July 13, 1965 S. G. BRADY 3,194,751

ELECTROLYTIC GRINDER WHEEL

Filed Sept. 1, 1961

Fig. 1

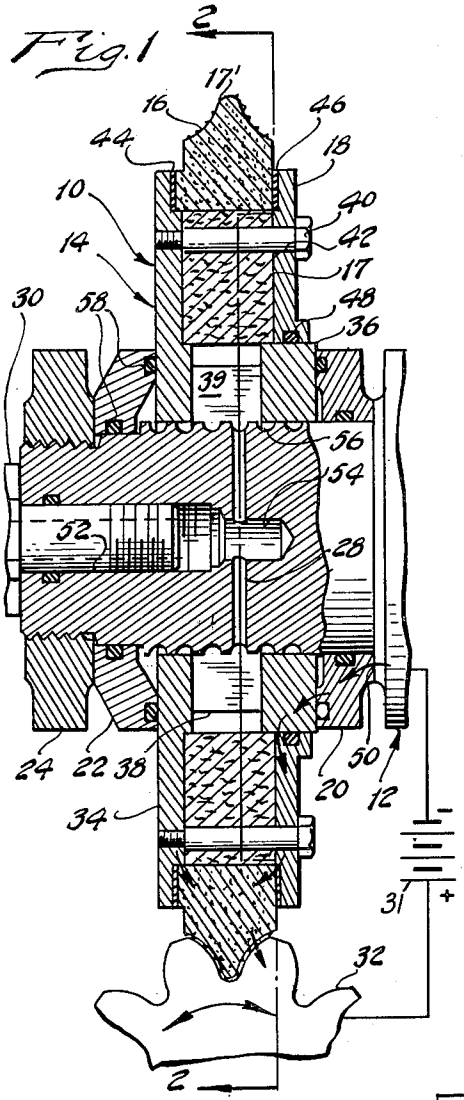


Fig. 2

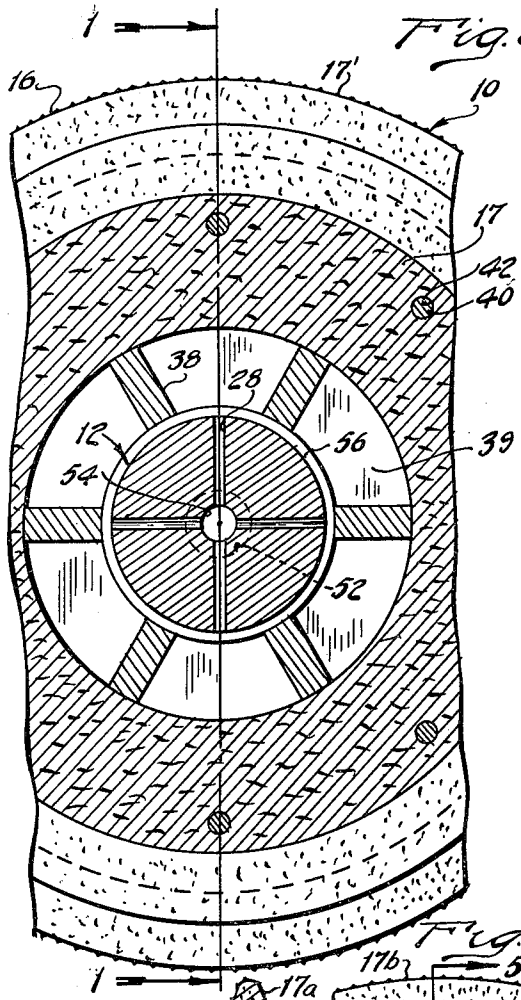


Fig. 3

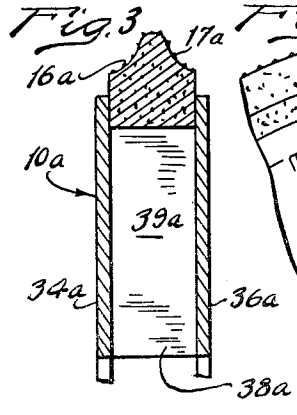


Fig. 4

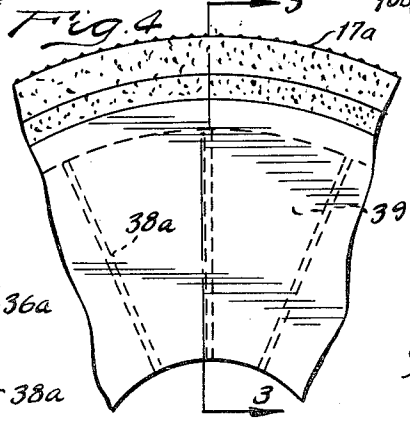


Fig. 5

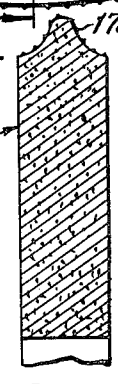
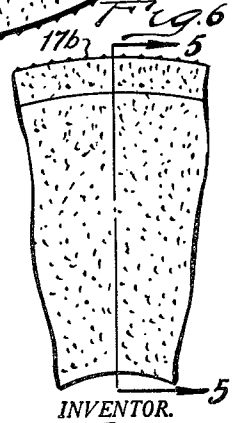


Fig. 6



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ELECTROLYTIC GRINDER WHEEL

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Filed Sept. 1, 1961, Ser. No. 140,967
5 Claims. (Cl. 204—212)

This application is a continuation-in-part of application Serial No. 817,366 filed June 1, 1959, now abandoned.

The present invention relates generally to grinder wheels and refers more specifically to a grinder wheel having an electrically conductive porous binder such as silver or copper alloys for use in an electrolytic process of forming workpieces wherein an electrolyte is circulated radially outwardly through the porous grinder wheel into the area between the grinder wheel and the workpiece.

It has in the past been known that finish forming of a metal workpiece may be accomplished electrolytically by a process including flowing electrolyte between a workpiece and a metallic grinder wheel between which an electric potential has been developed. The success of such metal forming depends on the extent to which the electrolyte is present between the grinder wheel and the workpiece. Therefore a space is required between the grinder wheel and the workpiece and within working limits the larger the space is the easier it is to maintain an optimum amount of electrolyte between the wheel and the workpiece. However it has been found that better control of the forming of the workpiece is possible if the spacing between the grinder wheel and the workpiece is kept to a minimum. Thus the problem previously confronting industry which the present invention provides an answer to is how to maintain sufficient electrolyte between a workpiece and a grinder wheel during electrolytic forming of the workpiece and still keep the spacing between the grinder wheel and the workpiece such that the desired control of the forming of the workpiece may be accomplished.

