

July 26, 1960

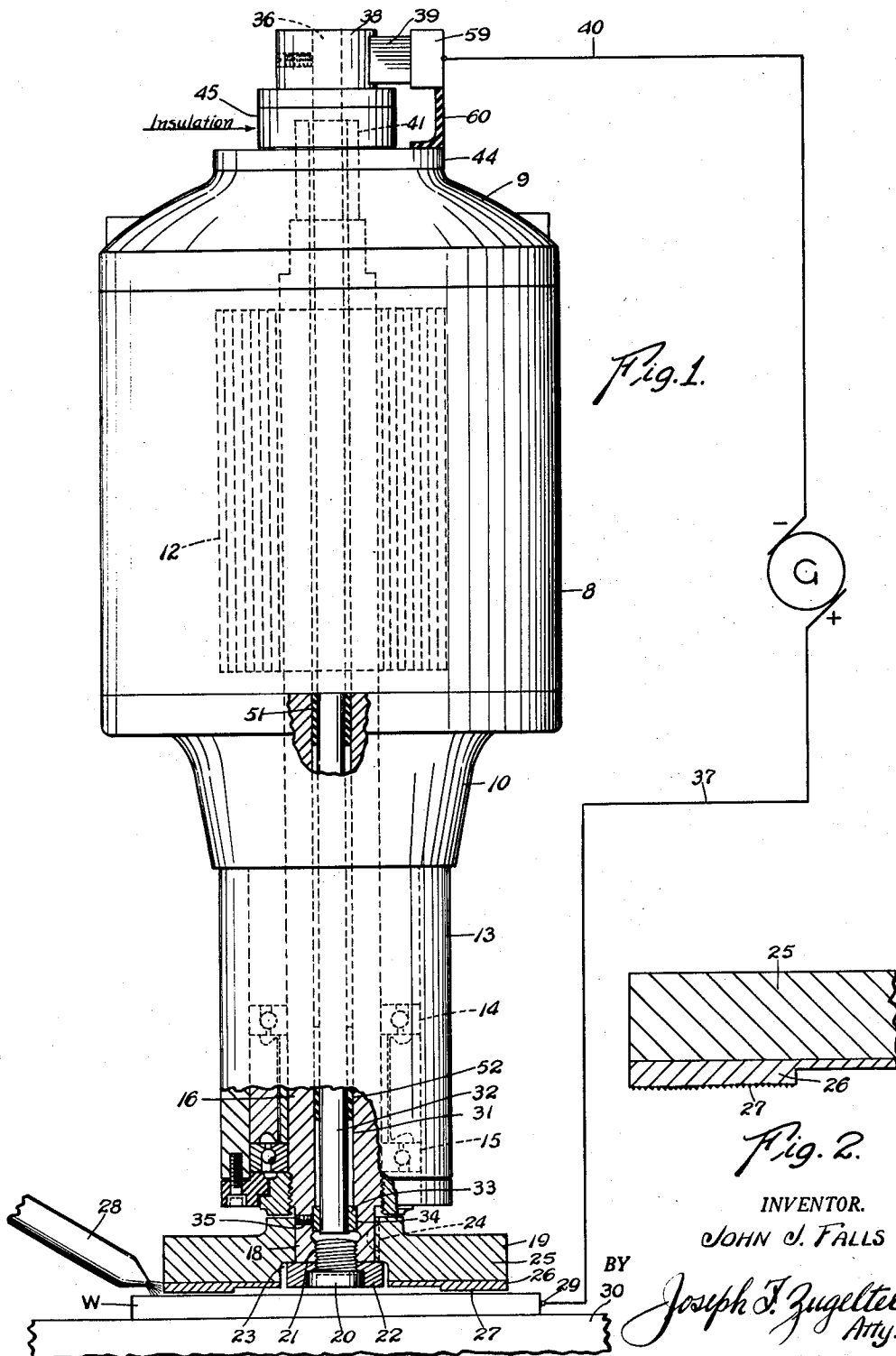
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METHOD AND APPARATUS FOR ELECTROLYTIC SHAPING

Filed Nov. 13, 1956

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3 Sheets-Sheet 2

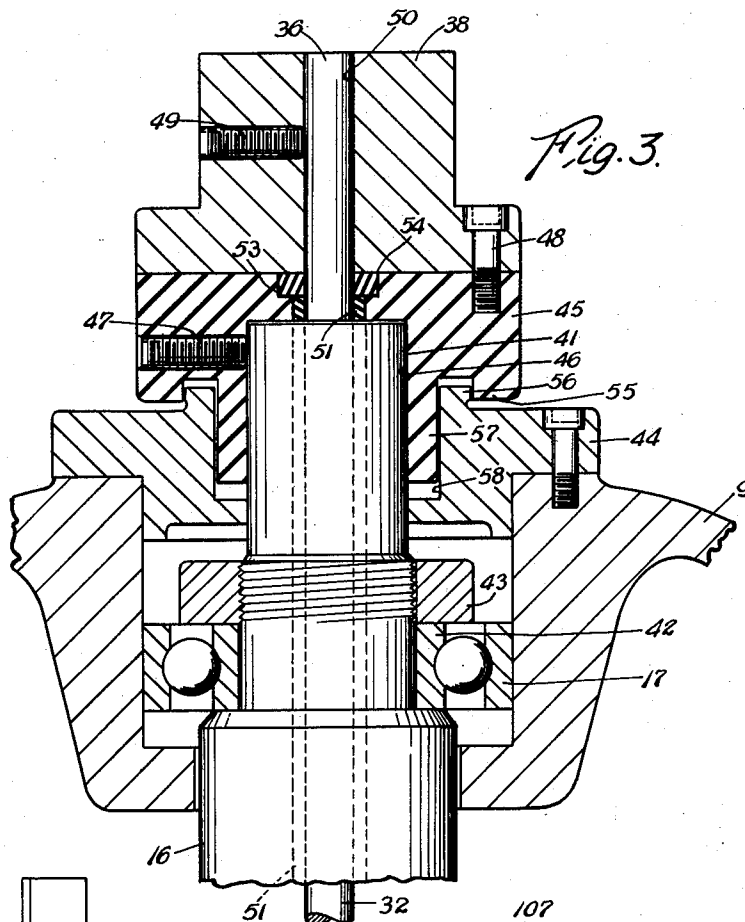


Fig. 3.

