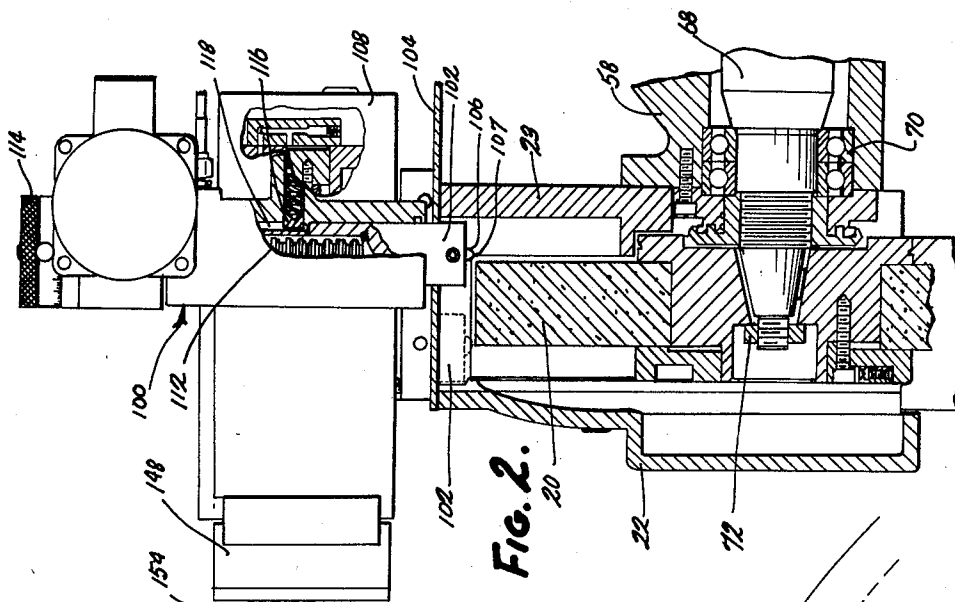
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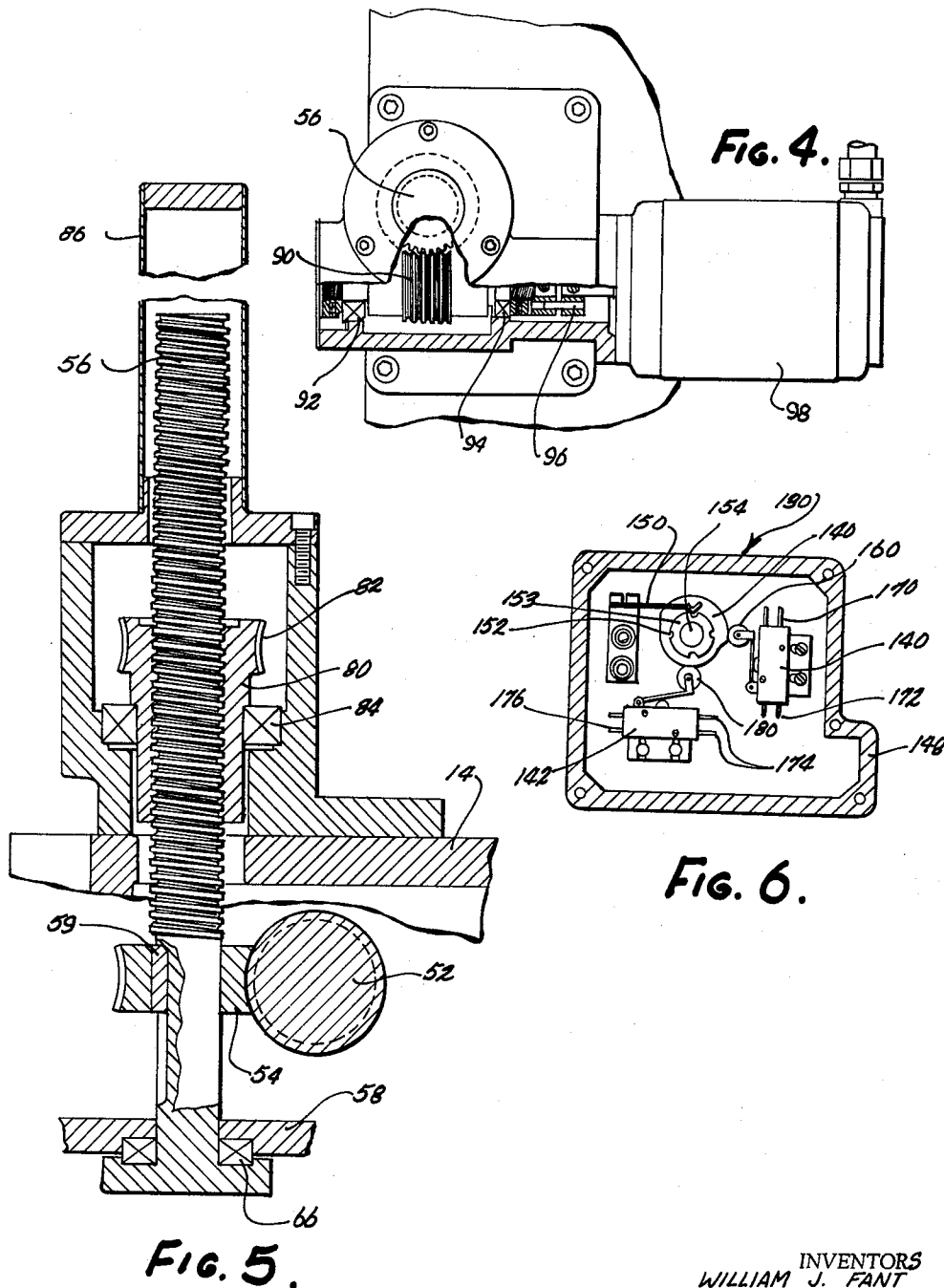
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4 Sheets-Sheet 4

