Feb. 19, 1952 J. C. WILSON 2,586,755

METHOD AND APPARATUS FOR GRINDING

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FIG. 1

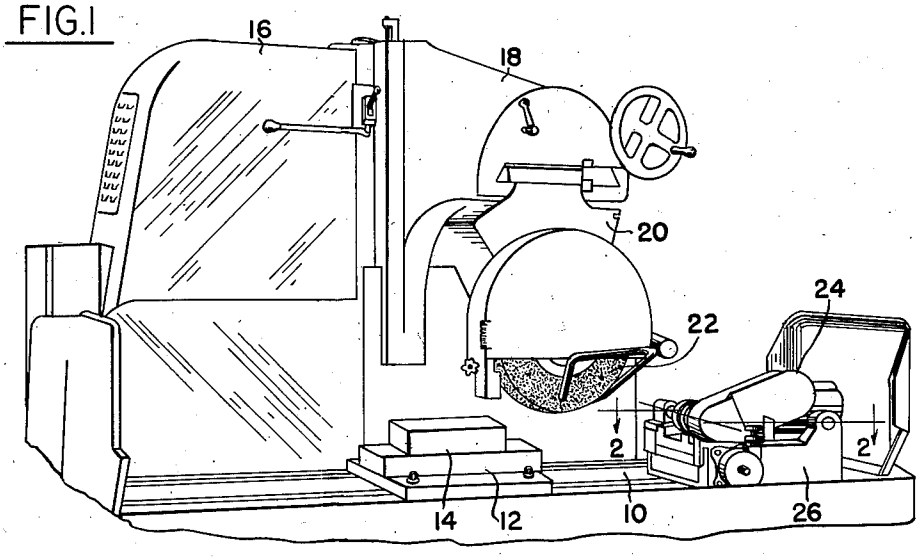
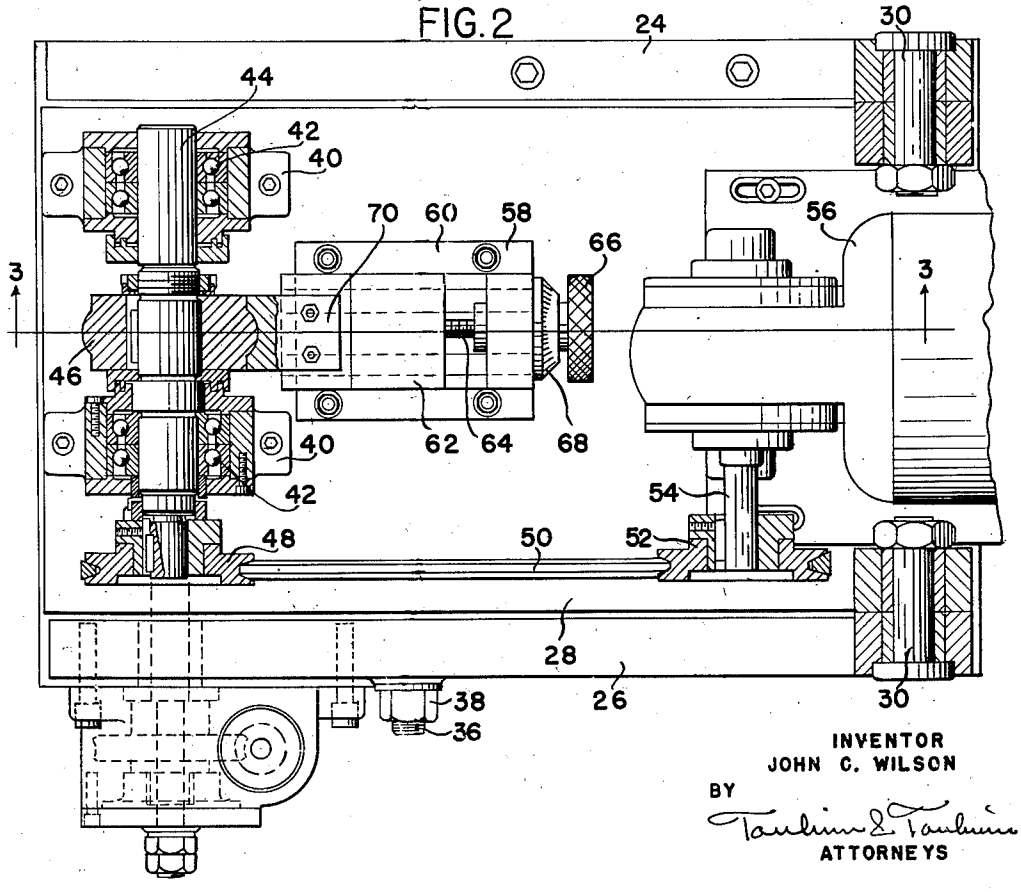