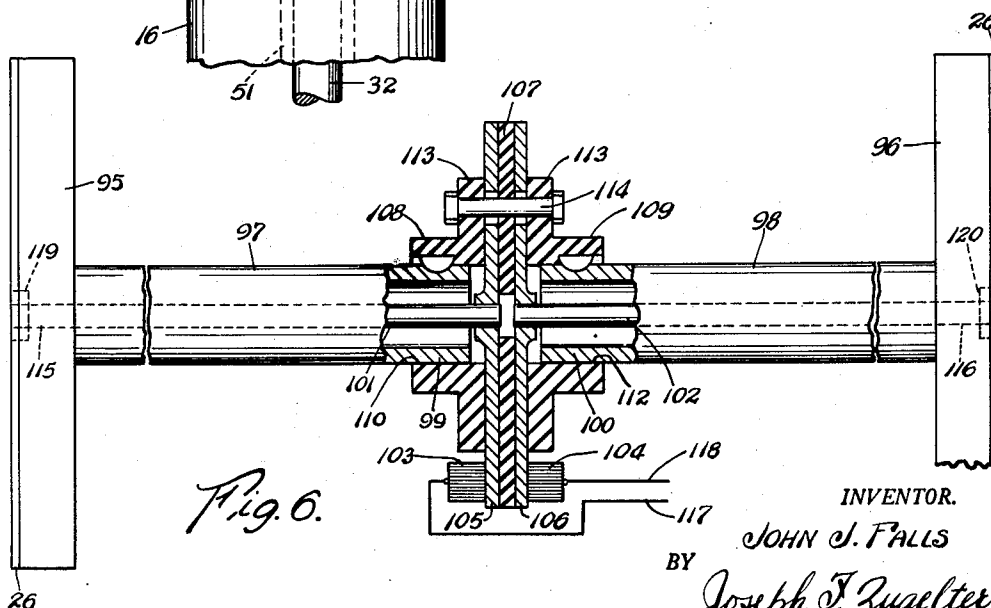


Fig. 6.

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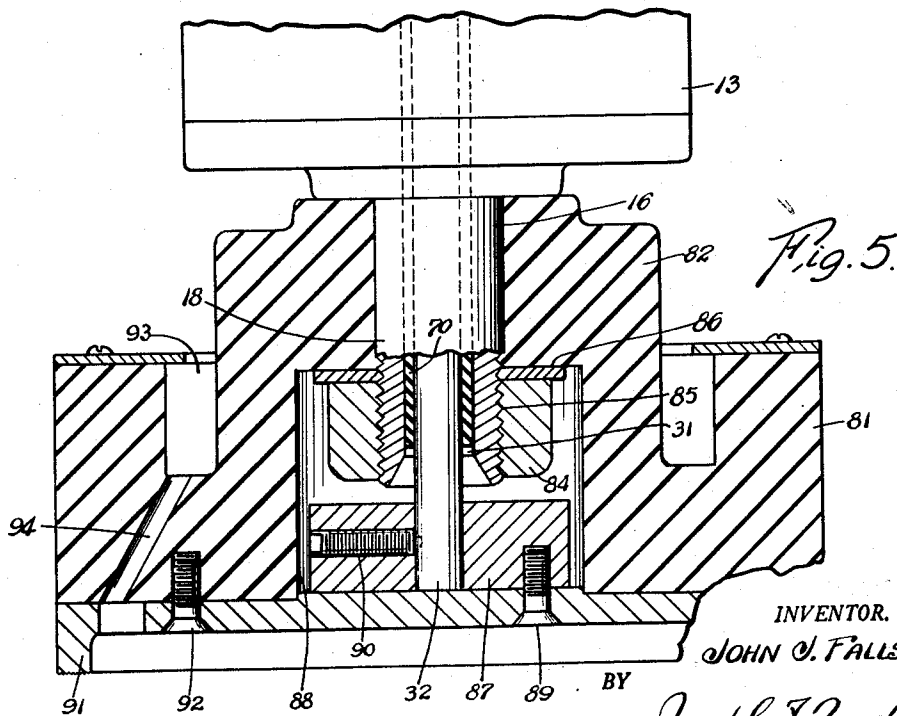
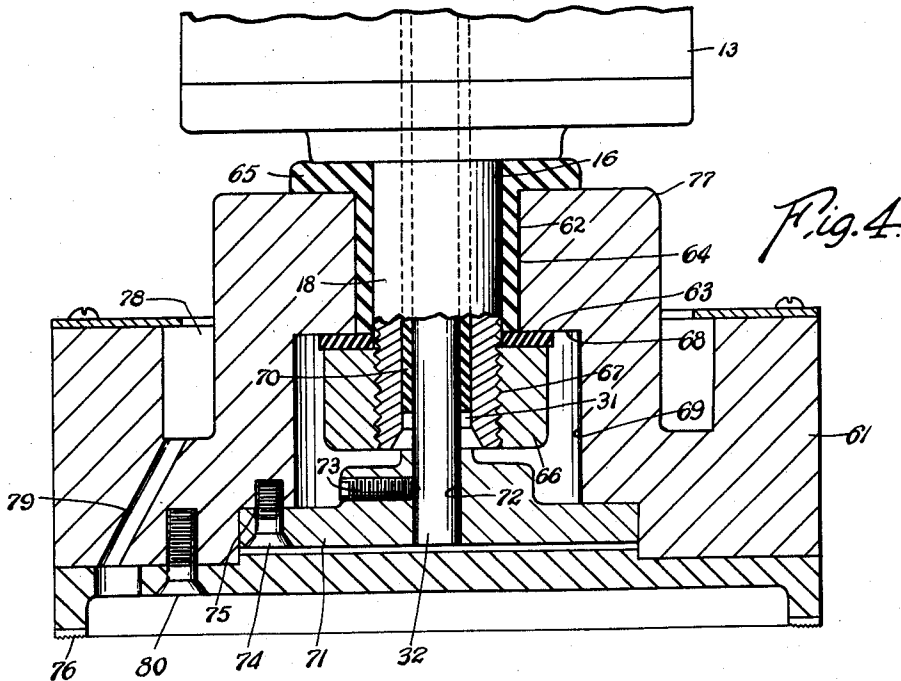
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3 Sheets-Sheet 3