In view of the above one of the objects of the present invention is to provide means for maintaining a proper amount of electrolyte between a workpiece and the metallic binder of a grinder wheel while maintaining the distance between the binder of the grinder wheel and the workpiece by means of abrasive material protruding from the surface of the grinder wheel such that the desired control of the electrolytic removal of stock from the workpiece may be accomplished.

Another object is to provide a grinding wheel including a porous metallic binder having abrasive material embedded therein and protruding from the surface thereof.

More specifically it is an object to provide a grinding wheel including an annular frame member supporting around the outer edge thereof a porous metallic bonded abrasive loaded annulus adapted for the outward radial passage of fluid therethrough.

Another object is to provide a grinder wheel of the indicated construction having an annular filter disposed between the frame and the porous metallic bonded annulus.

Still more specifically it is an object of the present invention to provide a grinder wheel comprising a pair of axially spaced flat annular side plates having perpendicular radially extending rib connections fusion bonded therebetween adapted to be sealed to a hollow grinder spindle around the inner periphery of said side plates, and a porous metallic bonded abrasive loaded annulus fusion bonded between said side plates around the outer edges thereof.

Still more specifically it is an object of the present invention to provide a grinder wheel comprising a pair of axially spaced flat annular side plates having perpendicular radially extending rib connections therebetween adapted to be sealed to a hollow grinder spindle around the inner periphery of said side plates, the outer edge of one of said side plates extending radially outward beyond the outer edge of the other side plate, an annular filter and a porous metallic bonded abrasive loaded annulus clamped against the radially outward portion of said one annular side plate by an annular clamp, said porous metallic bonded annulus being radially outward of said filter, and sealing means between said porous annulus and said one side plate and between said porous annulus and said clamp and between said clamp and said other side plate.

Other objects and features of the invention will become apparent as the description proceeds, especially when taken in conjunction with the accompanying drawing, illustrating preferred embodiments of the invention, wherein:

FIGURE 1 is a cross-section of a grinder wheel according to the invention attached to a hollow grinder wheel spindle.

