Jan. 16, 1962 L. A. WILLIAMS 3,017,340

ELECTROLYTIC APPLICATOR

Filed Aug. 25, 1959 2 Sheets-Sheet 1

Fig. 1.

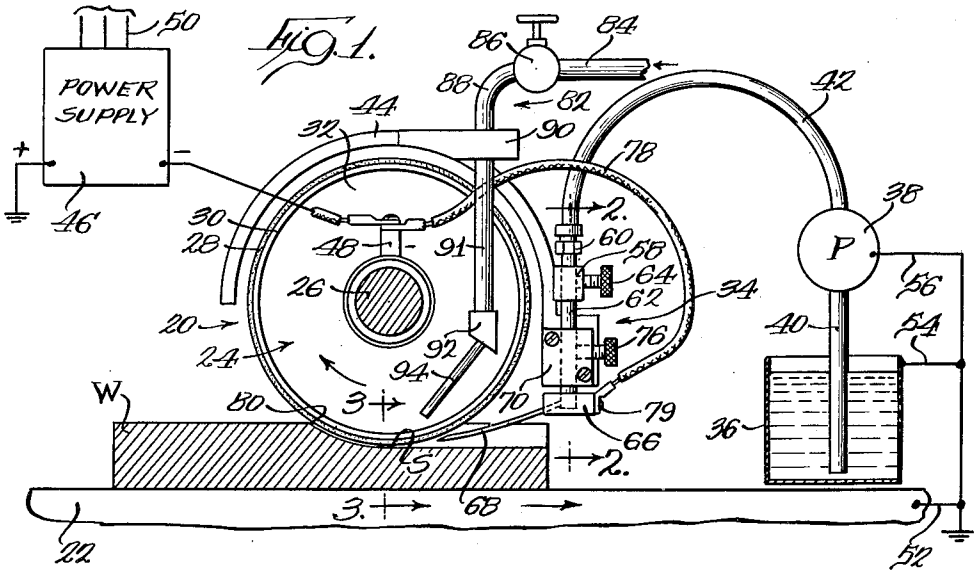


Fig. 2.

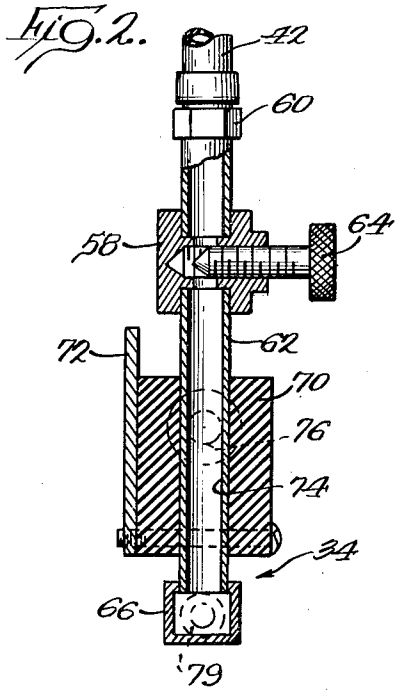


Fig. 3.

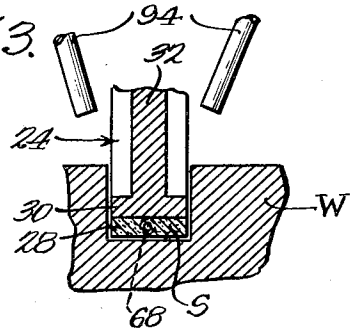
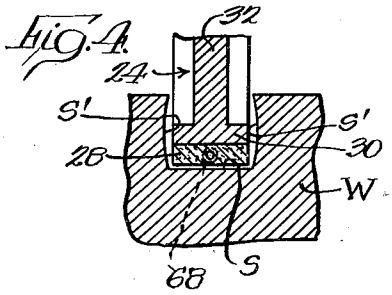


Fig. 4.



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Fig. 5.