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METHOD AND APPARATUS FOR ELECTROLYTIC SHAPING

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17 Claims. (Cl. 204—143)

This invention relates to a method and apparatus for shaping metallic objects by the electrolytic process. Electrolytic shaping involves the removal of material from a metallic object by passing high amperage direct current between a metallic object, or workpiece, and a rapidly rotating conductive wheel or disc moving in close proximity to the workpiece in the presence of a water solution of electrolytic salts. With the wheel or disc rotating in very light contact against the workpiece, material is removed from the workpiece principally by electro-chemical action rather than by the snagging action common to the ordinary abrasive wheel method. It may be said material is removed from the workpiece by a deplating or dissolving process which is performed as a direct reversal or opposite, of any electroplating process. Thus, in the practice of electrolytic shaping, the rapidly rotating wheel is not pressed into firm contact with the workpiece, and as a consequence, wearing of the wheel is greatly minimized. Notwithstanding the reduced pressure of the wheel or disc upon the workpiece, material is removed from the latter at a rapid rate.

Electrolytic shaping, commonly referred to as electrolytic grinding, may be performed on a machine simulating the well-known snagging grinder, which includes a work-support and a rapidly rotating grinding wheel or disc, with certain modifications. In the practice of electrolytic shaping or grinding, the metallic workpiece is kept charged with a low-voltage high-amperage direct current of positive or plus polarity, while at the same time the electricity-conductive grinding wheel or disc is kept negatively charged. The workpiece and the grinding wheel or disc are electrically insulated from one another, except for the fact that the current may pass from one to the other through a bath of liquid electrolyte applied at the area of contact between the workpiece and the wheel.

The wheel or disc may be fabricated principally of metal or other current-conductive material, with the working or grinding face thereof provided with an armor of minutely spaced abrasive particles of nonconductive material, an example of which is diamond powder or chips, which serves to slightly space the conductive material of the wheel from the workpiece as the wheel rotates lightly against the workpiece. The non-conductive armor material on the wheel face precludes metal to metal contact between the wheel and the workpiece, thereby maintaining a gap at the workpiece through which the low-voltage current will not be short-circuited. This gap, however, can be bridged by electrolytic fluid fed thereto, to pass current from the workpiece to the rotating wheel in performance of the electrolytic removal of material from the workpiece. In the process as outlined above, the workpiece becomes the anode in the electrolytic system, and the conductive wheel becomes the cathode.

The present invention is concerned with an improved method and means for keeping the workpiece and the rotating wheel properly charged continuously with opposite direct current polarities, in the course of shaping or grinding of the workpiece.

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One object of the invention is to impose an electrical charge upon the rotating wheel in such a manner as to avoid injury to the wheel driving spindle, its bearings, the housing supporting the bearings, and any other parts or mechanisms associated with the spindle.

Another object of the invention is to so impose an electrical charge upon the rotating wheel, as to avoid injurious heating of the wheel spindle and deterioration of its bearings, as well as undesirable interference with proper operation of any spindle-driving motor which may have direct application or connection to the spindle.

A further object is to provide means for maintaining an electrical charge upon the rotating wheel without interruption, and with due regard to safe and trouble-free operation of the apparatus.

A still further object of the invention is to achieve the foregoing objectives and advantages with the use of simple, inexpensive, and highly effective means requiring a minimum of servicing and shut-down expense, vital parts of the apparatus being so arranged and located that possible deterioration and damage thereto in service are practically eliminated.

The foregoing and other objects are attained by the means described herein and illustrated upon the accompanying drawings, in which:

Fig. 1 is a side elevational view, partly in cross-section, illustrating an apparatus embodying the present invention, and adapted for shaping metallic objects by the electrolytic process.

Fig. 2 is a fragmentary cross-sectional view on an enlarged scale, showing a portion of an electricity conductive wheel or disc utilized in the grinding apparatus and process of the invention.

Fig. 3 is an enlarged fragmentary cross-sectional view showing details of construction at the upper or tail end of the machine spindle.

Fig. 4 is an enlarged fragmentary cross-sectional view showing a grinding wheel mount, this being a modification of the mount shown in cross-section at the foot of Fig. 1.

Fig. 5 is a view similar to Fig. 4, showing a second modification of the wheel mount.

Fig. 6 is an elevational view, partly in cross-section, showing the invention applied to a twin-wheel spindle.