FIG. 2



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METHOD AND APPARATUS FOR GRINDING

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FIG. 4

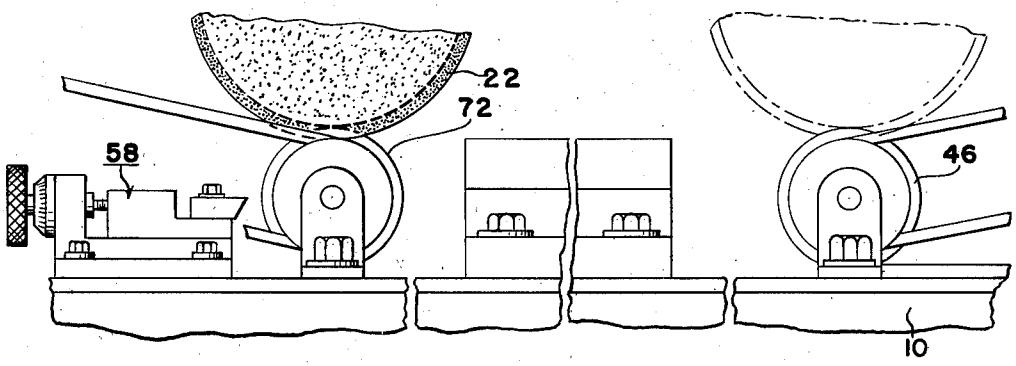


FIG. 6

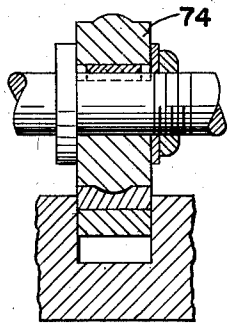


FIG. 5

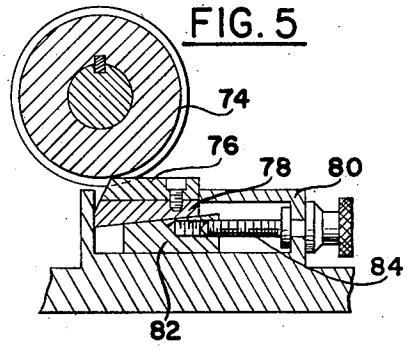
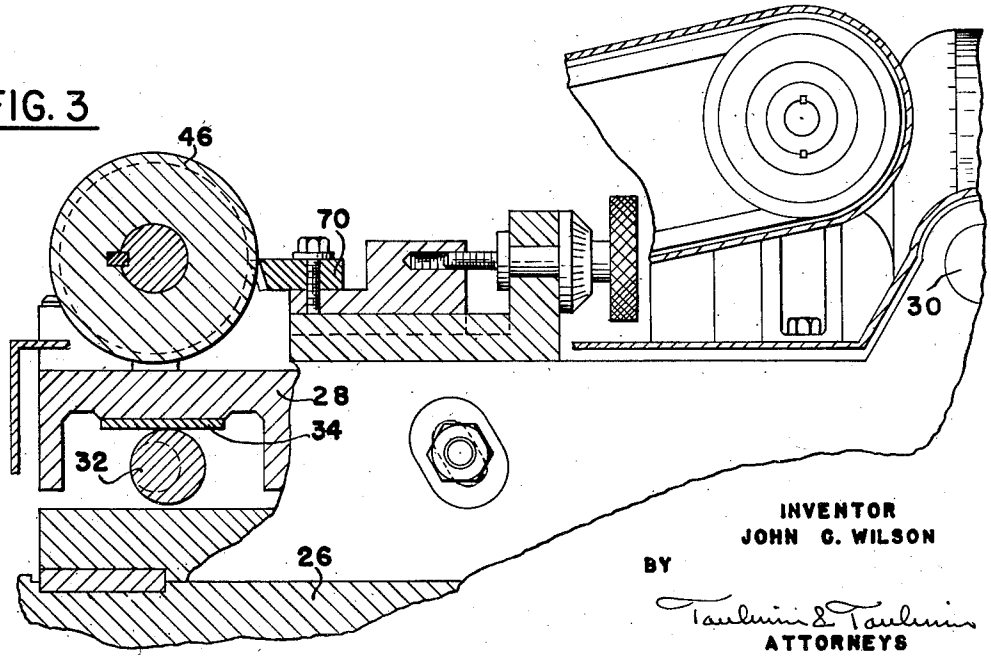


FIG. 3



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METHOD AND APPARATUS FOR GRINDING