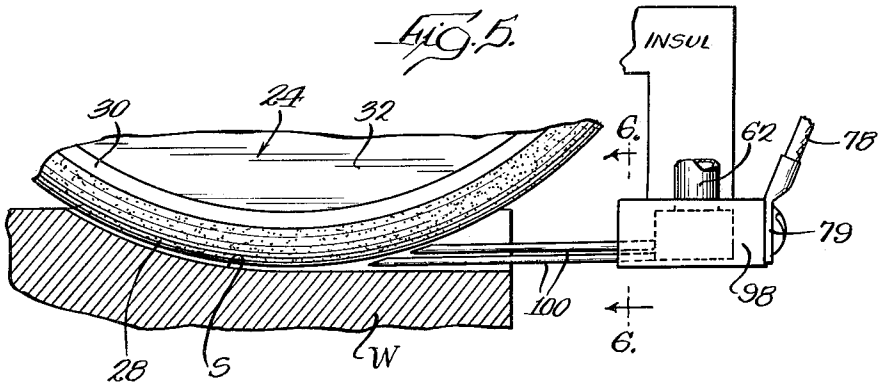


Fig. 6.

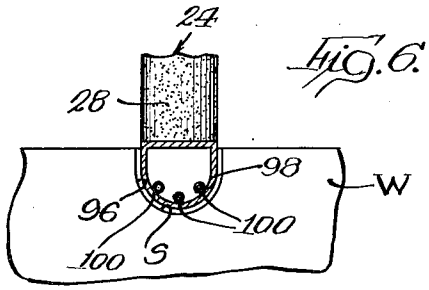
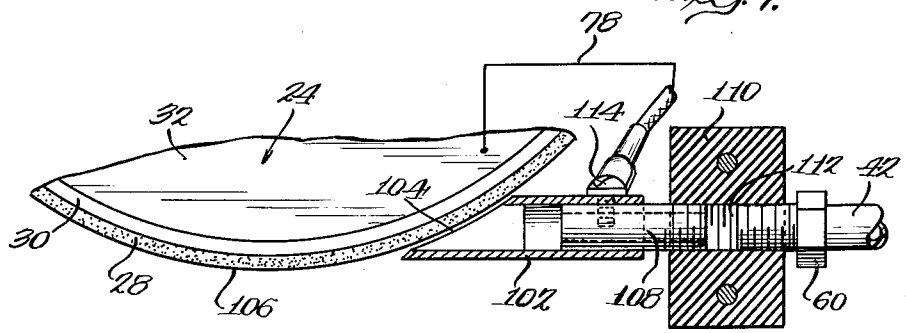


Fig. 7.



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3,017,340

ELECTROLYTIC APPLICATOR

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16 Claims. (Cl. 204—217)

The present invention relates to a new and improved electrolyte applicator. This applicator is particularly useful in the apparatus for and in practicing the method of electrolytic cutting, shaping, and grinding disclosed and claimed in George F. Keeleric Patent No. 2,826,540, dated March 11, 1958, entitled, "Method and Apparatus for Electrolytic Cutting, Shaping and Grinding."

In the patented apparatus, a workpiece to be ground or shaped is made anodic with respect to a rotating grinding wheel cathode having a conductive surface from which project or protrude a great plurality of minute insulating abrasive spacing particles to provide a gap between the workpiece and the active or conductive surface of the grinding wheel. The workpiece is brought into contact with these spacing particles, electrolyte is flowed into the small gap or space between the workpiece and the cathodic grinding wheel from an applicator nozzle, and a low voltage (5 to 10 volts) high density direct current (as high as 1,000 amp. or more per square inch) is passed between the anodic workpiece and the cathodic grinding wheel to remove material from the workpiece.

It has been found desirable in some applications of the patented method, nicely to control the feed of the electrolyte and the exact point at which it is introduced between the anodic workpiece and the cathodic grinding wheel. This may be accomplished by small diameter, small bore, relatively long tubes very much like hypodermic needles. In using this type of feed tube—and as a matter of fact, any type of metal feed tube or nozzle—there has been an undesirable electrolytic erosion of the needle, tube, or nozzle at the discharge end. One of the objects of the present invention is to overcome this electrolytic erosion.

In forming cuts or slots in a metallic workpiece of appreciable depth, such slots sometimes having a concave or contoured bottom, it is essential that the electrolyte be carefully flowed into the gap or interface between the workpiece and the periphery of the grinding wheel. The electrolyte feed must be so controlled as to prevent undesirable side belly in the cut or groove occurring from a side electrolytic action between the workpiece and the grinding wheel. It is, therefore, a principal object of this invention to provide such careful feed and control of the electrolyte.

Another object is to provide a new and improved electrolyte feeding apparatus incorporating a number of discharge tubes positioned to deliver electrolyte to the interface between the workpiece and the grinding wheel, with the tubes so arranged that the interface is flooded with electrolyte even though the grinding wheel is adapted to contour the workpiece.