With reference to the accompanying drawings, Fig. 1 illustrates at 8 a motor housing having opposed end bells 9 and 10 which enclose the field windings and the armature 12 of the motor. To the bell 10 is secured an extending spindle housing 13 containing suitable bearings such as 14 and 15, to rotatably support a rotary spindle 16 which extends through the bells and housing 8. Additional bearing means 17 associated with bell 9 may be provided, contributing to proper support of the spindle, as indicated upon Fig. 3. In the preferred form of the apparatus, the rotor or armature 12 is fixedly mounted directly upon the spindle to drive same whenever the motor is energized.

The tool end, or the working end 18 of the spindle, is fashioned and equipped to detachably support the disc or grinding wheel 19, which rotates in a plane transverse to the spindle axis. The disc or wheel is rendered detachable in order to facilitate replacements or substitutions as may be required, due to wearing of the wheels, or to varying characteristics of different workpieces to be operated upon. Workpieces formed of different types or grades of various metals may be electrolytically shaped to advantage, with the use of differing types or grades of grinding wheels. Any suitable or effective means may be employed for detachably mounting the wheel or disc 19 upon the tool end of the spindle, as for example, the socket-head screw 20 whose threads engage the internally threaded bore 21 in the end of the spindle. The head of the screw may bear upon a washer 22 as shown, abutting

the spindle end and a marginal portion of the counterbore 23 formed centrally of the wheel. A suitable key 24 may be provided, if desired, to lock the wheel against rotation relative to the spindle.

As previously mentioned herein, the grinding wheel or disc is to carry an electrical charge, and will therefore be constructed wholly or partly of metal or other current conductive material. In the form of wheel or disc illustrated by Fig. 1, the entire body portion 25 is of metal, and carries a fixed facing 26 also of metal from which a multitude of nonconductive particles 27 extend (Fig. 2). The nonconductive particles may be stones, such as diamond chips or the like, minutely spaced apart and extended equal distances from the facing material 26 as indicated upon Fig. 2, so that the particles 27 may contact a workpiece without placing the conductive facing 26 in actual electrical contact with the workpiece. A typical workpiece is indicated at W in Fig. 1.

From the foregoing, it will readily be understood that the particles 27 of nonconductive material electrically insulate the metallic wheel from the workpiece W, so that a low-voltage high-amperage electric current may not ordinarily pass between the workpiece and the grinding wheel resting thereon. However, current may be caused to pass between the charged wheel and the oppositely charged workpiece, by introducing between these elements a water solution of electrolytic salts, commonly referred to as electrolyte. The electrolyte may be directed to the space between the wheel and the workpiece in any suitable manner, as by means of a nozzle 28 in Fig. 1, or otherwise as will be explained.

Referring to Fig. 1, it may be noted that the workpiece W has electrical connection at 29 with the positive pole of a direct current source of electric energy, indicated as a generator G, whereas the grinding wheel or disc 19, as will be explained, is connected to the negative pole of the generator or source of electric energy. The connection 29, if desired, may be applied to the metallic bed or frame 30 of the machine, rather than to the workpiece directly, provided that the workpiece is in current conductive contact with the bed or frame during the shaping or grinding operation.

It is highly desirable to so impose an electrical charge upon the grinding wheel or disc, as to avoid various difficulties affecting operation of the machine, and the safety of an operator or attendant. For example, if the negative electrical connection is made at the grinding wheel where it may be exposed to chemical or corrosive action of the electrolyte solution, the connection will soon deteriorate and require replacement, with consequent periodic shut-downs of the machine and loss of production. On the other hand, if the electrical connection be made at a location remote from the electrolyte bath, for example at the tail end of the spindle or upon the casing of the apparatus, the continuous passage of current through the bearings and other vital parts of the machine will cause destructive electrolysis and corrosion of the parts, overheating, and a serious loss of motor efficiency due to electromagnetic interference occurring as the heavy direct current passes the field and armature windings of the motor, producing eddy currents and magnetic fields incompatible with those of the alternating-current driving motor. At the very high amperages with which the electrolytic grinding process is commonly practiced, the driving motor subjected to internal magnetic and electrical interference as mentioned above, may be irreparably damaged within a brief period of usage.

The present invention has as a primary objective, the complete elimination of destructive forces such as are mentioned in the preceding paragraph. To accomplish this, the spindle is provided throughout its length with a bore or passageway 31, in which is supported, in spaced substantial concentricity with the wall of the bore, an elongate rod or element 32 of copper or other highly conductive metal or material. The conductor rod 32 is

electrically insulated from the spindle at all points above or remote from the region of the grinding wheel or disc 19. In the region of the wheel or disc 19, electrical contact may be established with rod 32 in any suitable manner, as by means of a metallic cylindrical bushing 33 which snugly embraces the lower end of the rod and has a close fit within the counterbore 34 of the spindle end. The bushing may be secured within the spindle counterbore, a set screw 35 being suitable for the purpose.

From the foregoing explanation, it will be understood that an electric charge applied at the extreme upper end 36 of conductor rod 32, will be delivered directly to the grinding wheel through bushing 33 and the working end portion 18 of the spindle, without shunting or distributing any portion of the charge to the motor 12, the bearings 14, 15, 17, or to other vital parts of the apparatus. The complete circuit, therefore, would comprise the generator, conductor 37, the workpiece W, the electrolyte upon the workpiece, the grinding wheel 19, spindle end 18, bushing 33, conductor rod 32, a drum or ring 38 atop the conductor rod, a brush 39 contacting the drum 38, and a return conductor wire 40 leading to the negative terminal of the generator. The drum 38 is of course a conductor of current, and has electrical connection with the tail end 36 of conductor rod 32, but not with the tail end 41 of the spindle.