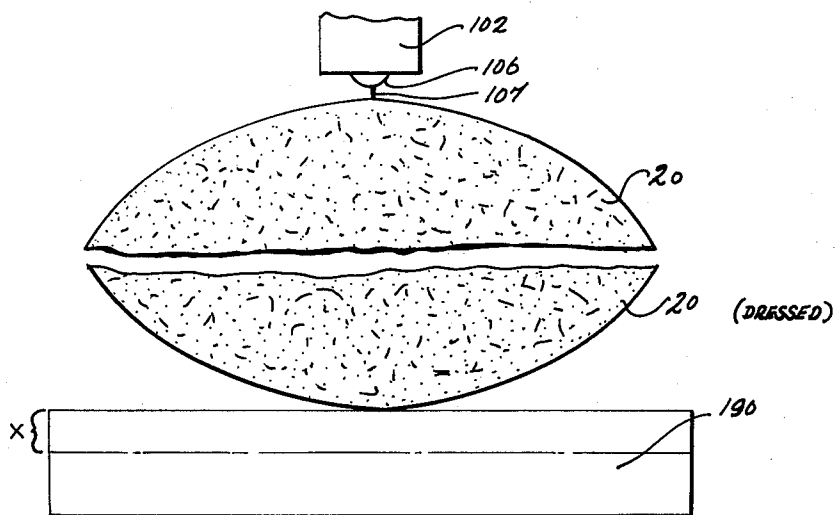


FIG. 7.