Another object is to provide a new and improved electrolyte feeding apparatus incorporating one or more relatively long and very thin discharge tubes, the outlets from which are positioned to deliver a controlled flow of electrolyte to the interface between the workpiece and the periphery of the grinding wheel at the bottom of a groove or slot being formed in the workpiece.

Another object is to provide a new and improved electrolyte feeding apparatus incorporating one or more discharge tubes of small bore and limited capacity, wherein the flow of electrolyte to and from these discharge

tube or tubes is controlled by a needle valve in the conduit between the tube or tubes and the electrolyte source.

Another object is to provide a new and improved electrolyte feeding apparatus incorporating one or more discharge tubes having their outlets close to the surface of the grinding wheel wherein means are provided to impress a potential on the electrolyte delivery tube identical with that of the cathodic grinding wheel, thereby to eliminate electrolytic action therebetween.

Another object is to provide a new and improved electrolyte feeding apparatus useful in forming a slot or groove in the surface of an anodic workpiece by the periphery of a cathodic grinding wheel wherein air blasts at either side of the grinding wheel are used to atomize the electrolyte at the sides of the grinding wheel and in the groove to control any side electrolytic action, and thereby to eliminate bellying of the slot or groove.

Other objects and advantages will become apparent from the following description taken in conjunction with the accompanying drawings, wherein

FIG. 1 is a schematic elevational view of the electrolyte applicator of this invention, illustrating the grinding wheel forming a groove in the workpiece;

FIG. 2 is a cross sectional view of the feed control valve and the applicator mounting;

FIG. 3 is a sectional view, taken along the line 3—3 of FIG. 1, showing the grinding wheel electrode in the base of a slot or groove being formed in a workpiece, an electrolyte feed tube, and the position of air tubes for controlling the electrolyte in the formed slot or groove;

FIG. 4 is a sectional view similar to FIG. 3, but showing the shape of the slot or cut when action of the air tubes is omitted;

FIG. 5 is a fragmentary schematic view similar to FIG. 1, showing another form of the electrolyte applicator;

FIG. 6 is a sectional view taken along the line 6—6 of FIG. 5, looking in the direction of the arrows; and

FIG. 7 is a fragmentary schematic view partially broken into section, showing still another form of electrolyte applicator.

In the drawings, only so much of a conventional grinding machine **20**, modified to incorporate the invention and practice the method of the previously mentioned George F. Keeleric Patent No. 2,825,540, is shown to obtain a complete understanding of this invention. A workpiece W is mounted on a reciprocable table **22** of the machine **20**. A grinding wheel **24** is mounted on the shaft **26** which is driven in the direction of the arrow from a motor (not shown). The shaft **26** of the grinding wheel is insulated from the frame of the machine **20** in a known manner.

The grinding wheel **24** has a metal body including a hub and is provided with a working surface on its periphery by a rim **28** which may be formed of a metal bonded impregnated abrasive, including aluminum oxide or diamond bort. The periphery of the abrasive carrying rim is dressed so that the particles of abrasive, which are nonconductors of electricity, project above the surface of the metal bond a spacing distance which may be as great as .010 inch and as small as .001 inch, depending upon the shaping operation to be performed. The rim **28** is bonded to a flange **30** of the wheel, which in turn is formed integrally with the wheel web **32** and the hub, thereby providing an electrically conductive path from the shaft to the metal bond of the rim.

A liquid electrolyte is fed through an applicator, indicated generally by the reference character **34**, from a source of supply or tank **36** by a pump **38** which has an inlet tube **40** extending into the tank **36** and an outlet connected to a flexible conduit **42** which preferably is made of a nonconductor of electricity, such as nylon.

A filter (not shown) may advantageously be included in the outlet line 42. The electrolyte is fed into the interface between the workpiece W and the periphery of the electrode tool, as typified by the tool rim 28. The grinding wheel 24 is surrounded by a hood 44 to minimize the splatter of the electrolyte from the working area.

Direct current for the electrolytic process is supplied from a power supply 46 which has its positive terminal grounded and its negative terminal connected to a brush 48 suitably mounted on insulating blocks (not shown) and contacting appropriate collecting rings on the shaft 26. Inasmuch as these specific details form no part of of this invention, they are shown only schematically. The power supply 46 may obtain its power from a conventional three-phase alternating current source 50. The current supplied by the power supply 46 is regulatable, and for the electrolytic process of the aforementioned Keeleric patent, it is preferred that the voltage be between 5 and 10 volts, which is adequate to supply direct current of an extremely high density such as 1,000 amperes per square inch of contact between the grinding wheel 24 and the workpiece W.