For a detailed disclosure of the construction at the tail end of the spindle, reference may be had to Fig. 3 wherein is shown the spindle reduced in diameter to accommodate the bearing 17, the inner race 42 of which may be secured to the spindle by means of a nut 43. An end cap 44 on the motor casing encloses the bearing, while permitting a portion of the spindle end 41 to extend therebeyond for accommodating an adapter 45 of insulating material, which supports the drum 38 and insulates it from the spindle and the motor casing. The central bore 46 of the adapter snugly receives the tail end of the spindle, and to ensure rotation of the adapter with the spindle, a set screw 47 or other securing device may be furnished. Drum 38 rests atop the insulating adapter 45 and may be secured thereto in any suitable manner, as by means of screws 48. A set screw 49 or equivalent means may fix the metallic drum 38 to the tail end 36 of conductor rod 32 as shown. Both the drum and the adapter are preferably concentric with the conductor rod, the latter extending into an axial bore 50 of the drum where electrical contact is established between the drum and the rod.

From the foregoing, it will readily be evident that an electrical charge from brush 39 imposed upon the drum 38 will pass to the conductor rod 32, the latter carrying the charge directly to the tool end of the spindle for transmission to the grinding wheel or disc 19. As was previously pointed out, the conductor rod 32 is insulated from the spindle by reason of the air space between the rod and the spindle bore at all locations between the bushing 33 and the tail end of the spindle. Insulation in addition to the air space may be furnished by means of one or more insulating sleeves 51, 52, surrounding the conductor rod 32 and fitting nicely within the axial bore of the spindle. The insulating sleeve means 51, 52 may be of one continuous length, if desired, and in the preferred construction such sleeve means will extend continuously along the conductor rod throughout the length of the motor and its armature 12, to bar radiation of magnetic flux and eddy currents from the rod to the motor windings and poles. The insulating sleeve 51 accordingly is shown extending from the lower bell 10 of the motor casing to the insulating adapter 45 at the remaining bell 9. The tail end of sleeve 51 may abut a suitable washer 53 carried in a counterbore 54 of the insulating adapter 45, if desired. From the standpoint of operability, the washer 53 might be of any material, conductive of current or not.

For the purpose of excluding dirt or foreign matter

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from the spindle bearing 17, the adapter 45 may be provided with a depending annular lip 55 which moves in close proximity to a cooperative upstanding annular shoulder 56 on cap 44 as shown in Fig. 3, while a depending cylindrical extension 57 of the adapter rides closely within the bore 58 of cap 44.

With reference to Fig. 1, it may be noted that the electrical contact brush 39, which bears constantly upon the metallic drum as the drum and spindle rotate in unison, is carried in a brush holder 59 that is insulated from the motor casing. The brush holder may be stationarily supported in any suitable manner, as by means of an insulating bracket 60 carried by the motor bell, or cap 44.

With the apparatus constructed as set forth in Figs. 1, 2 and 3, the motor casing 8 should be electrically insulated from the bed or frame 30, if the bed or frame is electrically charged through the workpiece W, as shown. This will avoid short-circuiting of the generator current through the motor casing. As an alternative, the workpiece W might be electrically insulated from the bed or frame, so as to carry the positive charge without transmitting any portion thereof to the bed or frame 30, in which event grounding of the motor casing upon the bed or frame would be inconsequential.

The possibility of short-circuiting the generator current may be reduced to a practical minimum by eliminating entirely all metallic contact between the grinding wheel and its drive spindle. Two methods of accomplishing this are disclosed in the structures exemplified by Figs. 4 and 5. In Fig. 4, the grinding wheel comprises a metallic body 61 which is electrically insulated completely from the spindle 16, by means of the dielectric elements 62 and 63. Element 62 is an insulating sleeve fitted in the central bore 64 of the body or wheel 61, the sleeve being adapted to snugly receive the tool end 18 of the spindle. An annular flange 65 integral with the sleeve 62 may overlie the wheel body and thereby provide an insulating barrier against the spindle housing 13. For securing the wheel to the spindle, a nut 66 may be applied to the spindle threads 67, to bear against the insulating washer 63 which in turn abuts the base 68 of a bore 69 in the wheel. By this means or a suitable equivalent connection, the grinding wheel may be fixed to the spindle for rotation therewith.

As in the previous disclosure, the electricity conductor rod 32 extends through the axial bore or passageway 31 of the spindle, from the working end or tool end, to the tail end where the brush connection from the generator is established, as in Fig. 3. A suitable insulating sleeve 70, or a series of such sleeves, may serve to space and insulate the conductor rod from the inner wall of the spindle bore. Electric current applied at the tail end of the conductor rod 32 is transmitted to the grinding wheel 61 through a metallic terminal plate 71 which is bored at 72 to accommodate the rod, and the connection may be rendered secure in any suitable manner, as by means of a set screw or fastener 73. It should be noted that the metallic terminal plate is free of any contact with the spindle, so that no current may pass to the spindle from the charged plate 71.

The terminal plate 71 has electrical connection with the grinding wheel 61 at the screw or screws 74, which hold the plate firmly against a shoulder 75 of the wheel surrounding the bore 69. Electric current so brought to wheel 61 may readily electrify the grinding wheel facing 76, which is similar to the facing illustrated by Figs. 1 and 2. By reason of the means described, the grinding wheel and its facing may be supplied with a negative electrical charge without in any way charging the spindle, its bearings, or the casing elements 13, 10, 8 and 9. It will therefore be understood that the motor casing may be fixed to the frame or bed 30 of the apparatus without the use of electrical insulation, and should an operator or attendant inadvertently drop a wire, chain, or other metallic object onto the motor casing and in contact with

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the machine frame, no dangerous short-circuiting of the high amperage current could result. The apparatus thereby is rendered safe to operate, and at the same time the motor, the bearings, and all other vital parts of the apparatus are protected against damage due to electrolysis and corrosion. The motor in any modification of the apparatus, is to be protected against damage due to eddy currents and stray electromagnetic flux emanating from the conductor rod 32, by surrounding the rod with a suitable insulator. This may take the form of a dielectric sleeve such as 51 of Fig. 1.

Reverting momentarily to Fig. 4, it may be noted that the hub 77 of wheel 61 may be encircled by an open-topped trough 78 into which a stream of electrolyte may be fed during rotation of the wheel, said trough having one or more downwardly directed jets or passages 79 to feed electrolyte continuously to the facing 76 and any workpiece being ground or scrubbed thereby. The facing element 76 may be secured to the wheel body 61 in any suitable manner, as by means of screws 80 passing through holes in the facing and anchoring into the wheel body. By preference, the jets or passages 79 diverge outwardly from the outer wall of trough 78, so that electrolyte from the trough will feed to the wheel facing automatically with the aid of gravity and centrifugal force.

In the modified structure of Fig. 5, the entire body of the grinding wheel or disc 81 is formed of hard insulation or dielectric material, an example of which is Mi-carta, this wheel comprising a hub 82 axially bored at 83 to snugly receive the spindle end 18. A nut 84 applied to screw threads 85 on the spindle, bears against a suitable washer 86 to fixedly mount the grinding wheel upon the spindle for rotation therewith.

As in the previous disclosures, an electrical charge carried to the tail end of conductor rod 32 by the brush 39, is transmitted by said rod directly to a terminal plate 87 of metal, housed within a bore 88 of the wheel body. By means of screws 89 and 90, or other appropriate expedient, the terminal plate 87 may be held in electrical contact with the wheel facing 91 and the tool end of the rod, as shown. Neither the rod 32 nor the terminal plate 97 is to be in electrical contact with the spindle end or its nut 84. Screws or other fasteners 92 in addition to those indicated at 89, may be employed for holding the facing element 91 in fixed position relative to the wheel body 81.

From the foregoing explanation, it should be evident that the grinding wheel facing 91 may be supplied with a negative electrical charge without in any way charging the spindle, its bearings, or the casing elements 13, 10, 8 and 9. Accordingly, the motor casing may be fixed to the frame or bed 30 of the apparatus without the use of electrical insulation. The structure of Fig. 5 will therefore embody all the advantages and improvements specified for the structure of Fig. 4, including a maximum of safety in operation due to the insulating nature of the entire wheel body 81. The body 81 may be furnished with a trough 93 and feed jets 94 for electrolyte, substantially in accordance with the disclosure and description of Fig. 4. It is noted that with slight modification of the working end of spindle 16 in Fig. 1, the modified grinding wheels or discs of Figs. 4 and 5 may be rendered interchangeable with the wheel or disc of Fig. 1.

It is to be understood that the apparatus disclosed may be operated in the vertical position as shown, or at any inclination including the full horizontal position, and depending upon the nature of the operation to be performed, the diamond wheel facing may be applied to the rim of the grinding wheel rather than to the flat face thereof.

The Fig. 6 modification is illustrative of a spindle structure such as might be employed when the spindle is to carry two grinding wheels or discs 95 and 96. In this instance, two spindles 97 and 98 are aligned axially, with

their tail ends 99 and 100 separated as shown, but coupled so that the spindles may rotate in unison. The spindles are hollow as previously explained, to accommodate elongate electric current conductors 101 and 102 which are insulated from the inner walls of the spindles. Conductors 101 and 102 may or may not abut one another endwise at their tail end portions, depending upon whether or not both wheels 95 and 96 are to be electrically charged simultaneously. That is, if the conductors 101 and 102 are to be individually charged, the tail ends of the conductors would be spaced from one another, and negative charges from separate sources of electrical energy could be supplied to each individually by way of brushes 103 and 104 wiping the metallic discs or drums 105 and 106 secured, respectively, to the rods or conductors 101 and 102. The discs or drums 105 and 106 may be separated physically and electrically by an insulating disc 107, as shown.

The characters 108 and 109 indicate flanged couplers of dielectric material, each bored as at 110 and 112 to snugly receive the spindle ends, and such couplers may be keyed or otherwise secured to the spindles against relative rotation. The flanges 113 of the couplers may be bored to receive a series of bolts or other fasteners 114 which clamp the discs or drums 105-106, along with the insulating disc 107, tightly between the flanges of the couplers. By this means, or equivalent structure, the entire assembly may be bound and unified for rotation as a single rigid spindle structure. As will be understood, the spindle sections 97 and 98 are to be journaled in bearings anywhere along their length, and rotation may be imparted to either spindle section by associating a motor therewith as in Fig. 1, or more simply, by securing a driving pulley to one of the sections.

In the event that both grinding discs or wheels 95, 96 are to be charged simultaneously with electrical energy, the insulating disc 107 may be omitted and/or the conductor rods 101, 102 may be butted endwise or even joined together at their tail ends. Otherwise stated, the conductor rod may be continuous from wheel 95 to wheel 96, affording the conductor rod two working ends, or wheel ends, 115 and 116. The intermediate portion of the single rod which mounts the brush disc or drum, would then have to be considered the tail end or tail portion of the conductor rod, within the portent of the claims appended hereto. It should be understood that the conductors 117 and 118 transmit negative charges to the brushes 103 and 104, originating preferably from separate generators or sources of electrical energy.

If only one wheel is to be used for electrolytic grinding, leaving the other available for plain or straight grinding, the Fig. 6 structure may simply eliminate one of the conductor rods, such as 101, along with its conductive disc 105 and the brush 103 associated therewith. Mere omission of rod 101 would of course produce the same result; or if desired, the brush 103 might simply be omitted or held out of contact with its cooperative disc 105.

At the locations 119 and 120, suitable electrical connections are provided between the conductor means 101, 102, and their respective grinding wheels or discs 95, 96, these connections being in accordance with the disclosures of Figs. 1, 4 or 5, or any other approved engineering practice. The space surrounding the conductor rods 101, 102, within the spindle sections, may accommodate insulating sleeves such as are indicated at 70 upon Figs. 4 and 5, if desired. Whether or not such sleeves are included in the structure, however, the spindle bodies are insulated from the charges passing through the conductor rods 101 and 102, so that the spindles will carry no electrical charge, this being one of the primary objectives of the instant invention as was explained in the description of Figs. 1 to 5, inclusive. The spindle sections of Fig. 6, when mounting the grinding wheels in accordance with Figs. 4 and 5, are fully insulated from electrical charge.

The grinding wheel in some instances may be metal-faced on the rim, rather than on the flat side face thereof, and the shape of the wheel may be altered as required, to present various contours to the workpiece. Under certain conditions, the diamond chips or particles may be eliminated from the working face of the conductive wheel, without materially or objectionably depreciating the effectiveness of the electrolytic shaping or grinding process. The foregoing and various other modifications and changes in structural details of the apparatus may be resorted to, within the scope of the appended claims, without departing from the spirit of the invention.

What is claimed is:

1. An electrolytic grinder for shaping an electrically charged metallic workpiece, comprising in combination, an elongate driving spindle having a working end and a tail end, a casing including bearing means rotatably supporting the spindle near the ends thereof, means at the working end of the spindle for supporting a current conductive grinding wheel in close proximity to the charged workpiece, and electric current conductive means electrically insulated from the spindle, for directing an electric current from a terminal upon the tail end of the spindle directly to a portion of the grinding wheel, to impose thereon a charge opposite in polarity to the charge upon the workpiece.
2. Apparatus for shaping a metallic workpiece by the electrolytic process, comprising in combination, an electric motor including a longitudinally bored rotary driving spindle having a working end and a tail end, a grinding wheel fixed upon the working end of the spindle for rotation therewith, said wheel including an electricity conductive facing to move in close proximity to the workpiece as the spindle rotates the wheel, an electric current conductive elongate rod supported in spaced substantial concentricity with the spindle inside the bore thereof, said rod having opposite ends disposed near the ends of the spindle, means electrically connecting the grinding wheel facing to the conductive rod at the working end of the spindle, and means for applying to the workpiece, and to the rod at the tail end of the spindle, electrical potentials of opposite polarities.
3. Apparatus for shaping a metallic workpiece by the electrolytic process, comprising in combination, an electric motor including an armature and field windings, and a longitudinally bored rotary driving spindle having a working end and a tail end, the armature being fixed to the spindle and embraced by the field windings along a portion of the spindle length, a grinding wheel fixed upon the working end of the spindle for rotation therewith, said wheel including an electrically conductive facing to move in close proximity to the workpiece as the spindle rotates the wheel, an electric current conductive elongated rod supported in spaced substantial concentricity with the spindle inside the bore thereof, said rod having opposite ends disposed near the ends of the spindle, means electrically connecting the grinding wheel facing to the conductive rod at the working end of the spindle, dielectric means interposed between the conductive rod and the motor armature for shielding the armature and field windings against interference emanating from the conductive rod when electrically charged, and means for applying to the workpiece, and to the rod at the tail end of the spindle, electrical potentials of opposite polarities.
4. Apparatus as specified in claim 3, wherein the current conductive elongate rod is insulated from the material of the spindle throughout the full length of the spindle.
5. Apparatus for shaping a metallic workpiece by the electrolytic process, comprising in combination, an electric motor including a longitudinally bored rotary driving spindle having a working end and a tail end, a grinding wheel fixed upon the working end of the spindle for rotation therewith, said wheel including an electrically conductive facing armored with spaced and extending

dielectric material, to contact the workpiece, an electric current conductive elongated rod supported within the spindle bore in an electrically insulated relationship to the spindle, said rod having opposite ends disposed near the ends of the spindle, means electrically connecting the grinding wheel facing to the conductive rod at the working end of the spindle, and means for applying to the workpiece, and to the rod at the tail end of the spindle, electrical potentials of opposite polarities.

6. Apparatus for shaping a metallic workpiece by the electrolytic process, comprising in combination, an electric motor including a longitudinally bored rotary driving spindle having a working end and a tail end, a grinding wheel fixed upon the working end of the spindle for rotation therewith, said wheel including an electrically conductive facing to move in close proximity to the workpiece as the spindle rotates the wheel, an electric current conductive elongated rod supported within the spindle bore in electrically insulated relationship to the spindle, said rod having opposite ends disposed near the ends of the spindle, means electrically connecting the grinding wheel facing to the conductive rod at the working end of the spindle, and means for applying to the workpiece, and to the rod at the tail end of the spindle, electrical potentials of opposite polarities.

7. In an electrolytic grinder, the combination which comprises, a longitudinally bored rotary driving spindle having a working end and a tail end, a grinding wheel detachably fixed upon the working end of the spindle for rotation therewith, said wheel including an electrically conductive facing to move in close proximity to an electrically charged object subject to grinding, an elongate electric current conductor disposed inside the spindle bore, and means electrically insulating said conductor from the material of the spindle, said conductor having opposite ends disposed near the ends of the spindle, means electrically connecting the grinding wheel facing to said conductor at the working end of the spindle, a casing for the spindle, bearing means in the casing for rotationally supporting the spindle, and means for applying to the conductor at the tail end of the spindle, an electrical potential opposite in polarity to that of the electrically charged object.

8. An electrolytic grinder for shaping an electrically charged metallic workpiece, comprising in combination, a casing including bearing means, a longitudinally bored driving spindle rotatably supported by the bearing means, said spindle having a working end and a tail end, a grinding wheel fixed upon the working end of the spindle for rotation therewith, said wheel including an electrically conductive facing to move in close proximity to the workpiece as the spindle rotates the wheel, an elongated electric current conductor supported in spaced substantial concentricity with the spindle inside the bore thereof, said conductor having opposite ends disposed near the ends of the spindle, means electrically connecting the grinding wheel facing to the conductor aforesaid at the working end of the spindle, and means for applying to said conductor at the tail end of the spindle, an electrical potential opposite in polarity to that of the charged workpiece.

9. The method of electrolytically grinding a metallic electrically charged workpiece, with the use of a motor driving a bearing-supported metallic rotary spindle carrying a metallic grinding wheel, said method including rotating the spindle and grinding wheel relative to the charged workpiece, and transmitting to the wheel exclusively of the spindle, from a spindle-supported terminal remote from the wheel, an electrical potential opposite in polarity to that of the charged workpiece.

10. The method of electrolytically grinding an electrically charged metallic workpiece, with the use of a motor rotating a longitudinally bored metallic spindle carrying on one end thereof a metallic grinding wheel, said method comprising rotating the spindle and grinding wheel relative to the charged workpiece, and supplying

an opposite electric charge to the wheel through the agency of a conductor passing through the spindle bore from end to end thereof, electric current supply being directed from said conductor at that end thereof which is remote from the grinding wheel.

11. An electrolytic grinding wheel comprising a cylindrical body bored axially to receive a driving spindle, and having an electric current conductive face for exposure to a workpiece, said body being annularly grooved concentrically with the bore to provide an open-topped trough receptive of liquid electrolyte, said trough at its base being provided with openings terminating at the conductive face of the wheel, to direct electrolyte from the trough continuously to said wheel face as the wheel rotates.

12. A grinding wheel for application to apparatus for shaping a metallic workpiece by the electrolytic process, said wheel comprising a cylindrical body bored axially to receive a driving spindle, and means for securing the spindle within said bore, the body being annularly grooved concentrically with the bore to provide a trough receptive of liquid electrolyte, said trough at its base being provided with jet openings for releasing electrolyte from the trough as the wheel rotates, and an electric conductive facing on the wheel exposed to the workpiece, said jet openings terminating at said facing to direct electrolyte onto said facing.

13. A grinding wheel for application to apparatus for shaping a metallic workpiece by the electrolytic process, said wheel comprising a cylindrical body bored axially to receive a driving spindle, and means for securing the spindle within said bore, an electric current conductive facing on the body for exposure to the workpiece, the body being annularly grooved concentrically with the bore to provide a trough receptive of liquid electrolyte, said trough being provided interiorly thereof with jet openings for releasing electrolyte from the trough as the wheel rotates, the jet openings terminating at said facing to direct electrolyte thereto, and an armor of spaced dielectric particles on said facing extending outwardly therefrom, to entrain and distribute the electrolyte upon the workpiece.

14. The grinding wheel as set forth in claim 13, wherein the body of the wheel is composed substantially wholly of dielectric material.

15. The method of electrolytically shaping a conductive electrically charged workpiece, with the use of a motor driving a bearing-supported metallic rotary spindle carrying an electric current conductive shaping wheel, said method including rotating the spindle with the wheel disposed in close proximity to the charged workpiece, and transmitting to the wheel exclusively of the spindle, from a spindle-supported terminal remote from the wheel through the intermediary of an electrically conductive rod, an electrical potential opposite in polarity to that of the charged workpiece.

16. Apparatus for shaping an electrically conductive workpiece by the electrolytic process, comprising in combination, an electric motor-driven rotary spindle having a working end and a tail end, and a longitudinally extending bore formed therein, a shaping wheel fixed upon the working end of the spindle for rotation therewith, said wheel including an electrically conductive facing to move in close proximity to the workpiece as the spindle rotates the wheel, an electric current conductive elongate rod supported in electrically insulated spaced substantial concentricity with the spindle inside the bore thereof, said rod having opposite ends disposed near the ends of the spindle, means electrically connecting the wheel facing to the conductive rod at the working end of the spindle, and means for applying to the workpiece and to the rod at the tail end of the spindle, electrical potentials of opposite polarities.

17. A grinding wheel for application to apparatus for shaping a metallic workpiece by the electrolytic process,

said wheel comprising a substantially cylindrical body bored axially to receive a driving spindle and having an upper and a lower face, means for detachably securing the spindle within said bore, an electric current conductive facing on the lower face of the wheel to scrub a workpiece, means electrically insulating the wheel body from the driving spindle, and means carried by the wheel body for directing an electrolytic liquid toward the wheel facing, said last-mentioned means including an annular trough formed in the upper surface of the wheel and having an open top, and at least one jet passage extending from the lower portion of the trough to said lower surface of the wheel, said jet passage thereby providing communication between said trough and said lower surface of the wheel, said jet passage sloping from the bottom of said trough toward the outer periphery of said wheel so that when the wheel is in operative position, electrolyte from the trough will feed to said facing automatically with the aid of gravity and centrifugal force.

References Cited in the file of this patent

UNITED STATES PATENTS

390,439	Bradley	Oct. 2, 1888
1,636,560	Hall	July 19, 1927
1,720,731	Jones	July 16, 1929
2,526,423	Rudorff	Oct. 17, 1950
2,739,935	Kehl et al.	Mar. 27, 1956
2,741,594	Bowersett	Apr. 10, 1956
2,798,846	Comstock	July 9, 1957
2,826,540	Keeleric	Mar. 11, 1958

OTHER REFERENCES

- 15 Mueller: "How to Grind Carbides Six Times as Fast," American Machinist, September 28, 1953, pages 122 and 123.
- Keeleric: "Electrolytic Grinding," Steel, vol. 130, No. 3, page 84, March 17, 1952.