Aug. 20, 1968 J. K. RYE 3,398,253

GRINDING MACHINE WITH ELECTRIC DISCHARGE MACHINING MECHANISM FOR RESHAPING CRUSH ROLL

Filed Oct. 19, 1965 2 Sheets-Sheet 1

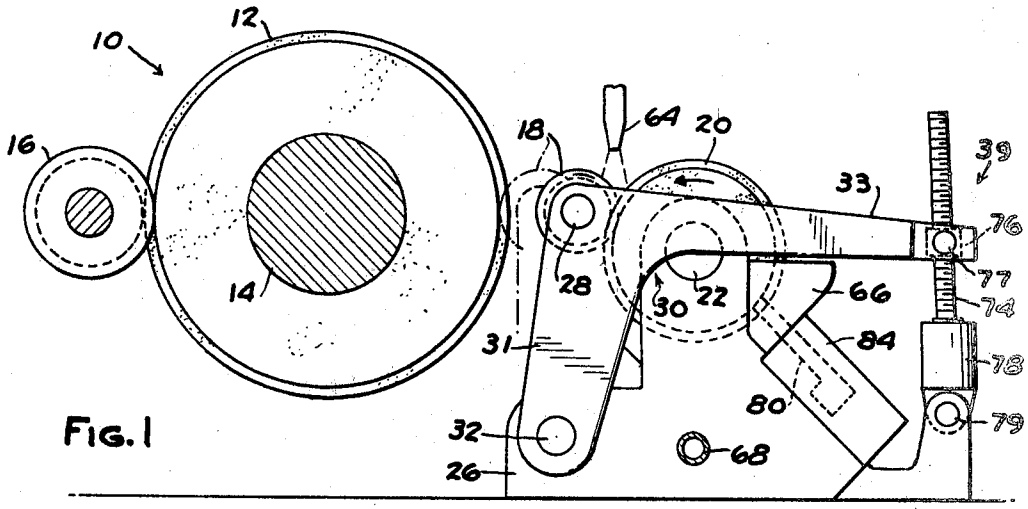

FIG. 1

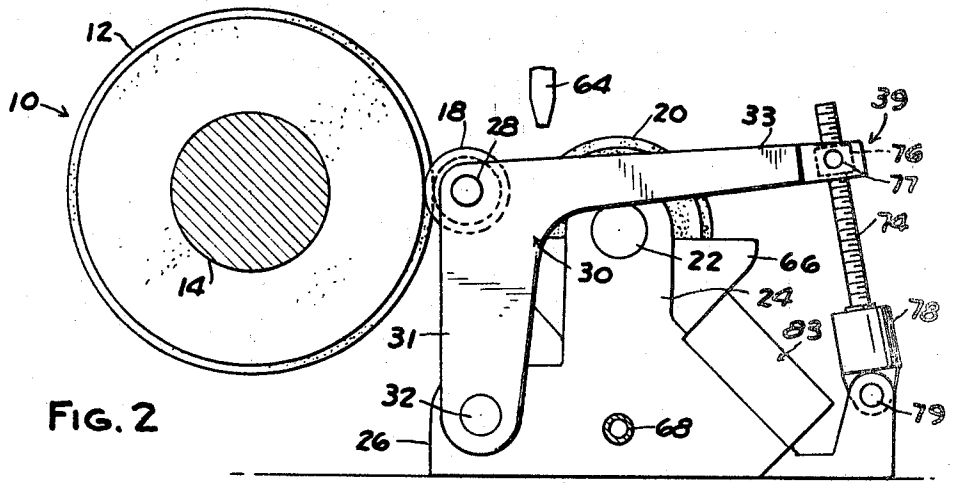

FIG. 2

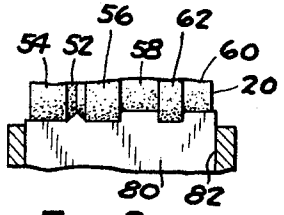

FIG. 3

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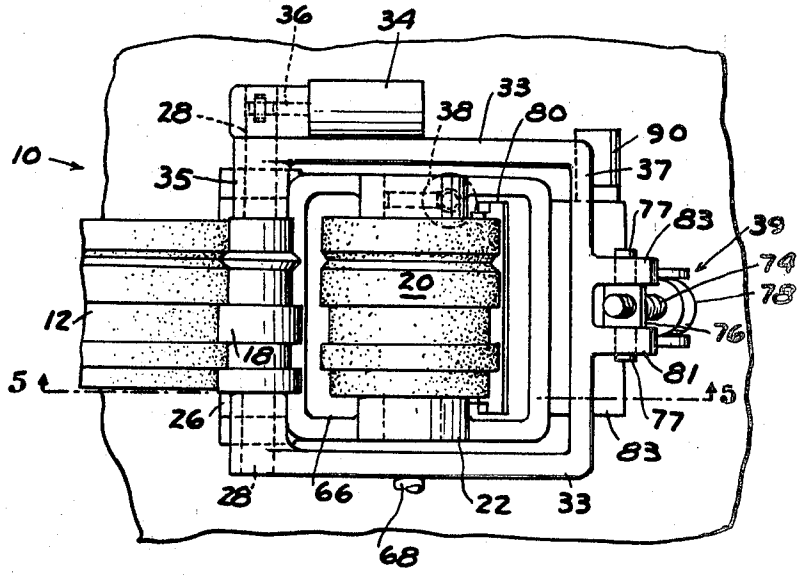

FIG. 4

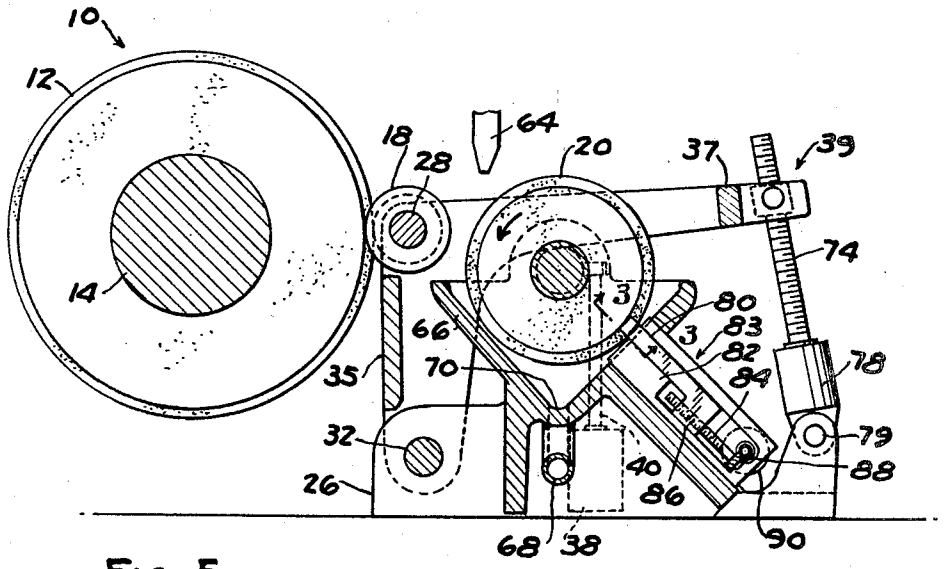

FIG. 5

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GRINDING MACHINE WITH ELECTRIC DISCHARGE MACHINING MECHANISM FOR RESHAPING CRUSH ROLL

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ABSTRACT OF THE DISCLOSURE

A grinding machine having a wheel dressing mechanism in the form of a crush roll formed of hard material such as a metal carbide and an electrode wheel for imparting the desired profile to the crush roll by means of electric discharge machining. The crush roll can be rocked from an operative position with the grinding wheel to an operative position with the electrode wheel.