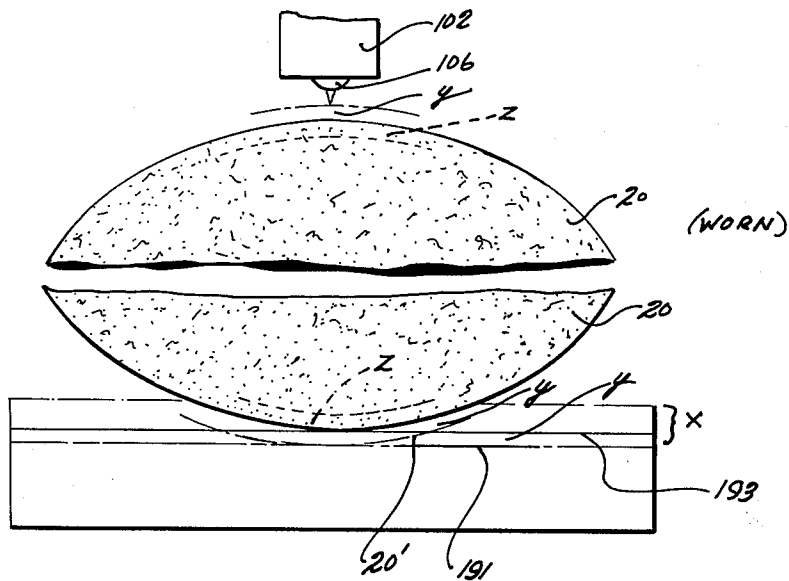


FIG. 8.

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6 Claims. (Cl. 51—165)

This invention relates to a grinder, and more particularly to a wheel compensating mechanism in combination with a precision grinder.

Modern technology often demands extremely accurate tolerances on finished metal parts. The finishing operation on such parts is usually made with a precision grinder. However, when the grinder feed is pre-set to remove an exact total amount of stock from the workpiece, it is common knowledge that, due to appreciable wheel wear which varies with the wheel composition, rate of feed, and workpiece characteristics, among other things, the actual thickness of stock removed is less than the pre-set desired value. The discrepancy or difference is equal to the amount of wheel wear occurring during the operation. This difference can be extremely important in the manufacture of precision parts finished to 0.0001 inch, for example. The human operator cannot accurately and conveniently measure the amount of discrepancy and manually adjust the grinder each time to remove it.

Another complicating factor involves the fact that the grinding wheel surface ordinarily becomes untrue after several passes, due to uneven wear of the wheel and the embedding of workpiece particles into the wheel. Therefore, as is well-known, the wheel surface should be dressed before the final finishing pass or passes are made. However, the wheel loss occurring with the dressing operation makes the task of removing the exact amount of stock on the workpiece even more difficult since the wheel must first be moved toward the workpiece the amount equal to the dressing loss, i.e. it must be brought into extremely light sparking contact, and then it must be advanced an amount exactly equal to the wheel wear. This may involve plus or minus 0.0001 inch. Consequently, to do this with extreme accuracy is usually impossible.

It is therefore an object of this invention to provide a grinder that removes the exact predetermined amount of stock from the workpiece to obtain extremely accurate tolerances, without any discrepancy between the amount of stock pre-set to be removed, and that actually removed. This is achieved irrespective of the type or composition of the wheel, the amount of wheel wear, the hardness of the stock, the thickness of stock to be removed, the number of one or more wheel dressing steps before the final pass, or the amount of wheel removed by dressing. The lack of any discrepancy between the pre-set desired amount of stock removal and the actual amount of stock removal is achieved every time and automatically by automatic compensation of the wheel feed when dressing the wheel.

It is another object of this invention to provide a compensated grinder in which the wheel feed is compensated simultaneously and automatically with the feed of the dressing tool toward the wheel. The compensation, just prior to the final finishing pass or passes on the workpiece, adjusts the wheel an amount exactly equal to the feed of the dressing tool from a pre-established reference, and accounts inherently both for wheel loss during dressing and for wheel wear during previous grinding passes. The compensation for these factors is exactly accurate regardless of the amount of wheel wear, the amount of wheel loss by dressing, the number of dressing passes, the type of wheel, the stock characteristics, or other factors.

2

The apparatus repeatedly performs this compensation function independently of the conventional wheel feed, and without disrupting or adversely affecting the conventional wheel feed mechanism, whether manual or automatic.

These and other objects of this invention will be apparent upon studying the following specification in conjunction with the drawings, in which:

FIG. 1 is a perspective front view of a grinder embodying the novel compensation apparatus;

FIG. 2 is a fragmentary, side elevational, sectional view of the wheel dressing control apparatus of the novel compensating unit;

FIG. 3 is a front elevational, fragmentary, partially sectional view of the apparatus in FIG. 2;

FIG. 4 is a plan, partially sectioned, fragmentary view of the spindle adjustment mechanism of the compensating apparatus;

FIG. 5 is a side elevational, sectional view of the apparatus in FIG. 4;

FIG. 6 is a sectional view through a portion of the apparatus in FIG. 2 showing the switching control mechanism for the wheel dressing and compensating apparatus in FIGS. 2 and 4;

FIG. 7 is a diagrammatic representation of the dressing tool, grinding wheel and workpiece at the beginning of the operation; and

FIG. 8 is a diagrammatic elevational representation of the apparatus in FIG. 7 illustrating the grinding, dressing, and compensating steps in the operation.