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FIG. 7

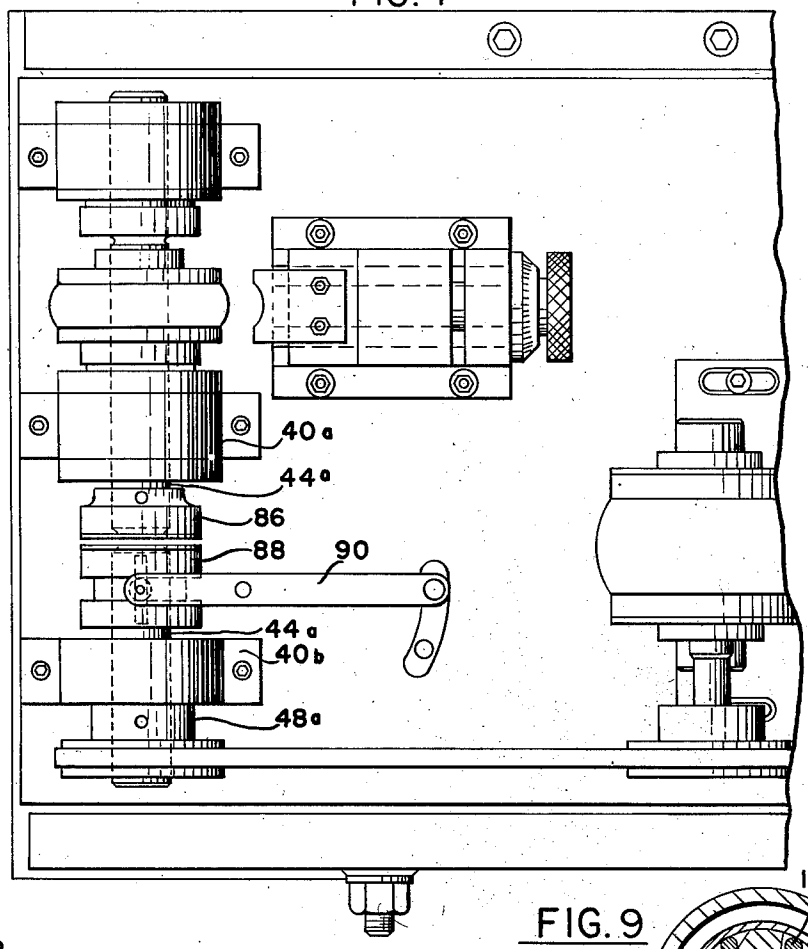


FIG. 8

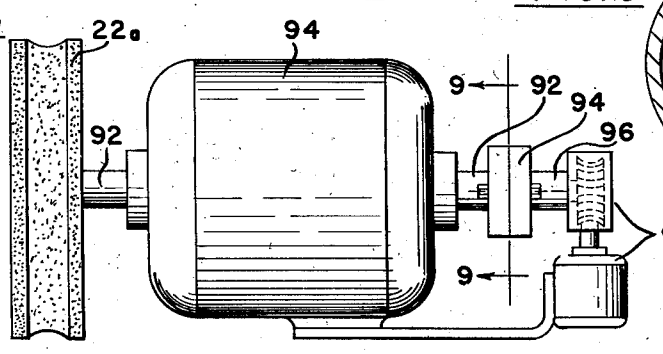
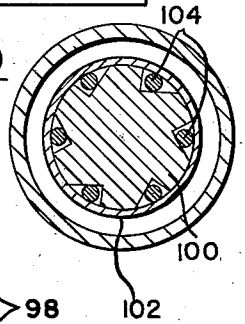


FIG. 9



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METHOD AND APPARATUS FOR GRINDING

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Application March 28, 1946, Serial No. 657,677

12 Claims. (Cl. 51—5)

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This invention relates to a method and apparatus for shaping workpieces by grinding, and is particularly concerned with a method and apparatus for dressing the wheel to maintain the configuration thereof.

In the art of grinding, it is desired to reproduce workpieces to precise limits, and to do so repetitively over long periods of operation. Inasmuch as the grinding wheel wears off when used, at a greater or lesser rate depending on the type of wheel and the bonding employed therein, it is essential that the wheel be repeatedly dressed to the exact cross section of the workpiece.

The dressing of a wheel may be accomplished by a diamond dressing tool or by an exceedingly hard metallic dressing member or by a process which is known as crush forming or crush dressing. The crush dressing process consists of forming a metallic roll to have a section conforming to the section of the workpiece to be ground and to shape the wheel thereby by bringing the two together under a predetermined pressure, and thereafter rotating the two together at a reduced speed. The pressure of the metal roll on the wheel breaks the bonding at the surface thereof so that the wheel assumes a shape which is complementary to the shape of the roll. Workpieces which are then ground with the wheel exhibit a high degree of accuracy and have an exceedingly fine finish thereon. The operation of crush dressing may be performed after every work cycle, or after several work cycles depending upon the closeness of the limits within which the workpiece must be produced.

The roll employed in the dressing operation is preferably of a relatively hard metal such as a carbon steel but need not be tool hard in order to produce good results or to have long life. Preferably, the roll is of sufficient hardness that it can be readily machine worked to the contour desired before being placed into operation.

After a roll has been employed in dressing a wheel for a period of time, the roll wears to the point where the dressing of the wheel does not bring it to within the proper tolerance limit. At this time, the roll must be reworked or replaced in order to produce further workpieces of the requisite size.

The reworking of the rolls is an operation requiring a high degree of skill and special machinery and, in many instances where this advantageous method of dressing a wheel could be employed, the available facilities are not sufficient to maintain the crushing rolls in proper condition.

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The primary object of the present invention is to provide an improved method and apparatus for crush dressing arrangements wherein the roll may be maintained in operation for a substantially longer period of time than is usually possible.

Another object is to provide a method and apparatus for reworking a crush dressing roll in its working position.

Still another object is to provide a method of an apparatus for reworking a crush dressing roll without removing it from the grinding machine in which it is used and to maintain the accuracy of the roll while accomplishing this.

These and other objects and advantages become more apparent upon reference to the following specification taken together with the accompanying drawings in which:

Figure 1 is a perspective view of a grinding machine equipped with the apparatus of, and being adapted for practicing the method of this invention;

Figure 2 is a plan view taken substantially on the line 2—2 of Figure 1 and shows the device which supports the crushing roll;

Figure 3 is a section indicated by the line 3—3 on Figure 2 and shows a vertical section through the crush dressing device;

Figure 4 is a diagrammatic view showing a modified arrangement for maintaining the crushing roll in condition;

Figures 5 and 6 are views of another modification;

Figure 7 is a plan view showing a crush dressing device according to this invention in which the dressing roll and its driving motor may be selectively clutched or unclutched;

Figure 8 is a diagrammatic view showing a low speed drive for the grinding wheel; and

Figure 9 is a section taken along the line 9—9 on Figure 8 and showing an overrunning clutch mechanism.

General arrangement

According to this invention, there is provided in connection with a grinding machine a crushing roll which has a cross-sectional configuration identical with that of the workpiece which is to be ground. The crushing roll may have means associated therewith, such as a motor, for driving it at low speed, or it may be freely rotatable on a shaft and the grinding wheel have the low speed driving means. In either case, the dressing of the wheel is accomplished by bringing the wheel against the roll while both

are stationary, thereafter driving the two together at the same low surface speed while exerting a pressure therebetween.

The pressure exerted between the wheel and the roll breaks the bonding of the wheel at the surface and it assumes an average cross-sectional configuration complementary to that of the roll.

Thereafter, a work cycle, or several work cycles, may be performed and the wheel again dressed.

According to this invention, after the roll has worn a predetermined amount, or after each dressing operation, the original outline of the roll is restored by a shaving operation accomplished by a properly formed shaving tool which is so supported that it can be moved against the roll in fine adjustment. Such a shaving tool has a long life and can be restored to its original accuracy by a truing cut with a grinding wheel.

Optionally, a pair of rolls may be provided, one of which may be referred to as the production dressing roll and which is employed for the routine dressing of the wheel. The other of the rolls may be designated as the master dressing roll and is only employed at intervals for the purpose of truing the wheel, whereupon the trued wheel may be utilized for grinding the production rolls to shape. In an arrangement of this type, the shaving tool is preferably associated with the master dressing roll. A system of this type has exceedingly long service life inasmuch as it is only necessary to dress the wheel by the master dressing roll at long intervals, and it is only necessary to perform a light shaving operation to maintain the master dressing roll in condition.

Structural arrangement

Referring to the drawings, there is shown in Figure 1 a grinding machine having a reciprocable bed at 10 which mounts a chuck 12 that may support a workpiece 14 in any suitable and well known manner.

Rigidly mounted adjacent the base on which the bed reciprocates is a column 16 which receives in vertical adjustability a saddle 18 that supports a wheelhead 20. The wheelhead 20 is transversely reciprocable in the saddle 18 and carries a grinding wheel 22 which is driven in rotation by any suitable motor means such as an electric motor.

Mounted on the bed 10 at one end thereof is a dressing device generally indicated by the numeral 24 and better shown in Figures 2 and 3.

In Figures 2 and 3 it will be seen that the dressing device 24 consists of a bed 26 to be secured to the grinder bed 10 and an auxiliary bed or table 28 which is pivoted to the bed 26 as by the pivot bolts 30. The end of the bed 26 opposite the pivots 30 includes an eccentric shaft 32 which bears on a pad 34 on the auxiliary bed 28. A locking bolt 36 having the nut 38 extends through the beds and locks them in any position of adjustment.