In order to make the workpiece W positive with respect to the grinding wheel, the machine table 22 is grounded at the connection 52, and if desired there may be a ground connection directly to the workpiece or to the workpiece holder if such is used. For safety and to comply with electrical codes, the tank 36 is grounded at 54 and the pump 38 is grounded at 56. All of these are insulated from the grinding wheel 24 and the electrolyte applicator 34 by the electrically nonconductive conduit 42, but there may be some unavoidable leakage of current from the cathode wheel 24 throught the column of electrolyte in the conduit 42.

The conduit 42 is connected to the inlet of an adjustable flow control needle valve 58 by a coupling 60, and the outlet of the valve 58 is connected to a tube 62. The flow through the valve 58 is controlled by a thumb screw 64, and this flow is regulated in a manner which will be described.

The outlet from the tube 62 leads to a header 66 from which projects one or more thin, curved, metallic electrolyte delivery tubes 68. These tubes may be likened to hypodermic needles, and each has an outside diameter of about .060 inch and a bore of .040 inch, for example. Their inlet ends are welded to a wall of the header 66, and they are sufficiently long so that they extend to the peripheral surface of the grinding wheel 24 at a point very close to the point of tangency with the work. If desired, they may have their delivery ends ground to the contour of the peripheral surface of the wheel 24 and are spaced therefrom a minute fraction of an inch so that the electrolyte is delivered from the tube or tubes directly onto the working surface of the cathodic tool 24.

An appreciation of the length of the delivery tube 68 can be obtained from FIG. 1, even though this is a schematic view. It will be noted that the valve 58 and tube 62 are disposed at one side of the grinding wheel 24 with the header 66 immediately below the valve and at the outlet end of the vertical tube 62. The delivery tube 68 extends the entire distance from the header 66 to a point immediately adjacent the interface between the peripheral surface of the grinding wheel and the contoured surface of the workpiece W. It should be appreciated that it is not unusual for the delivery tube or tubes to be four inches in length.

The vertical and horizontal positions of the delivery tube 68 relative to the bottom of the cut are adjusted by a mounting which is in the form of an insulating block 70 carried on a stationary part 72 of the machine 20, which part may be associated with the hood 44. The tube 62 slidably extends through a bore 74 in the block 70 so that its vertical and axial positions may be adjusted, and it is locked in such position by a set screw 76 threaded into the block in a tapped bore that intersects the vertical bore 74. The position of the header 66 and the tube 68 with respect to the grinding wheel 24 is determined in part by the type of shaping operation being done. As illustrated, a slot or groove S is being formed in the workpiece W, and the tube 68 must be so positioned and must be of such size with respect to the grinding wheel that it can enter the slot S.

Because this applicator is designed to be usable with wheels which make quite narrow slots, it is necessary that the feeder elements 68 be small enough to enter these slots. When they are made this small, it is necessary to make them of metal in order to assure adequate rigidity. However, most commonly available metals are subject to electrolytic attack if they are anodic in an electrolytic circuit. While it would seem to be possible, and indeed is possible, to mount the metallic feeders in headers made of insulating material, it has been found that this is not a satisfactory solution at all, for a sufficient amount of current is carried up through the column of liquid in the conduit 42 to make the surface of the feeders 68 anodic with respect to the cathode wheel 24. And, because the feeders are always in close proximity to the wheel, there is a constant electrolytic attack on them, with the result that within a day or two of operation they are eaten away from the wheel far enough to impair their effectiveness in feeding electrolyte, so that it becomes necessary to readjust their position with respect to the cathode wheel. Before long the limit of adjustment has been reached, and it becomes necessary to replace the feeders with new ones, all of which constitutes an inconvenience and one which has proven troublesome in actual practice, partly because of the inconvenience but even more because of the fact that all too frequently in industrial service the required adjustment of position is not made at all, with the result that electrolyte is improperly applied and the work results become quite unsatisfactory. After considerable investigation of the possible use of non-metallic materials which yielded no satisfactory results, the expedient of this invention for overcoming this troublesome problem was discovered. This consists not in trying to isolate the feeder tubes electrically but, rather, indeliberately connecting them to the cathodic side of the electrical system.