FIGURE 2 is a partial section of the grinder wheel and hollow spindle of FIGURE 1 taken on line 2—2 of FIGURE 1.

FIGURE 3 is a partial cross-section of a modification of the grinding wheel of the invention.

FIGURE 4 is a partial plan view of the grinder wheel of FIGURE 3.

FIGURE 5 is a partial cross-section of a second modification of the grinding wheel of the invention.

FIGURE 6 is a partial plan view of the grinder wheel of FIGURE 5.

A particular embodiment of a grinder wheel 10 constructed according to the invention will now be described with reference to the figures.

In FIGURES 1 and 2 the grinder wheel 10 is shown mounted for rotation with a hollow spindle 12 which may be attached to a grinding machine (not shown). The grinder wheel 10 includes a frame 14, a porous metallic bonded abrasive loaded annulus 16, a filler 17, and a clamping ring 18. As shown the grinder wheel 10 is secured to the hollow spindle 12 between clamping plates 20 and 21 by locking nut 24. Means such as passages 28 are provided connecting the grinder wheel 10 to the interior of the hollow spindle 12.

In operation an electrolyte is introduced into the hollow spindle 12 by means of a fitting 30 and on rotation of the spindle the electrolyte is forced radially outward through the passages 28, filter member 17, and annulus 16 into the area between the grinder wheel 10 and workpiece 32 being formed thereby. Thus due to an electric potential applied between the grinder wheel and workpiece by electric power source 31 stock may be removed from the workpiece.

The introduction of an electrolyte between grinder wheel 10 and the workpiece 32 being formed thereby through the grinder wheel 10 insures a proper amount and distribution of electrolyte between the grinder wheel and the workpiece while allowing a closer spacing between the outer surface of the metallic binder of the annulus 16 of the grinder wheel 10 and the workpiece 32 thereby insuring proper control of the electrolytic removal of stock from the workpiece during the forming process. Furthermore since the usual external flowing of the electrolyte into the space between a non-porous grinder wheel and a workpiece is eliminated, the electrolytic removal of stock from workpieces may be accomplished in a more economical manner due to more efficient application of the electrolyte during a forming operation.

As shown in FIGURE 1 the frame 14 of the grinder wheel 10 comprises a pair of generally flat annular side plates 34 and 36 in axial alignment. The annular plates 34 and 36 are spaced apart axially by radial web members 38 which extend substantially perpendicularly between

the annular plates 34 and 36. The spaces between the web members 38 provide fluid inlet ports 39 for the grinder wheel 10 between the passages 28 and the filter 17 as illustrated. As shown the outer periphery of the side plate 34 extends radially beyond the outer periphery of the side plate 36 to receive the filter member 17 and the porous metallic bonded abrasive loaded annulus 16.

A clamping ring 18 is provided as shown in FIGURE 1 and extends radially outward in the plane of the side plate 36 between the outer periphery of the side plate 34. Clamping ring 18 is provided to clamp filter material 17 and annulus 16 to side plate 34 of frame 14 of the grinder wheel 10.

As shown in assembly in FIGURE 1 an annular filter member 17 and concentric porous metallic bonded annulus 16 are clamped between the clamping ring 18 and the extended portion of side plate 34 by means of angularly spaced bolts 40 extending through angularly spaced orifices 42 in clamping ring 18 through filter 17 and threadedly engaging the side plate 34. The porous metallic bonded abrasive loaded annulus 16 is positioned radially outward of the filter member 17. Sealing members 44, 46 and 48 are provided between the annulus 16 and the side plate 34, the clamping ring 18 and the annulus 16, and the clamping ring 18 and side plate 36 respectively, to prevent the escape of electrolyte axially of the grinder wheel 10 during rotation of the grinder wheel.

The frame 14 and clamping ring 18 of grinder wheel 10 may be made of steel or other desirable rigid material of suitable strength which is electrically conductive and not reactive with the electrolyte. Filter material 17 is provided to filter the electrolyte as it proceeds radially outwardly from the fluid inlet ports 39 of grinder wheel 10 to the porous metallic bonded abrasive loaded annulus 16 so that the annulus is not clogged with impurities in the electrolyte during passage of the electrolyte therethrough. The filter 17 may be of any of a number of well known materials suitable for such a purpose such as steel wool, fiber glass, cloth or polyurethane for example. The exact filter material will depend on the electrolyte, the impurities therein, the conditions of use of the grinder wheel and other variable factors normally considered in the design of filters. The porosity of the filter material will be slightly greater than that of the annulus 16.