Basically, the inventive grinder comprises a main frame including a workpiece bed support and a slidable spindle and wheel housing in which are rotatably mounted a spindle and grinding wheel, a dressing tool mounted to the spindle housing and adapted to normally move therewith, but also including drive means operated by a stepping motor to adjust the tool with respect to the housing and towards or away from the wheel, wheel feed drive means for the adjustable spindle housing and wheel including a second stepping motor independent of the main wheel feed motor drive mechanism. Both stepping motors are electrically connected to a switching means so that switch actuation simultaneously causes dressing tool feed towards the wheel and an equal amount of movement of the spindle housing and wheel towards the workpiece, to compensate for all wheel loss due to dressing and for wheel wear. The spindle compensating means includes the stepping motor which drives a worm gear engaged with a gear collar around a screw shaft which vertically adjusts the spindle housing. The main wheel feed motor also operates this same screw shaft in an independent manner. The dressing tool also operates from a screw shaft rotated by an electrical stepping motor through a worm gear.

Referring now specifically to the drawings, the grinding apparatus 10 includes a conventional base 12, upright back 14, table or workpiece bed support 16 for holding a workpiece, and a grinding wheel assembly 18 including a spindle and wheel housing assembly vertically slidably adjustable in ways with respect to the bed 16, and including an abrasive wheel 20 and protective shield 22. The bed 16 is adapted to reciprocate longitudinally by conventional mechanism (not shown). It may be manually moved longitudinally by a crank 24 operating a pinion and gear rack mechanism in conventional fashion. The bed may be laterally shifted back and forth by manual crank 25 and a conventional connected gear and rack assembly for cross feed.

The grinding wheel may be fed toward workpiece 190 supported on bed 16, either manually or automatically in increments according to conventional methods. For purposes of illustration, the wheel 44 in FIG. 1 can repre-

sent either a manually rotatable wheel or crank for manually feeding the grinding wheel through a worm 52 (FIG. 5) mounted on a shaft operated by the hand wheel 44, or may be a dial wheel for setting and indicating the incremental feed of the grinding wheel when worm gear 52 is driven by an electrical motor 50. The incremental feed can be regulated using a control panel 42 of switch actuators. The table reciprocation is controlled using auxiliary control means 36 to regulate its speed of traverse, means 38 to regulate stroke length, and means 39 for stopping and starting. Bed reciprocation may be reversed by plunger 40.

The worm 52, whether operated manually or automatically, rotates gear collar 54 rotatably keyed with key 59 to screw shaft 56. This screw shaft 56 supports the spindle housing 58 (FIG. 2) on the lower end of the shaft and is rotatable with respect thereto on thrust bearings 66 or the equivalent. Thus, rotation of motor 50 causes rotation of worm gear 52, of gear 54, and of shaft 56. The shaft turns inside gear collar 80 which has internal screw threads. Since collar 80 will not rotate therewith (for reasons explained hereinafter), screw shaft 56 moves up or down to raise or lower the spindle housing 58 on the lower end of the shaft.

Mounted in spindle housing 58 on bearings 70 is a conventional spindle 68. Affixed to the outer end of spindle 68 by nut 72 is a conventional grinding wheel 20 inside protective wheel housing 23 including a front shield 22. Thus, raising and lowering of the spindle housing and wheel housing and thereby also raises and lowers spindle 68 and wheel 20.