This is accomplished by a conductor 78 which connects the header 66 to the negative terminal of the power supply. In the particular arrangement shown, one end of the conductor leads to the brush 48, and the other end 79 is secured to the header, but this specific arrangement need not be used, and the conductor 78 may be connected directly to the negative terminal of the power supply. It is essential that the connections be such that the potential on the surface of the grinding wheel 24 be identical with the potential at the end of the tube or tubes 68, and that, therefore, there be no current flow between the tubes 68 and the working surface of the grinding wheel 24 to erode by electrolysis the delivery ends of the tubes. With the connections as made in FIG. 1, there is no possibility of any electrolytic action between grinding electrode 24 and the electrolyte feed tube 68. It also will be noted that the tube 68 is spaced sufficiently from the workpiece W that the electrolyte which is delivered therefrom in a stream onto the surface of the grinding electrode or tool 24 does not set up any electrolytic action between the tubes 68 and the workpiece W which would cause a deposit of material on the surfaces of the tubes or on the header itself. As a matter of fact, the rotation of the grinding wheel electrode 24 is such as to carry the electrolyte away from the delivery tube 68 and no pool or puddle is formed to sustain an electrolytic action between the applicator 34 and the workpiece W.

In operation, where the equipment is to be used in forming a slot in a workpiece W, such, for example, as a

slot 3/8 of an inch wide and 3/8 of an inch deep, the delivery of the electrolyte from the tube 68 to the interface between the tool and the workpiece is regulated by the throttling effect of the needle valve 58, adjusted by the thumb screw 64, so that there will be no gushing or spurting of the electrolyte around the sides of the wheel 24 as the electrolyte is delivered. This insures that the electrolyte delivered to the interface is, by rotation of the grinding wheel, carried through the interface and across the surface where the grinding and electrolytic action between the grinding wheel and workpiece W take place.

It has been found under certain circumstances that the side walls S' of the groove or slot S may belly, barrel, or flare outwardly from the bottom of the slot, thereby not being perfectly parallel or exactly perpendicular to the bottom of the slot. This can be and is objectionable under many conditions. This flaring, bellying or barreling of the slot S occurs through side or lateral electrolytic exchange between the workpiece and the edges of the rim 28 of the grinding wheel 24 and the flange 30 to which the rim is bonded. Since the shaping in the bottom of the groove S requires the presence of the electrolyte, the rotational action of the wheel 24 tends to pump excessive electrolyte from the bottom up along the sides of the wheel in the direction of rotation and out the top of the slot at the sides of the wheel, and before the individual rotating wheel increments which carry the electrolyte reach the end of the slot, indicated by the reference character 80 in FIG. 1. To overcome this, the needle valve 58 is carefully throttled until there is just enough liquid supplied to carry current electrolytically between the surface of the work and the periphery of the cathode wheel 24, but no excess. This adjustment of the valve can be made by adjusting during the making of a practice cut from a flow which is known to be excessive downwardly until a characteristic plume of electrolyte which squirts up out of the slot alongside the wheel disappears.

Further to prevent this undesirable side electrolytic action, and to control the disposition of the electrolyte in the slot S, there is provided air blast means 82 for this purpose. A source of air under pressure (not shown) and at a value, for example, in the range of 90 to 150 p.s.i. is connected by a conduit 84 to a valve 86. The outlet from the valve is connected by a conduit 88 to an air flow dividing header and mounting 90 secured to an appropriate and preferably fixed part of the machine. A pair of tubes 91 depend from the flow divider 90 at either side of the wheel 24 and terminate in headers 92 from which project smaller bore air nozzles 94 which may be made of a plastic or metallic material which is readily manually deformed so as to place the open ends of the nozzles 94 at strategic positions and pointed in the proper directions.

It will be observed from FIGS. 1 and 3 that the open ends of the nozzles 94 are close to the upper edges of the slot S and are directed toward the base of the slot S at about the point where the grinding wheel periphery 24 is in tangential engagement therewith. The nozzles 94 are also directed inwardly as indicated in FIG. 3, so that the air streams enter into the spaces defined by the web 32 of the wheel and the peripheral flange 30, and prevent the electrolyte from flowing and puddling into the space between the wheel web 32 and the sides of the slot S. There is, of course, some electrolytic action between the flange of the grinding wheel and the edges of the rim 28 and the side wall S' of the slot, but the net result of this air blast and the throttling by the valve 58 is to hold the gap between the edges of the wheel and the slot side wall S' to a minimum and prevent the collection of electrolyte which would create a condition of excessive electrolysis. When an appreciable amount of electrolyte tends to accumulate, the air blast atomizes it and blasts it out of the slot, thereby removing the electrolyte before excessive electrolytic action can occur. Tests have been made on a large number of pieces, and a high degree of precision and uniformity of dimension has been attained throughout all of the pieces. The test was made in the formation of a slot about 3/8" wide and 3/8" deep in one pass of the workpiece beneath the grinding wheel 24. Dimensions of 100 pieces were identical within .0002".