The adjustment of the beds relatively is preferably such that the grinding wheel need not be altered in elevation in order properly to engage both the work to be ground and the dressing roll of the dressing device.

Mounted on the auxiliary bed 28 are the bearing blocks 40 which carry the anti-friction bearings 42 which journal the shaft 44. Keyed and clamped to the shaft 44 between the bearing blocks is a dressing roll 46 which is preferably metal and more preferably still of a carbon steel somewhat less than tool hard.

One end of the shaft 44 has keyed thereto the pulley 48 over which passes a belt 50 which also extends over a pulley 52 on the output shaft 54 of a geared head motor 56. The motor 56 is carried on the auxiliary bed 28 so that adjustment of the angularity of the beds does not effect the driving of the dressing roll by the motor.

Also mounted on the bed 28 is a mechanism generally indicated at 58 which comprises the base 60 which reciprocably receives the slide 62. The screw 64 which engages the slide 62, passes through the end wall of the bed 60 and has connected therewith the knurled handwheel 66 and graduated dial 68. The slide 62 has rigidly secured thereto a tool 70 which, as seen in Figure 2 has a configuration complementary to that of the roll 46. On reference to Figure 3, it will be noted that the tool 70 is presented to the roll 46 substantially on the center line thereof and that there is substantially no angle of rake on the said tool. Thus, as the tool is urged against the wheel, metal is removed from the roll by a cutting action which is properly termed shaving. By shaving the roll rather than cutting the configuration of the tool is accurately transferred to the roll while the finish of the roll is greatly superior to that which would result if it were attempted to present the tool 70 thereto with an angle of rack sufficient to perform a cutting operation. Also, by the arrangement shown, the entire width of the dressing roll is renewed at one time and with a minimum of material being removed.

A typical grinding work cycle would comprise the grinding of a workpiece, the dressing of the wheel, and the shaving of the roll during the next grinding operation. Optionally, the wheel may be dressed at intervals of several grinding operations if the work is of a nature which will permit. Also, optionally, the shaving of the roll may be done at intervals of several dressing operations, this also depending upon the nature of the work being operated and the degree of accuracy desired.

Figure 4, there is shown an arrangement wherein, in addition to the production dressing roll 46 there is a master dressing roll 72 which may be supported on the bed 10 wherever desired but which is shown in the drawings as being at the end of the bed opposite the production roll 46.

In Figure 4, the wheel 22 is trued up at intervals by the master roll 72 and utilized for grinding the production roll 46 to its original configuration. Thereafter, the wheel is dressed by the roll 46 until the said roll has worn to the point where it is necessary that it be ground. It will be seen that the usage of the master roll 72 is considerably less than that of the production roll 46. Accordingly, by locating the shaving device 58 to operate on the master roll 72, the length life of the tool 70 is greatly increased and production runs of substantially greater length may be made while maintaining the same accuracy of the workpiece.

An alternative method of supporting the shaving tool is shown in Figures 5 and 6. In these views the dressing roll is indicated at 74 and the shaving tool at 76. The tool 76 is formed with the configuration of the roll running lengthwise and is secured to a wedge member 78 and is reciprocable vertically in the frame 80. Recip-

rocable transversely in the frame 80 is a second wedge 82 which is adjusted by the screw 84. In the arrangement shown in Figures 5 and 6, the tool 76 is elevated vertically to bring it into shaving engagement with the roll 74. After a shaving operation, the tool 76 may be lowered and the roll is then ready for dressing a wheel.

A still further modification is illustrated in Figure 7 wherein the dressing roll may be selectively clutched or unclutched from its driving motor. The parts in Figure 7 which correspond to those in Figures 2 and 3 are correspondingly numbered with the addition of a subscript *a*. In Figure 7, the shaft 44*a* is separated between the bearing block 40*a* and the pulley 48*a*. An additional bearing block 40*b* may be provided in order to journal an end of the shaft 44*a* adjacent the pulley 48*a*. Carried on one part of the shaft 44*a* is a clutch portion 86 which is selectively engageable by the clutch portion 88 slidably keyed to the other portion of the shaft 44*a*. The lever 90 may be provided which may be actuated to engage or disengage the clutch halves. When the roll 46*a* is to be shaved by the tool 70*a*, the clutch halves are engaged so that the roll is driven by its motor 56*a*. When the wheel is to be dressed the clutch halves are disengaged, the wheel and roll brought together and driven in rotation by driving the wheel at low speed.

For the purpose of so driving the wheel, there is provided the arrangement shown in Figures 8 and 9. In these views the wheel 22*a* is carried on a shaft 92 which is driven by the high speed motor 94. The shaft 92 at the other end of the motor is connected to a clutch mechanism 94 with the low speed output shaft 96 of the geared head motor generally indicated at 98.

The clutch 94 is indicated in section in Figure 9 and will be seen to comprise a notched portion 100 connected with the shaft 96 and a cylinder 102 connected with the shaft 92. The rollers 104 and the notches in the member 100 provide a driving connection between the said member and the cylinder 102 when the member is driven counterclockwise but permit free relative rotation of the member and cylinder when the member is driven clockwise or when the cylinder is driven counterclockwise at a greater speed than the said member.

In the case of large wheels and heavy drive motors, it is preferably to drive the wheel by a low speed motor during dressing, and to drive the roll therethrough because it eliminates the possibility of the wheel slipping on the roll and causing the roll to wear rapidly.

It will be seen that this invention provides for an improved method and apparatus for maintaining grinding wheels in condition to produce accurate workpieces. This invention furthermore materially extends the life of any setup and, in certain instances where the work is light, the original setup may be employed throughout the job.

It will be understood that this invention is susceptible to modification in order to adopt it to different usages and conditions and, accordingly, it is desired to comprehend such modifications within this invention as may fall within the scope of the appended claims.

I claim:

1. In a grinding machine; a grinding wheel rotatably mounted thereon of a given work surface width, said grinding wheel comprising a surface having abrasive grains embedded in a crushable bonding material a rotatable crush dressing roll having a surface hard enough to crush the bonding material on said grinding wheel when the same is pressed there against, said roll being mounted on said machine for rotation on an axis parallel with the axis of rotation of said grinding wheel, said crush dressing roll having a surface width at least equal to said work surface of said grinding wheel and corresponding surface parts of said wheel and roll being co-planer, means mounted on said machine selectively operable for bringing said grinding wheel into crushing relationship with said roll to break said bonding material and cause said grinding wheel to take a shape which is complementary to the shape of said roll, and means mounted on said machine for truing said roll comprising a shaving tool having a width sufficient for engagement with the entire surface width of said crush roll and movable into engagement with the surface of said roll, the complementary shaped cutting edge of said shaving tool having all parts thereof in true radial disposition relative to said roll.

2. In a grinding machine; a grinding wheel rotatably mounted thereon of a given work surface width, said grinding wheel comprising a surface having abrasive grains embedded in a crushable bonding material first and second rotatable crush dressing rolls having roll surfaces which are sufficiently hard to crush the bonding material on said grinding wheel when the same is pressed there against, said rolls being mounted in said machine for rotation on axes parallel with the axis of rotation of said wheel, said rolls having a surface width at least equal to said work surface of said grinding wheel and corresponding surface parts of said wheel and rolls being co-planer, one of said rolls being a master dressing roll for truing the other of said rolls, a shaving tool mounted on said machine and having a width sufficient for engagement with the entire surface width of said crush roll and movable into engagement with the surface of said master dressing roll, the complementary shaped cutting edge of said shaving tool being presented to said roll substantially on the center line thereof and in true radial disposition relative to said master roll, and means mounted on said machine selectively operable for bringing the grinding wheel into crushing relationship with either of said rolls for dressing the wheel thereby.

3. In a grinding machine; a grinding wheel rotatably mounted thereon of a given work surface width, said grinding wheel comprising a surface having abrasive grains embedded in a crushable bonding material first and second rotatable crush dressing rolls having roll surfaces which are sufficiently hard to crush the bonding material on said grinding wheel when the same is pressed there against, said rolls being mounted on said machine for rotation on axis parallel with the axis of rotation of said wheel, said rolls having a surface width at least equal to said work surface of said grinding wheel and corresponding surface parts of said wheel and rolls being co-planer, a shaving tool having a width sufficient for engagement with the entire surface width of said crush roll and fixedly mounted adjacent one of said dressing rolls, means mounted on said machine selectively operable for bringing said shaving tool into engagement with said roll, the complementary shaped cutting edge of said shaving tool having all parts thereof in true radial disposition relative to said

roll, and means mounted on said machine selectively operable for bringing the wheel into crushing relationship with either of said rolls for dressing the wheel thereby or into grinding relationship with said first roll for grinding the said first roll by the wheel.

4. The method of dressing the working surface of a grinding wheel which comprises the steps of bringing the crushing roll against the working surface of a grinding wheel by moving one of them in a single plane to surface form the grinding wheel working surface complementary to that of the surface of the crushing roll, establishing a surface truing roll adjacent the crushing roll to dispose the surface form of the truing roll in radial alignment with the surface form of the crushing roll, intermittently causing the working surface of the grinding wheel to engage the truing roll by moving one of them in said single plane to surface form the grinding wheel surface to that of the surface of the truing roll, establishing a surface truing device having a cutting edge thereon adjacent said truing roll in a predetermined relationship thereto and adjustable into and out of contact with said roll with the complementary cutting edge of said surface truing device having all portions thereof in true radial disposition relative to the surface form of said truing roll, at least intermittently causing the truing device and truing roll to be brought into engagement at the complementary shaped edge of the truing device to maintain the shape of the truing roll accurate to within predetermined limits, and causing the grinding wheel to engage the crushing roll by movement of one of them in said single plane to reform the surface of the crushing roll to that of the surface of the shaped truing roll.

5. A method of dressing the working surface of a grinding wheel which comprises the steps of bringing a crushing roll against the working surface of a grinding wheel to surface form the grinding wheel working surface complementary to that of the surface of the crushing roll, establishing a surface-truing roll adjacent the crushing roll to dispose the surface form of the truing roll in radial alignment with the surface form of the crushing roll, both of which surfaces are in radial alignment with the complementary surface formed on the working surface of the grinding wheel, establishing a surface truing device having a cutting edge thereon adjacent the truing roll in a predetermined relationship thereto and adjustable into and out of contact with said roll with the complementary cutting edge of said surface truing device having all portions thereof in true radial disposition relative to the surface form of said truing roll, intermittently causing the working surface of the grinding wheel to engage the truing roll to surface form the grinding wheel surface to that of the surface of the truing roll, at least intermittently causing the truing device and truing roll to be brought into engagement at the complementary shaped edge of the truing device to maintain the shape of the truing roll accurate to within predetermined limits, and causing the grinding wheel to engage the crushing roll to reform the surface of the crushing roll to that of the surface of the truing roll.

6. A method of dressing the working surface of a grinding wheel which comprises the steps of bringing a crushing roll against the surface of a grinding wheel by movement in a single plane to surface form the grinding wheel working surface complementary to that of the surface of the crushing roll, establishing a surface-truing roll adjacent the crushing roll to dispose the surface form of the truing roll in radial alignment with the surface form of the crushing roll, establishing a surface-truing device having a cutting edge thereon adjacent the crushing roll in a predetermined relationship thereto and adjustable into and out of contact with said roll with the complementary cutting edge of said surface truing device having all portions thereof in true radial disposition relative to the surface form of said truing roll, intermittently causing the working surface of the grinding wheel to engage the truing roll by moving one of them in said single plane to surface form the grinding wheel surface to that of the surface of the truing roll, causing the grinding wheel to engage the crushing roll by movement of one of them in said single plane to reform the surface of the crushing roll to that of the surface of the truing roll, and at least intermittently causing the truing device and crushing roll to be brought into engagement at the complementary shaped edge of the truing device to maintain the shape of the crushing roll accurate to within predetermined limits.

7. In a grinding machine, a grinding wheel rotatably mounted thereon of a given work surface width, said grinding wheel comprising a surface having abrasive grains embedded in a crushable bonding material, a rotatable crushing roll at least equal in width to said grinding wheel and having a surface hard enough to crush the bonding material on said grinding wheel when the same is pressed there against, said roll being disposed on said machine adjacent said grinding wheel with the surface form of the crushing roll in true radial alignment with the complementary surface on said grinding wheel, a truing roll having a width equal to that of said crush roll and disposed adjacent said grinding wheel and having the surface form thereof in true radial alignment with the surface form of said crushing roll and with the complementary surface on said grinding wheel, a shaving tool having a width sufficient for engagement with the entire surface width of said truing roll and mounted adjacent said truing roll the complementary edge thereof movable into and out of contact with the entire working width of said roll, means mounted on said machine for bringing said tool into shaving engagement with said roll, means mounted on said machine for effecting relative movement between said grinding wheel and said crushing and truing rolls, the surface form of the grinding wheel remaining always in radial alignment with the surface form on said crushing roll and said truing roll.

8. In a grinding machine, a support, a rotatably mounted grinding wheel of a given work surface width secured on said support, a reciprocable bed spaced from said support and having a chuck adapted to position workpieces in engagement with the said grinding wheel on the said support, a dressing device secured on said bed and comprising a table and a crush dressing roll mounted on said table, said crush roll having a surface width substantially equal to the said work surface of said grinding wheel and adapted for engagement with the said surface of the grinding wheel, means, including bearing means on said table rotatably supporting said crush roll, for driving the said crush roll at crushing speed in said engagement with said

rotatably mounted grinding wheel, and a shaving tool supported on said table of said dressing device and having a width sufficient for engagement with the entire surface width of said crush roll for shaving of the same, said crush roll, said grinding wheel and said shaving tool being mounted in substantially the same vertical plane and movable relative to each other in said vertical plane for pressured revolving engagement of said crush roll and said grinding wheel, and for said engagement of said roll and shaving tool in shaving relationship.

9. In a grinding machine, a support, a rotatably mounted grinding wheel of a given work surface width secured on said support and vertically adjustable thereon, said grinding wheel having a given plane of rotation, a reciprocable bed spaced from the said support and having a chuck adapted to position workpieces in engagement with the said grinding wheel on the said support, a dressing device secured on said bed and comprising a table and a crush dressing roll fixedly mounted on said table, said crush roll having a surface width substantially equal to the said given work surface of said grinding wheel and adapted for engagement with the said grinding wheel, means, including bearing means on said table rotatably supporting said crush roll, for driving the said crush roll at crushing speed in said engagement with said rotatably mounted grinding wheel, and a shaving tool movably supported on said table of said dressing device and having a width sufficient for engagement with the entire surface width of said crush roll for shaving of the same, said crush roll, said grinding wheel and said shaving tool being mounted in substantially the same vertical plane and movable relative to each other in said vertical plane for pressured revolving engagement of said crushing roll and said grinding wheel, and for said engagement of said crush roll and said shaving tool in shaving relationship.

10. In a grinding machine, a support, a rotatably mounted grinding wheel of a given work surface width secured on said support and having a given plane of rotation, a first, reciprocable bed having a chuck adapted to position workpieces in engagement with said grinding wheel, said first bed and said grinding wheel being spaced in fixed vertical relation, a dressing device secured on said first bed and comprising a second bed secured to said first bed, a table on said second bed and a crush dressing roll mounted on said table, said crush roll having a working surface width complementary to the said work surface of said grinding wheel adapted for engagement with said grinding wheel, means including a pivot member securing said table and said second bed in adjustable relation in the said plane of rotation of said grinding wheel, means, including bearing means rotatably supporting said crush roll on said adjustable table, for driving the said crush roll at crushing speed in said engagement with said rotatably mounted grinding wheel, and a shaving tool supported on said table of said dressing device and having a width sufficient for engagement with the entire working surface width of said crush roll, said crush roll, said grinding wheel and said shaving tool being mounted in substantially the same vertical plane and having movement relative to each other in said vertical plane for said engagement of said crush roll and said shaving tool in shaving relationship, and for pressured revolving engagement of said crush roll and said grinding wheel, said relative movement between said grinding wheel and said crush roll being effected by movement of said adjustable table on said pivot member.

11. In a dressing device for mounting on a reciprocable bed of a grinding machine, said machine comprising a grinding wheel rotatably mounted thereon of a given work surface width, said grinding wheel comprising a surface having abrasive grains embedded in a crushable bonding material, a wheel dressing bed adapted to be fixedly secured to said reciprocable bed of said grinding machine, a table pivotally secured to said wheel dressing bed for vertical adjustment of said table, a rotatable crush roll having a surface hard enough to crush the bonding material on said grinding wheel when the same is pressed thereagainst, said roll having a surface width substantially equal to the said given width of the grinding wheel of the machine and adapted for pressured revolving engagement with the said grinding wheel of the said grinding machine, a shaving tool supported on said table and having a width sufficient for engagement with the entire surface width of said crush roll for shaving of the same, said crush roll and said shaving tool being mounted in substantially the same vertical plane and movable relative to each other in said vertical plane for said engagement thereof, an electric motor means mounted on said table for driving the said crush roll in said engagement with said shaving tool when said crush roll is dulled by said engagement with said grinding wheel.

12. In a grinding machine, a support, a rotatably mounted grinding wheel of a given work surface width secured on said support, said grinding wheel having a given plane of rotation, a reciprocable bed spaced from said support and having a chuck adapted to position workpieces in engagement with the said grinding wheel on the said support, a dressing device secured on said bed on one end thereof and comprising a table and a production crush dressing roll mounted on said table, said production crush roll having a surface width substantially equal to the said work surface of said grinding wheel and adapted for engagement with the said grinding wheel, means, including bearing means on said table rotatably supporting said production crush roll, for driving the said crush roll at crushing speed in said engagement with said rotatably mounted grinding wheel, a master crush roll positioned on the said bed with the end thereof remote from said production roll, means including a rotatable mounting for said master roll for driving said master roll, and a shaving tool supported on said bed adjacent said master roll and having a width sufficient for engagement with the entire surface width of said master crush roll for shaving of the same, said production crush roll, said master crush roll, said grinding wheel and said shaving tool being mounted in substantially the same vertical plane and movable relative to each other in said vertical plane for pressured revolving engagement of said production crush roll and said grinding wheel, for said engagement of said master crush roll and said shaving tool in shaving relation and for pressured revolving engagement of said grinding wheel and said master crush roll.

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