Gear collar 80 threadably engaged with screw shaft 56 by screw threads on its interior, has gear teeth 82 on its exterior. Collar 80 is rotatable on screw 56, and is supported on bearings 84 within the upright back 14 of the grinder. A cylindrical casing 86 covers the upper end of the screw shaft above this collar assembly. Gear teeth 82 engage a second worm 90 (FIG. 4) supported on suitable bearings 92 and 94 and operably connected through drive connection 96 to an electrical stepping motor 98 resembling a rotary solenoid. This stepping motor has a slow basic shaft speed with almost negligible over-shoot. Each rotation of the motor may include several precise incremental moves such as 100 or 200. It has a high torque, with each step being made instantly without flip or chatter. A typical motor is the SLO-SYN synchronous motor produced by the Superior Electric Company, Bristol, Connecticut. Rotation of motor 98 in an incremental fashion rotates drive connection 96 and worm gear 90 tiny amounts to thus rotate collar 80 slightly on bearings 84. Screw 56 does not rotate with the collar 80 since the connection of worm 52 and gear 54 keyed to shaft 56 prevents its rotation. Therefore, rotation of collar 80 causes vertical movement of shaft 56 without rotation. This raises or lowers the spindle housing supported on the shaft to raise or lower grinding wheel 20 with respect to the workpiece 190 on the bed 16.

It will now be seen that the engagement of worm 90 with gear collar 80 prevents rotation of gear collar 80 when shaft 56 is rotated by worm 52 and gear 54.

Referring to FIG. 2 mounted above the wheel housing 23 and wheel 20 is a dressing tool assembly 100, including a plunger 102 fitting through an opening in a slide plate 104, and having a dressing tool 106 removably mounted in the lower end thereof. The tool includes a diamond tip 107. The cylindrical support plunger 102 is adapted to reciprocate transversely across the surface of the wheel 20 between the position illustrated in solid lines in FIG. 2 to that illustrated in dotted lines. It moves back and forth with the bearing slide plate 104 as controlled by a conventional hydraulic reciprocating apparatus 108 controlled by a manual actuator 110. Thus, the dressing tool can move back and forth across the wheel to dress the wheel in a conventional fashion. The diamond support plunger or post 102 has a hollow upper end and is

threadably engaged (FIG. 3) with screw shaft 112. To manually adjust the tool, a setting dial 114 is supplied. Since, however, it is affixed to the upper end of the screw shaft, and the screw shaft is locked into engagement with the wheel feed, the dial 114 can only be rotated manually when the relationship is unlocked temporarily to allow the dial to manually cause vertical movement of plunger 102. Rotation of the plunger is prevented while allowing vertical movement thereof due to a radially projecting key 116 in elongated vertical key-way or slot 118 on one side of the plunger.

Affixed to the upper end of the screw shaft is a worm gear 119 meshing with a worm 120 driven through connection 122 by a second stepping motor 124, similar to motor 98. Actuation of motor 124 therefore rotates worm 120, which rotates gear 119, which rotates screw shaft 112, which vertically moves plunger 102 and the diamond contained therein to feed it toward wheel 20.

Both of these stepping motors 98 and 124 are electrically connected to switch control mechanism 130 (FIGS. 3 and 6). The switch mechanism is operated manually and controls the stepping motors 98 and 124. It may incorporate either one switch 140, a pair of switches 140 and 142, or any other number of switches to cause the desired number of actuations of both stepping motors per revolution of cam 144. Rotation of cam 144 is manually achieved by a crank 146 mounted to the front of the switch housing 148. Suitable spring detent means 150 interfits with grooves 152 in a locator disc 153 mounted to the same shaft 154 as cam 144 and crank 146. The crank may be rotated in small, exact arcuate amounts for accuracy. For example, rotation of the crank one revolution or four "clicks" first actuates switch 140 by depressing its cam follower roller 160 which closes the switch to actuate stepping motor 98 electrically connected to terminals 170 and to simultaneously actuate stepping motor 124 electrically connected to terminals 172. Then, the adjacent switch 142 is actuated by follower roller 180 depressing the switch to again actuate stepping motor 98 through terminals 174 and stepping motor 124 through terminals 176. Each switch actuates both stepping motors so that rotation of manual crank 146 creates simultaneous feed of the dressing tool 106 towards the wheel, and lowering of the entire spindle assembly, i.e. wheel feed towards workpiece platform 16. There are two switches, and each actuates the stepping motors when shifted in either direction. Thereby the stepping motors are actuated four times per each crank revolution. Presently, it is found that by causing tool feed and wheel feed of 0.00005 inch each for each quadrant of crank turn, a total feed per revolution of 0.0002 inch occurs to give good results. This may be varied. Since each switch actuates each feed system for the same time period, and since the two feeds must be exactly the same, the motor and drive means must be geared to provide the same linear feed.

Operation

In the operation of the apparatus 10 illustrated in FIG. 1, the workpiece 190 which is to have a predetermined amount (x) of material removed from its surface (FIG. 7) is placed and held upon bed 16 by any suitable retention means. Next, grinding wheel 20 is placed into operation by actuation of a suitable switch (not shown) to rotate spindle 68 through a belt and pulley mechanism or other suitable conventional drive connection (not shown). Before the grinding operation begins, knob 114 with an indicator dial adjacent thereto may, if necessary, be unlocked from the interconnected gearing and rotated by hand to manually lower the diamond dressing tool 106 to a position near the surface of wheel 20. Then hydraulic control 110 is actuated to cause the hydraulic mechanism 108 to cause the dressing tool assembly and dirt barrier slide plate 104 to reciprocate back and forth over the wheel surface. Since the valving and hydraulic passage-

ways, for this reciprocation are not part of the inventive concept, are conventional, and would only lengthen this specification unduly, a detailed description is not here given. Then crank 146 is rotated a revolution at a time until it begins to contact the wheel while reciprocating. Crank 146 is repeatedly rotated small amounts to take the desired number of ten thousandths from the wheel to dress it properly, and also to establish an important tool reference point. The reciprocation of the diamond is then stopped at the position illustrated in FIG. 2 out of the way of the wheel. It is not vertically retracted from this position, however, since this would destroy its use as a reference for the compensating mechanism. Next, the bed is actuated to start it to reciprocate and move the workpiece back and forth beneath the wheel. Then, manual crank 44 is rotated to drive worm 52 and thus gear 54 affixed to screw shaft 56 to rotate screw shaft 56 and lower spindle housing 58 as well as spindle 68 and wheel 20 until the wheel is in sparking contact with workpiece 190. Since the dressing tool is mounted to the spindle housing or housing portions connected thereto, it moves directly with the spindle housing and the wheel as the wheel is lowered and therefore remains in its reference position as illustrated in FIG. 2 and as shown graphically in FIG. 7. It is then ready to grind the workpiece. (A conventional guard 19 limits the travel of hot particles during grinding.) Continued feed of the wheel may be manually using the wheel 44. Alternatively, it may be through an automatic incremental feeding mechanism using panel 42 and motor 50 with wheel 44 serving to pre-set the total amount of stock to be removed. In either case, the thickness of stock which the machine theoretically removes is indicated on the wheel disc 45. As the wheel 20 is slowly lowered successive amounts from the position illustrated in FIG. 7 to grind the surface of workpiece 190, if the wheel had no wear (an impossible condition), at the end of the (x) amount of wheel feed, the lower surface of the wheel should still be of a diameter represented by phantom line 20' in FIG. 8 and should have removed exactly (x) inches of stock to be at line 191 on the workpiece. This was the thickness removed according to dial 45. However, the wheel surface has a definite amount of wear, for example, plus or minus 0.0001 inches in a cut of a few thousandths of an inch. Thus, as shown by the exaggerated condition in FIG. 8, the actual surface of the wheel will be in line 193, a distance of (y) inches above phantom line 191 where it should be at the bottom of the thickness (x). Thus, this (y) amount of wheel wear is exactly equal to the (y) thickness discrepancy of the stock removed, i.e. of actual surface 193 above theoretical surface 191.