In FIGS. 5 and 6 there is shown a further form of the apparatus useful in forming a slot S having a contoured shape 96. In the particular form shown the slot has a rounded bottom, and for this purpose a grinding wheel 24 having a complementally shaped working face and rim 28 is used. In this particular form the header 98 has a shape which generally conforms to that of the base of the slot but is smaller than the slot, so that the header may enter it if necessary, as might be the case in forming relatively long grooves. In order properly to feed the electrolyte to the interface between the periphery of the grinding wheel 24 and the surface of the workpiece W, a plurality of relatively long, small bore, metallic feed tubes 100 is used. It will be noted from FIG. 5 that the lowermost tube is the longest, while the two tubes disposed at either side thereof are somewhat shorter, thereby feeding electrolyte directly from their outlets onto the surface of the wheel from which it is carried to the interface between the workpiece and the surface of the grinding wheel. The contouring wheel 24 illusutrated is merely typical, and it will be obvious that other contours may be obtained by appropriately shaped wheels and with the proper placement of the feed tubes 100.

So that there will be no electrolytic action between the header 98, its side walls may be covered with an epoxy paint which is an electrical insulator. The header may be made of a plastic material in which case it will be necessary to run conductors within the header between the terminal 79 and the inner ends of the metallic feed tubes 100 so that the potential on the latter will be the same as that on the cathodic grinding wheel 24.

In FIG. 7 there is shown still another form of applicator for electrolyte, wherein a tubular metal nozzle 102 has its outlet end 104 contoured to the shape of the wheel by bringing it against the periphery 106 of the wheel 24 so that it will have precisely the shape of the wheel. The applicator tube 102 is then moved slightly away from the wheel so that there will not be any further grinding or abrading action between the wheel and the tubular nozzle 102. The nozzle 102 is mounted on a fitting 108 which in turn is screwed into an insulating mounting block 110 secured to a fixed part of the machine. The electrolyte is fed to this block through the supply conduit 42 which preferably is made of an electrically nonconductive material. There is a bore 112 formed in the mounting block 110 which separates the end of the fitting 108 from the coupling 60 for the supply tube 42, but places the bores of the fittings 60 and 108, nozzle 102, and conduit 42, in communication with each other. In order to prevent erosive electrolytic action between the electrolyte supply nozzle 102 and the grinding wheel 24, the potential of the two is made the same by means of the connector 78 which is shown as having its terminal fastened at 114 directly to the nozzle 102. It should be noted that this arrangement, while showing the supply tube 102 positioned closely adjacent the periphery of the wheel 24, need not be so limited and may be arranged so that it is closely adjacent the frontal disc surface or the active face of a cup shaped wheel.

From the foregoing description of the invention, it is clear that the objectives which are claimed for this invention in the opening paragraphs of this specification have been fully attained.

While preferred embodiments of the electrolyte applicator have been shown and described, it will be apparent that numerous modifications and variations thereof may be made without departing from the underlying principles of the invention. It is therefore desired, by the following claims, to include within the scope of the invention all such variations and modifications by which substantially the results of this invention may be obtained through the use of substantially the same or equivalent means.

What is claimed as new and desired to be secured by United States Letters Patent is:

1. An applicator for an electrolytic grinding machine for feeding electrolyte into the interface between an electrically conductive workpiece and an electrically conductive grinding tool wherein an electric current is passed between the workpiece and the tool across the interface, including in combination, at least one metallic electrolyte feed tube mounted on and insulated from the machine and having its outlet positioned closely adjacent the interface, means including electrically nonconductive conduit means connected to said feed tube and adapted to supply electrolyte thereto from an electrolyte source, and electrical connections making the electric sense and potential of said metallic feed tube the same as that of the grinding tool.

2. The combination set forth in claim 1, wherein said feed tube is relatively long and has a small outside diameter and a small bore similar to that of a hypodermic needle.

3. The combination set forth in claim 1, wherein a plurality of relatively long, small bore feed tubes connected to said conduit have their outlets positioned to deliver electrolyte to the interface between the workpiece and the grinding tool.

4. An applicator for an electrolytic grinding machine for feeding electrolyte into the interface between an electrically conductive workpiece and an electrically conductive grinding tool wherein an electric current is passed between the workpiece and the tool across the interface, including in combination, at least one metallic electrolyte feed tube, electric insulating means mounting said feed tube on the machine so that its outlet is positioned closely adjacent the interface, means including electrically nonconductive conduit means connected to said feed tube and adapted to supply electrolyte thereto from an electrolyte source, and electrical connections making the electric sense and potential of said metallic feed tube the same as that of the grinding tool.

5. The combination set forth in claim 4, wherein said feed tube is relatively long and has a small outside diameter and a small bore.

6. An applicator for an electrolytic grinding machine for feeding electrolyte into the interface between a metallic workpiece and a rotating grinding wheel wherein the workpiece is made anodic, the grinding wheel cathodic, and an electric current is passed between the workpiece and the grinding wheel, including in combination, at least one small diameter, small bore, metallic electrolyte feed tube having its outlet positioned closely adjacent the interface, insulating means mounting said feed tube on the machine, electrically nonconductive conduit means adapted and connected to supply electrolyte to said feed tube from an electrolyte source, and electrical connections making the electric sense and potential of said metallic feed tube the same as that of said cathodic grinding wheel.

7. An applicator for an electrolytic grinding machine for feeding electrolyte into the interface between a metallic workpiece and a conductive grinding wheel wherein the workpiece is made anodic, the grinding wheel cathodic, and an electric current is passed between the workpiece and the grinding wheel, including in combination, a plurality of small diameter, small bore, metallic electrolyte feed tubes having their outlets positioned closely adjacent the interface, a header mounting said tubes, means including electrically nonconductive conduit means connecting said header to a source of electrolyte, insulating means mounting said tubes and said header on the machine, and electrical connections making the electric sense and potential of said metallic feed tubes the same as that of said cathodic grinding wheel.

8. The combination set forth in claim 7, including electrolyte flow controlling valve means in said means connecting said header to the source of electrolyte and adjusted to inhibit the formation of pools of electrolyte on the workpiece adjacent the feed tubes and the flow of electrolyte along the sides of the grinding wheel.

9. An applicator for an electrolytic grinding machine for feeding electrolyte into the interface between a metallic workpiece and a rotating grinding wheel wherein the workpiece is made anodic, the grinding wheel cathodic, and an electric current is passed between the workpiece and the grinding wheel, comprising in combination, a source of electrolyte, a pump for pumping electrolyte from the source to the interface, at least one small diameter, small bore, metallic electrolyte feed tube having its outlet positioned closely adjacent the interface, a header mounting said tube, conduit means connecting said header to the outlet of said pump and including a flow regulating needle valve close to said header and adjusted to inhibit the formation of pools of electrolyte on the workpiece adjacent the feed tube and the flow of electrolyte along the sides of the grinding wheel, at least a substantial section of said conduit means between said valve and said pump being made of an electrically nonconductive material, insulating means mounting said feed tube, said header, and said valve on the machine, and electrical connections making the electric sense and potential of said metallic feed tube the same as that of said cathodic grinding wheel.

10. An applicator for an electrolytic grinding machine for feeding electrolyte into the interface between a metallic workpiece and a rotating grinding wheel wherein the workpiece is made anodic, the grinding wheel cathodic, and an electric current is passed between the workpiece and the grinding wheel comprising in combination, a source of electrolyte, a pump for pumping electrolyte from the source to the interface between the workpiece and the grinding wheel, a cluster of small diameter, small bore, metallic electrolyte feed tubes having their outlets positioned closely adjacent the interface, a header mounting said tubes, conduit means connecting said header to the outlet of said pump and including a flow regulating needle valve adjusted to inhibit the formation of pools of electrolyte on the workpiece adjacent the feed tubes and the flow of electrolyte along the sides of the grinding wheel, at least a substantial section of said conduit means between said valve and said pump being made of an electrically nonconductive material, insulating means mounting said feed tubes, said header, and said valve on the machine, and electrical connections making the electric sense and potential of said metallic feed tubes the same as that of said cathodic grinding wheel.

11. An applicator for an electrolytic grinding, shaping, and cutting machine for feeding electrolyte into the interface between a metallic workpiece and the periphery of a grinding wheel used in forming a groove in the workpiece wherein the workpiece is made anodic, the grinding wheel cathodic, and an electric current is passed between the workpiece and the grinding wheel, including in combination, at least one relatively long, small diameter, small bore, metallic electrolyte feed tube mounted on and insulated from the machine and having its outlet positioned closely adjacent the interface, means including electrically nonconductive conduit means connecting said feed tube to a source of electrolyte, electrical connections making the electric sense and potential of said metallic feed tube the same as that of said cathodic grinding wheel, and a pair of nozzles positioned at either side of the grinding wheel where it enters the workpiece and connected to a source of air under pressure so as to direct jets of air at the cut in the workpiece at either side of the grinding wheel to confine the electrolyte to the groove to eliminate pumping or spurting of electrolyte from the sides of the groove as it is being formed.

12. The combination set forth in claim 11, including valve means in said means connected to the source of electrolyte and adjustable to regulate the flow of electrolyte through said feed tube.

13. The combination set forth in claim 11, including valve means interposed between said air nozzles and the source of air under pressure and adjustable to regulate the air jets at the sides of the grinding wheel.

14. An applicator for an electrolytic grinding, shap-

ing, and cutting machine for feeding electrolyte into the interface between a metallic workpiece and the periphery of a grinding wheel used in forming a groove in the workpiece wherein the workpiece is made anodic, the grinding wheel cathodic, and an electric current is passed between the workpiece and the grinding wheel, comprising in combination, a source of electrolyte, a pump for pumping electrolyte from the source to the interface between the workpiece and the grinding wheel, at least one relatively long, small diameter, small bore, metallic electrolyte tube having its outlet positioned closely adjacent the interface, a header mounting said tube, conduit means connecting said header to the outlet of said pump and including a flow regulating needle valve, said conduit means between said valve and said pump having a substantial length thereof made of an electrically nonconductive material, insulating means mounting said tube, said header, and said valve on the machine, electrical connections making the electric sense and potential of said metallic feed tube the same as that of said cathodic grinding wheel, and a pair of nozzles positioned at either side of the grinding wheel where it enters the workpiece and connected to a source of air under pressure so as to direct jets of air at the cut in the workpiece at either side of the grinding wheel to confine the electrolyte to the groove to eliminate pumping or spurting of electrolyte from the sides of the groove as it is being formed.

15. An applicator for an electrolytic grinding, shaping, and cutting machine for feeding electrolyte into the interface between a metallic workpiece and the periphery of a conductive grinding wheel used in forming a groove in the workpiece wherein an electric current is passed between the workpiece and the grinding wheel, including in combination, at least one relatively long, small diameter, small bore, metallic electrolyte feed tube having its outlet positioned adjacent the interface, a header smaller than the groove being formed mounting said tube, means including electrically nonconductive conduit means connecting said header to a source of electrolyte, insulating means mounting said tube and said header on the machine, electrical connections making the electric sense and potential of said tube and said header the same as that of said grinding wheel, and a pair of nozzles positioned at either side of the grinding wheel where it enters the workpiece and connected to a source of air under pressure so as to direct jets of air at the cut in the workpiece at either side of the grinding wheel to confine the electrolyte to the groove to eliminate pumping or spurting of electrolyte from the sides of the groove as it is being formed.

16. An applicator for an electrolytic grinding, shaping, and cutting machine for feeding electrolyte into the interface between a metallic workpiece and the periphery of a conductive grinding wheel used in forming a groove in the workpiece wherein an electric current is passed between the workpiece and the grinding wheel, including in combination, a plurality of relatively long, small diameter, small bore, metallic electrolyte feed tubes having their outlets positioned closely adjacent the interface, a header smaller than and shaped complementally to the contour of the groove being formed mounting said tubes, means including electrically nonconductive conduit means connecting said header to a source of electrolyte, insulating means mounting said tube and said header on the machine, electrical connections making the electric sense and potential of said tube and said header the same as that of said grinding wheel, and a pair of nozzles positioned at either side of the grinding wheel where it enters the workpiece and connected to a source of air under pressure so as to direct jets of air at the cut in the workpiece at either side of the grinding wheel to confine the electrolyte to the groove to eliminate pumping or spurting of electrolyte from the sides of the groove as it is being formed.

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Dedication

3,017,340.—*Lynn A. Williams*, Winnetka, Ill. ELECTROLYTIC APPLICATOR. Patent dated Jan. 16, 1962. Dedication filed Dec. 23, 1971, by the assignee, *Anocut Engineering Company.*

Hereby dedicates to the Public the portion of the term of the patent subsequent to Dec. 24, 1971.

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