This invention relates generally to grinders and more particularly to a method and apparatus wherein a crush roll for dressing a grinding wheel may be reformed between grinding cycles by electric discharge machining.

Numerous grinding machines are equipped with a crush roll mechanism for dressing the grinding wheel periodically between grinding operations. Eventually the crush roll wears to a point where its contour must be reformed. This normally necessitates removal of the crush roll from the grinding machine and reforming its shape on another machine such as by a diamond wheel or the like. This procedure is not only time consuming but also necessitates shutting down the grinding machine.

It is an object of this invention to eliminate the necessity of removing the crush roll from the grinding machine for the purpose of reforming the contour thereof.

A further object of the invention resides in the provision of a method and apparatus for reforming the contour of a crush roll without interrupting the operation of the grinding machine on which it is mounted.

Other objects, features and advantages of the invention will become evident from the following description, considered with the accompanying drawings, in which:

FIG. 1 is a side view, partly schematic, of apparatus according to the invention and shows an abrasive wheel crush roll in a retracted position where it may be reformed in the apparatus.

FIG. 2 is a side view similar to FIG. 1 showing the crush roll advanced into contact with a grinding wheel in order to dress it.

FIG. 3 is a detail section taken on line 3—3 of FIG.5 showing the profile of an electrode wheel which serves as a reforming tool in the apparatus.

FIG. 4 is a fragmentary plan view of the apparatus of FIG. 2.

FIG. 5 is a longitudinal section taken on line 5—5 of FIG. 4 showing the internal construction of the apparatus.

The method aspect of invention is carried out by grinding a workpiece with an abrasive wheel, dressing the abrasive wheel with a crush roll and reforming the crush roll by electric discharge machining. The crush roll is made of a very hard material, such as a metal carbide or the like, which is harder than the material of the abrasive grinding wheel. Despite its hardness, the crush roll may be formed accurately to the proper surface profile by electric discharge machining.

One embodiment of apparatus according to the invention includes a movable member which supports the crush roll between the abrasive wheel and an electrode wheel having a reforming surface of the desired profile. By operation of a driving mechanism, the movable member advances the crush roll into contact with the abrasive grinding wheel to true it up for a grinding operation, and retracts the crush roll to a position adjacent the electrode wheel where the roll is reformed by electric discharge machining.

The grinding machine **10** has an abrasive grinding wheel **12** supported for rotation on a spindle **14** which is rotated by an electric motor (not shown) to grind a workpiece **16**. The surface of abrasive wheel **12** ordinarily deteriorates due to the abrasion of grinding. In order to dress abrasive wheel **12** so that its contour will conform exactly to that required, a crush roll **18** is provided in the apparatus. Roll **18** on at least its outer surface may be of metal carbide or the like, as previously mentioned, which makes it sufficiently hard that it does not wear very much from one dressing operation to another. Some wear of the dressing surface occurs, however, so an electrode wheel **20** having a reforming surface is also provided in the appartus. Electrode wheel **20** is supported for rotation on a spindle **22** which is journalled in upright arms **24** on a supporting base **26**. Crush roll **18** is supported for rotation on spindle **28** journalled in a frame **30** which is pivotally supported on base **26** by a pin **32**. Frame **30** comprises a pair of axially spaced levers having angularly related arms **31** and **33**, the levers being interconnected to form the integral frame **30** by cross arms **35** and **37** (FIGS. 4 and 5). Cross arm **37** is connected to a jack mechanism **39**.

Crush roll **18** is located betwen abrasive wheel **12** and electrode wheel **20** such that it may be rocked back and forth between the two wheels about pivot pin **32**. When it is desired to dress abrasive wheel **12**, frame **30** is moved pivotally counterclockwise by operation of jack mechanism **39** to place dressing roll **18** in contact with abrasive wheel **12** (FIG. 2). When the dressing operation is completed, frame **30** may be pivoted clockwise by lowering jack mechanism **39** to retract or disengage crush roll **18** and move it to a position adjacent electrode wheel **20** (FIG. 1) wheren the surface of crush roll **18** is close to but spaced from the reforming surface of electrode wheel **20**.