The annulus 16 is formed of a metal binder which is abrasive loaded and is sufficiently porous to allow the passage therethrough of the desired electrolyte due to centrifugal force at the desired rotational speed of the grinder wheel 10. A suitable porosity for many grinding applications is obtained with openings through the annulus of 5 or 6 microns in diameter. However, the openings through the annulus may be as large as 10 microns in diameter.

Such a porous metallic bonded annulus may be formed by pressing powdered metal as for example copper or silver alloy mixed with abrasive material such as Carborundum and a substance which may later be caused to burn out during a heat treating or other process designed to remove the material with which the powdered material is combined to give the required porosity to the powdered metal annulus. Alternatively the porosity of the metallic binder may be varied by varying the pressure used in forming the powdered metal in the annular shape during sintering thereof.

The abrasive material in the annulus 16 protrudes from the surface of the metallic binder to remove non-conductive residue such as oxides formed thereon from the work. The abrasive material 17 protruding from the surface of the annulus 16 also provides a minimum spacing between the workpiece and the metal binder material to prevent arcing between the oppositely charged workpiece and the metallic binder material during electrolytic removal of stock from the workpiece.

As shown in FIGURE 1 the spindle 12 is provided with a shoulder 50 against which an annular clamping plate 20 is held by means of the grinder wheel 10, a second annular clamping plate 22 sleeved over the spindle 12 and a locking nut 24. Spindle 12 is hollow to provide the axially extending chamber 52 therein which has at its inner end 54 radially extending passages 28 connected therewith. Passages 28 are also connected at their other end with the helical grooves 56 around the outer surface of spindle 12 as shown. A fitting 30 is provided at the outer end of chamber 52 through which electrolyte may be introduced into the hollow spindle 12. Suitable seals 58 are provided between the clamping plates and both the hollow spindle 12 and the grinder wheel 10 as shown in FIGURE 1 to prevent undesirable leaking of the electrolyte during the rotation of the grinder wheel 10.

In operation a fluid electrolyte is introduced through fitting 30 into chamber 52. The electrolyte may be under pressure or not as desired. On rotation of the grinder wheel 10 with spindle 12 the electrolyte within chamber 54 is caused by centrifugal force to proceed outwardly through passages 28 into grooves 56 and the fluid inlet ports 39 to filter 17. The impurities which may possibly be present in the electrolyte are filtered from the electrolyte by the filter 17 as the electrolyte passes radially outwardly therethrough under pressure of the centrifugal forces created by the rotation of the grinder wheel 10. After having passed through filter 17 the now filtered electrolyte is caused to move radially outwardly of grinder wheel 10 through the porous metallic bonded annulus and thus into the space between the metallic binder of annulus 16 and the workpiece 32 being formed by the grinder wheel 10.

A modification 10*a* of the grinder wheel 10 is shown in FIGURES 3 and 4. The modified grinder wheel 10*a* comprise a pair of identical flat annular side plates 34*a* and 36*a* held in axial spaced relation by means of radial web members 38*a* extending substantially perpendicularly thereto and a porous metallic bonded abrasive loaded annulus 16*a* held between side plates 34*a* and 36*a* and bonded thereto around the outer periphery of the side plates. The grinder wheel 10*a* is adapted to be positioned on a spindle 12 in the manner previously described in connection with grinder wheel 10 with the clamping plates 20 and 21 abutting and firmly gripping the inner periphery of side plates 36*a* and 34*a* respectively. The materials and methods of construction of the annulus 16*a* are substantially the same as the materials and method used in constructing the annulus 16.

The operation of grinder wheel 10*a* is substantially the same as that of grinder wheel 10. On rotation of the hollow spindle 12 carrying a grinder wheel 10*a* the electrolyte within the chamber 52 will be caused to move radially outward in passages 28 to fill the fluid inlet ports 39*a* between the side plates 34*a* and 36*a* of grinder wheel 10*a*. Further rotation of the grinder wheel 10*a* will then cause the electrolyte within ports 39*a* to pass through the porous metallic bonded annulus 16*a* and into the space between the metal binder of annulus 16*a* and a workpiece 32 which is maintained by abrasive protruding from the annulus 16*a* whereby the workpiece is formed by electrolytic action in the manner previously described in connection with grinder wheel 10.