The novel apparatus, however, provides automatic compensation for this in the following manner. Just prior to the final pass or passes of the workpiece past wheel 20, the wheel is dressed with tool 106. This is achieved by rotating crank 146 to lower the tool 106 toward the wheel. There will be a gap (y) between the diamond tip of the dressing tool (in its reference position) and the upper surface of wheel 20, due to the wheel wear which has displaced the worn wheel surface from the original surface. Thus, as crank 146 is initially rotated to actuate switches 140 and 142 and rotate stepping motor to drive worm 120 and worm gear 119 around screw shaft 112, the tool will first have to move across distance (y) to contact the wheel. This is done in successive increments of 0.00005 inch. It should be noted that switches 140 and 142 simultaneously actuate stepping motor 98 also so that it rotates worm gear 90 in the same increments to simultaneously lower screw shaft 56. Exact amounts of feed of both the spindle housing with wheel and the dressing tool occurs. Thus, as the diamond tip moves (y), the entire apparatus including the spindle housing, spindle, wheel and dressing tool moves the distance (y) toward the workpiece. Next, crank 146 is turned a further amount to enable the tool 106 to dress the surface of the wheel. Actuation of hydraulic control 110 therefore reciprocates the

tool across the wheel to remove any desired amount (z) from the surface of the wheel. Any amount of material may be removed from the wheel to obtain proper dressing, i.e. to remove any irregularities on the surface of the wheel and/or any particles embedded into the wheel. As tool 106 is lowered the amount (z) to be dressed from the wheel, by its respective stepping motor 124, the entire spindle wheel will also be simultaneously lowered this same exact amount (z) by stepping motor 98 and its co-operative screw drive mechanism. Therefore, it does not matter how much of the wheel is removed in dressing, since the wheel will always be lowered a compensating amount toward the workpiece. Then the final pass is taken by reciprocating the workpiece under the wheel, with the result that the wheel cuts exactly to line 191 to remove the exact amount (x) which was pre-set to be taken from its surface. This accurate result occurs regardless of the hardness of the material of the workpiece, or of the characteristics of the dressing wheel, or of the amount of wheel removed during dressing, or of the amount of wheel wear in previous passes. The important factors are the initial tool reference point achieved with the first dressing (FIG. 7) and the final dressing just prior to the final pass or passes so that the automatic compensation for the distance (y) (z) is made for the wheel as well as the tool to obtain a removal of (x) thickness of stock. It has been found with repeated operation of the apparatus that it works completely effectively, and extremely accurately, time after time, in an automatic manner, without requiring any special operating skill or patience.

Certain advantages in addition to those cited above will occur to those in the art upon studying the foregoing illustrated form of the invention and the principles involved. Also, certain obvious modifications may readily occur to those in the art, upon studying the invention as taught, without departing from the inventive principles and concepts. These obvious modifications are deemed to be part of this invention, which is to be limited only by the scope of the appended claims and the reasonable equivalents to those defined therein.

We claim:

1. In a grinder, a workpiece support bed, and support means for a grinding wheel and wheel dresser adjustable with respect to said bed; grinding feed means to feed said wheel and dresser toward said bed to grind a workpiece; means including a stepping motor to feed said dresser towards said wheel controlled increments; a second stepping motor operably connected with said support means and independent of said grinding feed means to advance said grinding wheel and dresser independently of said grinding feed means; and electrical switch means operably connected with both of said stepping motors to simultaneously actuate both said stepping motors; said stepping motors and feed means being arranged to cause equal feeds thereof and thereby enable compensation of said wheel with dressing thereof, for wheel loss and wear.

2. A grinder comprising: a housing containing a rotatable spindle and grinding wheel and adapted to be adjustably mounted to a support to enable said wheel to be moved toward or away from a workpiece on said support for feeding the wheel into the workpiece; grinding feed drive means operably connected to said housing and support to effectuate said feed including operating means to operate said feed drive means; compensator motor means operably connected to said drive means and capable of operating said drive means independently of said operating means; a wheel dressing tool adjustably mounted on said housing adjacent said wheel, normally moving with said housing, and adapted to be fed toward said wheel with respect to said housing; dresser drive means to effectuate said dresser feed; dresser feed motor means operably connected to said dresser feed drive means; actuator means independent of said operating means operably associated with both said dresser motor means to cause a pre-selected dresser feed, and said com-

pensator motor means to cause simultaneous actuation of said motor means to move said housing, including said wheel and dresser means toward said workpiece an amount equal to the feed of said dressing tool towards said wheel and thereby compensate for both wheel wear and wheel dressing loss.

3. A grinding wheel assembly, comprising: spindle and housing means supporting a grinding wheel, dressing tool means and work support means; motor operated adjustable support means for said dressing tool means including a first stepping motor capable of moving said tool incremental amounts with respect to said housing and toward said wheel; motor operated adjustable support means for said spindle and housing including a second stepping motor capable of moving said wheel and said tool means incremental amounts toward said work support means; and progressive electrical switch actuating means operably associated with the motor means of both said adjustable support means to cause simultaneous compensating wheel and tool movement in exact increments toward said work supporting means with tool movement toward said wheel upon actuation of the dressing action.

4. A grinder comprising: support means for a workpiece, and a spindle and wheel housing movable towards said support means; grinding wheel and spindle means rotatably supported in said housing including means to feed said wheel toward said support means; a wheel dresser supported on said housing adjacent said wheel and adapted to normally move with the housing; said dresser being supported on dresser drive means adapted to move it with respect to said housing so as to feed it toward and away from said wheel; stepping motor means connected to said dresser drive means for incremental operation thereof; said spindle housing also including compensating drive means operably connected to a second stepping motor for incremental drive thereof; said dresser drive means and motor and said spindle housing compensating drive means and motor adapted when actuated to move the dresser towards said wheel an amount equal to the movement of the spindle housing, wheel, and dresser toward said workpiece support means; and switch means electrically connected to said stepping motors to actuate them simultaneously and momentarily to move them an increment whereby wheel compensation is made for both wheel wear and dressing loss when the wheel is dressed.

5. A grinder, comprising: workpiece support means, and a spindle and wheel housing rotatably supporting a grinding wheel and spindle; screw drive means to feed said wheel and spindle toward said support means; first feed motor means operably connected to said screw drive means; a second, independent, compensating stepping motor means operably connected to said screw drive means for incremental actuation thereof; wheel dresser means operably supported on said housing adjacent said wheel and adapted to normally move with said housing and wheel; said dresser having drive means between it and said housing and adapted to move it with respect to

said housing so as to feed it toward said wheel; a third, stepping motor means operably connected to said dresser drive means for incremental driving thereof; switch means electrically connected to both said second motor means and third motor means and adapted to actuate them substantially simultaneously; and said compensating motor means and screw drive means adapted to move said wheel and dresser means toward said workpiece support means an amount equal to the movement of said dresser by said third motor means and dresser drive means toward said wheel to provide exact compensation of said wheel when the wheel is dressed for both wheel wear and dressing loss.

6. A grinder, comprising: a support including a workpiece supporting bed and a spindle and wheel housing spaced from said bed and rotatably mounting a spindle and grinding wheel; said housing being adjustable on said support; a rotatable screw shaft between said support and housing and adapted to move said housing and wheel toward and away from said bed when rotated in opposite directions; a first electrical feed motor; a worm gear operated by said motor and engaged with a gear keyed to said screw shaft to enable said motor to rotate said shaft but to prevent rotation of said shaft from another source of power operably engaged with said shaft; a second electrical motor of the stepping type for incremental operation; a worm gear operated by said second motor and engaged with a gear collar threadably engaged around said screw shaft to enable said second motor to rotate said collar for vertical driving movement of said shaft, but to prevent rotation of said collar, worm gear and second motor by rotation of said shaft from another source so that rotation of said shaft from another source causes vertical movement of said shaft through said collar; a wheel dresser operably supported on said housing adjacent said wheel and adapted to normally move with said housing, wheel and spindle; a second screw shaft between said dresser and housing and adapted to drive said dresser toward and away from said wheel; a third electrical motor, also of the stepping type for incremental operation, operably connected to said second screw shaft; and electrical switch means electrically connected to both of said stepping motors to simultaneously operate them in increments of movement to shift said housing, wheel and dresser toward said bed, and shift said dresser towards said wheel, equal predetermined incremental amounts to automatically compensate for wheel wear and loss.

References Cited by the Examiner

UNITED STATES PATENTS

1,896,533	2/33	Vuilleumier	-----	125—11 X
2,545,730	3/51	Fouquet	-----	51—165.14 X
2,944,373	7/60	Mentley et al.	-----	51—165.14 X

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