During reforming, crush roll **18** is rotated slowly counterclockwise by an electric motor **34** mounted on one arm **33** of frame **30** (FIG. 4). Motor **34** is operatively connected by a worm wheel drive **36** to spindle **28** for rotating the spindle. Electrode wheel **20** is also rotated during reforming but at a faster speed than crush roll **18**. The power for rotating electrode wheel **20** is supplied by a high speed electric motor **38** (FIG. 5) connected by a worm drive **40** to spindle **22**. The motor which rotates abrasive wheel **12** is also a high speed type and it rotates wheel **12** faster than roll **18** is rotated. Wheel **20** may be made of carbon, and electrical contact is made to this wheel by means of brushes (not shown) (FIG. 5). Crush roll **18** is ordinarily maintained at ground potential and a high potential either A.C. or interrupted D.C. is applied to electrode wheel **20** from a power source (not shown). It will be understood, however, that high potential could alternatively be applied to crush roll **18** while maintaining electrode wheel **20** at a reference potential. The objective is to produce an electric field between the dressing surface of roll **18** and the reforming surface of electrode wheel **20** which causes intermittent arcing as crush roll **18** rotates. The arcing removes material from the dressing surface of roll **18**. By this electric discharge process, the dressing surface of roll **18** is made to conform inversely with the reforming surface of electrode wheel **20**.

The surface profiles of wheels **12** and **20** and crush roll **18** will vary from job to job. An illustrative profile for electrode wheel **20** is shown in FIGS. 3 and 4. There is a V-groove **52** between two land areas **54** and **56** and flat recesses **58** and **60** on opposite sides of another land **62**. The surface profile of abrasive wheel **12** is identical to that of electrode wheel **20**, whereas the surface profile of crush roll **18** inversely matches that of the electrode wheel, as is evident in FIG. 4.

A dielectric oil flows from the outlet **64** of a liquid supply system into the space between the adjacently positioned dressing surface of crush roll **18** and reforming surface of wheel **20** (FIG. 1). The oil is desirable for its dielectric properties and also as a medium for carrying the metal particles away from roll **20** during reforming. A trough **66** (FIG. 5) is supported on base **26** beneath electrode wheel **20** to collect the oil and has a drain outlet **68** at its bottom end **70** which connects with a pump and filter (not shown).

The jack mechanism **72** for shifting frame **30** includes a worm screw **74** threaded through a tapped opening in a nut **76** having pins **77** journalled for rotation in lugs **81** and **83** which are integral with cross arm **37** of the frame. Worm screw **74** may be rotated in either rotary direction by a reversible electric motor **78**. The worm screw and motor are pivotally supported on base **26** by pivot pin **79**. In one direction of rotation, worm screw **74** raises arms **33**, **35** and **37** of frame **31** and thereby pivots the frame about pin **32** to move dressing roll **18** into contact with abrasive grinding wheel **12**. Conversely, when worm screw **74** rotates in the opposite direction, it lowers arms **33** and **37** to retract dressing roll **18** to its reforming position adjacent electrode wheel **20**.

Motor **78** is preferably of the type that can be rotated rapidly to produce a rapid advance and rapid retraction or slowly to produce a slow feed rate when the crush roll is in operative relation with abrasive wheel **12** on electrode wheel **20**. Motor **34**, which rotates crush roll **18**, is likewise a variable speed motor which is adapted to rotate crush roll **18** rapidly when in operative relation with abrasive wheel **12** and very slowly when in operative relation with electrode wheel **20**. Motor **34** is preferably of the type that can be rotated by very small increments under the control of the potential of the arc established between roll **18** and wheel **20** to control the rate of stock removal by the electrical discharge action.

Electrode wheel **20** is dressed between successive operations on crush roll **18** by means of a wheel dresser in the form of a blade **80**, the edge of which is ground with a contour coresponding to that required on the workpiece to be ground. Dresser **80** is mounted in a guideway **82** within a housing **83** on base **26** for movement radially toward and away from the periphery of electrode wheel **20**. Dresser **80** is shifted in guideway **80** by a screw **84** engaging a threaded lug **86** on the dresser. Screw **84** is rotated in opposite directions by a worm drive **88** from a motor or manual turning knob **90**.

In accordance with the invention, reforming of a crush roll may be accomplished without removing the crush roll from the grinding machine. Reforming may take place during or between grinding cycles such that there is no disturbance of the grinding schedule. The invention may be applied to many types of grinders and is not limited in its utility to the specific grinding machine described and illustrated herein by way of example.

I claim:

1. In a grinding machine the combination comprising an abrasive wheel supported for rotation to grind a workpiece, a rotatably-supported crush roll for dressing the abrasive wheel, a rotatably-supported electrode wheel, means movably supporting the crush roll between the abrasive wheel and the electrode wheel, a feed screw operatively connected to said movable means, a reversible motor operatively connected with the feed screw for rotating the same in opposite directions for shifting the crush roll in one direction into contact with the abrasive wheel and in the opposite direction to a position adjacent the electrode wheel, said electrode wheel having a surface adapted to reform the dressing surface of the crush roll by electric discharge machining, liquid supply means having an outlet adjacent the electrode wheel for supplying a dielectric liquid to the space between adjacent portions of the crush roll and the electrode wheeel when they are adjacently positioned, a motor for rotating the electrode wheel at a relatively high speed, a motor for rotating the crush roll at a speed substantially lower than the speed of the electrode wheel and electrical energy supplying means connecting said crush roll and said electrode wheel in circuit for electric discharge machining.

2. In a grinding machine the combination comprising a support, an abrasive wheel journalled on said support for grinding a workpiece, a crush roll journalled on said support, an electrode wheel journalled on said support, said crush roll being relatively movable toward and away from the abrasive wheel and electrode wheel so that the abrasive wheel and crush roll can be brought into tangential rolling contact and the crush roll and electrode wheel can be brought into close tangential relation, said crush roll comprising an electrically conductive metal of the type which is too hard to be shaped by conventional metal cutting tools, said electrode wheel having a surface adapted to reform the dressing surface of the crush roll by electric discharge machining, power means for rotating said crush roll and said abrasive and electrode wheels and electrical energy supplying means connecting said crush roll and said electrode wheel in circuit for electric discharge machining.

3. The combination called for in claim **2** wherein the dressing surface of said crush roll comprises a metal carbide.

4. The combination called for in claim **2** including a blade type wheel dresser for said electrode wheel, said wheel dresser being mounted on said support for relative movement toward and away from the periphery of the electrode wheel.

5. The combination called for in claim **2** wherein said crush roll and said wheels are arranged with their axes generally parallel, means movably mounting said crush roll on said support for movement in opposite directions toward and away from said abrasive wheel and said electrode wheel, a feed screw operatively connected with said last-mentioned means for moving the same and a reversible motor operatively connected with said feed screw.

6. The combination called for in claim **2** wherein said crush roll and said wheels are arranged with their axes generally parallel, a rocking lever pivotally mounted on said support, said crush roll being journalled on said rocking lever and being disposed between said abrasive wheel and said electrode wheel for pivotal movement with said lever toward and away from the abrasive wheel and the electrode wheel and means for rocking said lever in opposite directions including a reversible motor operatively connected with said lever.

7. The combination called for in claim **6** wherein said lever rocking means includes a nut on said lever and a feed screw engaged with said nut, said feed screw being operatively connected with said motor for rotation in opposite directions.

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