A second modification 10*b* of the grinder wheel 10 is shown in FIGURES 5 and 6. The grinder wheel 10*b* as illustrated is a flat annulus of abrasive material bonded together with a metallic binder which is sufficiently porous to allow the passage of electrolyte therethrough. The grinder wheel 10*b* is adapted to be held in place on a hollow spindle 12 in the same manner as grinder wheels 10 and 10*a* are held in position with respect thereto by clamping plates 20 and 22 abutting and firmly gripping opposite sides thereof around the inner periphery thereof. Also as disclosed above on rotation of a grinder wheel 10*b* and the hollow spindle 12 on which it is mounted and which is filled with electrolyte the electrolyte will be caused to pass radially outwardly through the

grinder wheel 10*b* into the spaces between the metallic binder of the grinder wheel 10*b* and a workpiece 32 being formed thereby which space is maintained by abrasive protruding from the annulus.

As previously mentioned with the grinder wheels indicated above, each including an annulus of porous binder material having abrasive material protruding therefrom, acting in conjunction with a hollow spindle as disclosed it is possible to maintain a proper amount of electrolyte between the porous metallic binder of a grinder wheel and a workpiece from which stock is being removed by an electrolytic process while maintaining a space therebetween which will prevent arcing between the binder and workpiece and allow optimum control of the forming operation.

Shorting between the metal binder of the annulus and the workpiece does not occur due to metal particles from the workpiece collecting on the grinder wheel since the protruding abrasive is provided to remove oxides or other non-conductive material from the surface of the workpiece and provide proper spacing between the conductive binder of the grinder wheel and the workpiece only. The metal which might cause a short between the workpiece and annulus is dissolved electrolytically from the workpiece rather than being removed therefrom by the abrasive action. In addition if added protection against damage to workpieces due to shorting which may periodically occur between the grinder wheel and workpiece is needed, an increased current detector and power switch such as shown in United States Patent No. 2,826,540 may be added to the electric circuit illustrated schematically in FIGURE 1 in conjunction with the grinder wheel 10.

Also since there is no inefficient flow of electrolyte over the grinder wheel and/or workpiece the electrolytic forming of the workpiece with a grinder wheel according to the invention will confine the electrolyte to an area immediately adjacent the radial outer edge of the grinding wheel and will be economical due to the efficient use of electrolyte.

What I claim as my invention is:

1. Apparatus for use in the electrolytic removal of stock from electrically conductive workpieces comprising a rotatable grinder wheel having an annulus composed of non-conductive abrasive grains held together in an electrically conductive porous metallic binder having a high conductivity, means for causing a forced flow of electrolyte radially outward through said annulus, said binder being exposed at the radially outer surface of said annulus so that said radially outer surface is electrically

conductive, grains of said abrasive protruding from the radially outer electrically conductive surface of said annulus for maintaining a predetermined spacing between said radially outer electrically conductive surface and the surface of the workpiece during the electrolytic removal of stock and for removing non-conductive stock by abrasive action.

2. The apparatus defined in claim 1, wherein said grinder wheel also includes laterally spaced annular side members respectively secured to opposite sides of said annulus, a spindle on which said grinder wheel is mounted, and passage means from said spindle to said grinder wheel for directing a forced flow of electrolyte radially outward through said annulus.

3. The apparatus defined in claim 1, wherein said annulus has a contoured radially outer surface adapted to produce the same contour on the workpiece.

4. The apparatus defined in claim 1, wherein said grinder wheel includes laterally spaced annular side plates connected by radial webs extending therebetween, one of said side plates having a radial extension extending outwardly beyond the outer periphery of the other side plate, a clamping ring concentric with said other side plate and extending in the plane of said other side plate in spaced opposed relation to the extension of said one side plate, said annulus being clamped between said extension of said one side plate and said clamping ring, a spindle on which said grinder wheel is mounted, and passage means from said spindle to said annulus for directing a forced flow of electrolyte radially outward through said annulus.

5. The apparatus defined in claim 4, wherein an annular filter is provided between the extension of said one said plate and said clamping ring radially inwardly of said annulus.

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JOHN H. MACK, *Primary Examiner.*

JOSEPH REBOLD, *Examiner.*

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,194,751 July 13, 1965

Samuel G. Brady

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 6, line 34, for "said", first occurrence, read side --.

Signed and sealed this 18th day of January 1966.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents