Aug. 23, 1960 L. A. WILLIAMS 2,950,239

CONTROL SYSTEM FOR ELECTROLYTIC GRINDING

Filed March 2, 1956

Fig. 1.

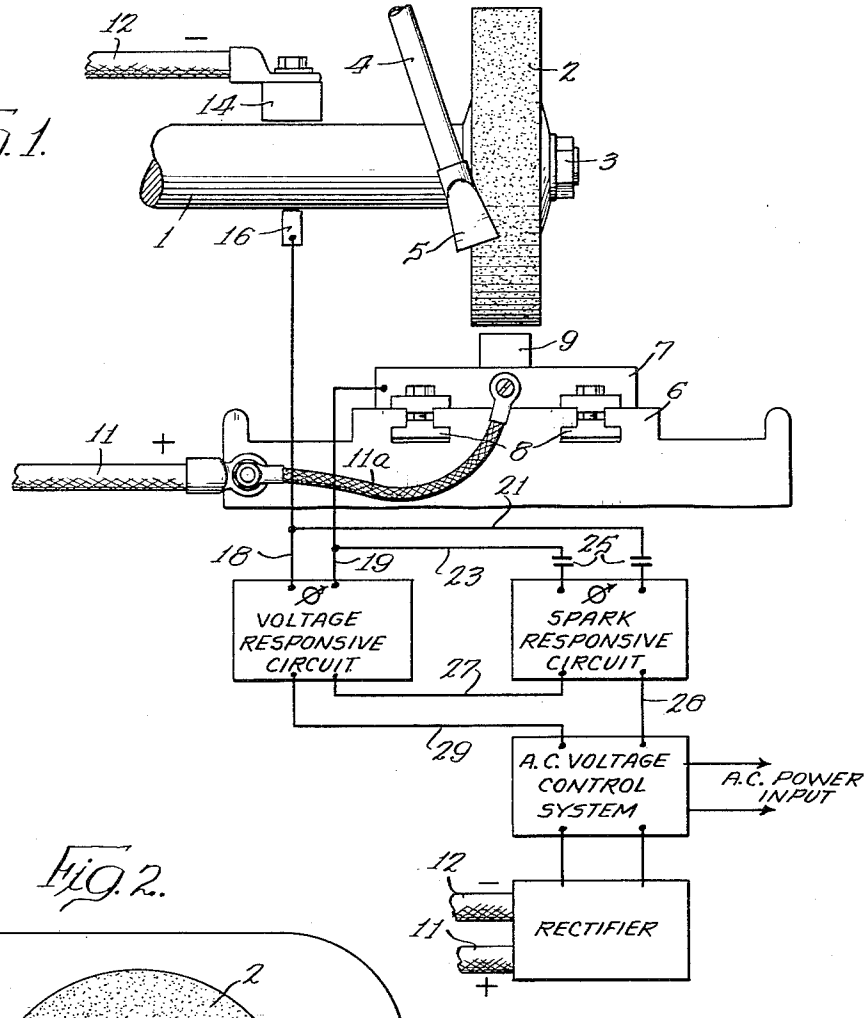
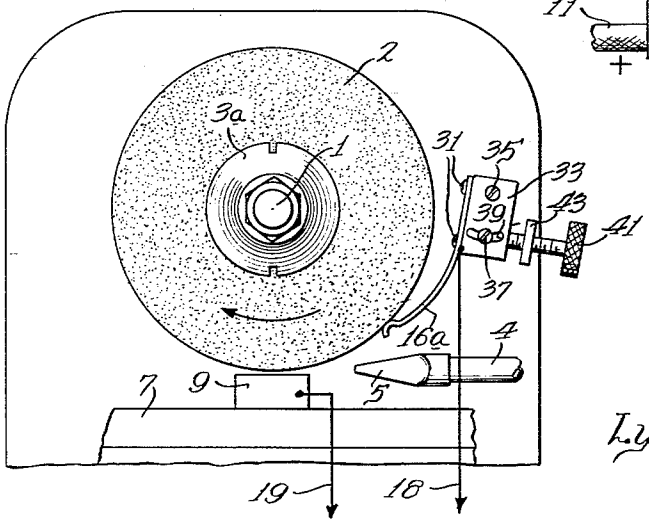


Fig. 2.



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CONTROL SYSTEM FOR ELECTROLYTIC GRINDING

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5 Claims. (Cl. 204—218)

The object of this invention is to provide an improvement in the control system for an electric supply for electrolytic grinding as disclosed in the pending application of George F. Keeleric et al., Serial No. 381,278, filed September 21, 1953 for "Electric Supply System for Electrolytic Grinding." The above-identified pending application discloses a system for supplying direct current for the purpose of electrolytic grinding and it shows two interacting control systems; one intended to provide voltage regulation at a constant voltage for the purpose of limiting the maximum voltage and also for the purpose of maintaining the desired voltage under increased load, the other intended to respond to a signal derived from sparking between the grinding electrode and the workpiece to reduce the voltage level in response to such sparking.

It has been found that a surprisingly improved result can be obtained by making the connection for the control signals not to the power cables as might be indicated by conventional practice but to the moving spindle of the grinding machine or even to the working surface of the grinding electrode. This is the basic concept of this invention.

In the drawings:

Fig. 1 is a schematic representation of electrolytic grinding apparatus including a rotating grinding wheel, a workpiece, means for mounting and moving the workpiece, the electric supply system and the controls therefor.

Fig. 2 is a schematic representation of a grinder adapted for electrolytic grinding and showing a variant means of electrical pick-up for the control circuits.

Referring to Fig. 1, on a spindle 1 of a conventional grinding machine is mounted a grinding electrode 2. The spindle is arranged in accordance with conventional practice to be rotated by a motor or other power source not shown. The grinding electrode 2 is mounted to the spindle in the conventional manner, here indicated by mounting nut 3. In this instance, the grinding electrode is intended for peripheral grinding but it should be understood that the electrode might be in the form of a cup wheel intended for grinding on the circular face thereof or it might take any other appropriate and desired form. The grinding electrode may consist of a metal center portion with its working surface covered with an electroconductive matrix bearing abrasive material of diamonds, silicon carbide, aluminum oxide or the like. The matrix may be of metal bond or any other electroconductive material including electroconductive vitrified bond of the ceramic class.

A tube 4 is provided to direct an electrolyte into the work area through a nozzle 5. The foregoing portions of the construction are described more in detail in the pending application of George F. Keeleric, Serial No. 310,244, filed September 18, 1952 for "Method and Apparatus for Electrolytic Cutting, Shaping and Grinding," and issued as Patent No. 2,826,540, dated March 11, 1958.

As illustrated here, the machine is of the surface-

grinder type having a movable table 6, shown fragmentarily. On the table is mounted a magnetic chuck 7 held to the table by bolts 8 fastened to the conventional T slots. A workpiece 9 is held on the magnetic chuck, being held without other means if it is of steel or other magneto-responsive material or by an appropriate vise or clamps if it is of cemented tungsten carbide or other non-magnetic material.

Direct current electric power is provided through heavy power cables 11 and 12. Cable 11 is ordinarily bolted to the table 6 of the machine. Where there is a multiplicity of joints between the table 6 and the workpiece 9, as for example where a magnetic chuck is used or where vises or other clamping means are used, it is desirable to provide an auxiliary bonding connection 11*a*. This may be conveniently made of the type of copper braid commonly used for grounding storage batteries in automobiles. By the use of such an auxiliary bonding cable, losses through the joints are avoided. In addition, electrolytic action between one member and another is also avoided.

Cable 12 is connected to a brush system represented here for convenience by a single brush 14. Ordinarily, it is more convenient to provide a plurality of brushes, for by this means a larger brush area may be conveniently obtained. It should be understood that the brushes will be held in a conventional manner in brush holders and urged lightly against the spindle by springs. Since the mounting arrangement for the brushes is conventional, no detail is shown in the drawings. It should also be understood that, if desired, the spindle proper may be sleeved with a hard copper slip ring instead of having the brushes run directly on the steel spindle. The spindle is suitably insulated from the bed of the machine so that there is no short circuiting. This may be done by mounting the outer races of the conventionally used ball bearings in fiber insulating sleeves pressed into the grinder head.

An electrical supply system is provided which provides direct current which is carefully regulated to accommodate varying grinding conditions. Since the detail of this electrical system is no part of this invention it will be described only in general terms. Ordinarily, power is taken from the alternating-current power line through a step-down transformer to a rectifier. Means are provided in the alternating-current portion of the circuit to regulate the alternating-current voltage automatically. The regulating means is controlled by a dual control circuit; one a voltage-responsive circuit by which the power output is held at a constant voltage, the other a spark-responsive circuit which automatically modifies the signal provided by the voltage-responsive circuit whenever alternating-current components appear across the electrolytic gap, as, for example, when there is sparking between the grinding electrode and the workpiece. To actuate the two control circuits it is necessary, of course, to make connection to the power lines, and in the above-identified application of Keeleric et al. such connections are shown as made in the conventional way to the power cables themselves.

According to this invention, however, the control connections are carried not to the supply cables but either to the workpiece or the means directly holding the workpiece, as, for example, the table or chuck of a grinder, and either to the spindle of the grinder or directly to the working surface of the grinding electrode itself. By this means, a surprising improvement in grinding results is obtained.

An auxiliary control brush 16 is mounted to run against the spindle 1 so that it receives the potential of the spindle itself. Thus, if there are any losses in the brush 14 or through the cables themselves or their connections,

all of these losses are reflected at the spindle and the auxiliary brush **16** thus receives substantially the potential which is available for the electrolytic operation itself. In addition, signals from sparking are detected without losses or aberrations coming from the cable system.

In electrolytic grinding heavy currents are sometimes used at relatively low voltages. For example, it is not uncommon to use 250 amperes at a voltage under ten volts. With such currents even a very low resistance through the brush system may bring about a substantial drop in voltage. If, for example, the resistance of the brush system is only .01 ohm, there will be a voltage drop of 2.5 volts. If then the source voltage had been ten volts, the voltage actually reaching the grinding electrode would be 7.5 volts, a significantly lower potential. In most electrical circuits this kind of problem is not encountered, for it is usually possible to transmit power at higher voltages, stepping it down at the point of application, or, alternatively, it is possible without much difficulty to use heavy cables. But where it is necessary to use a running brush contact, as in this instance, it is quite difficult to reduce the ohmic resistance throughout the entire system including the brush system to a value low enough to assure against significant voltage losses.

Brush **16** carries only a very light signal current of a few milliamperes and thus, by contrast with brush **14**, may be very small. It is mounted in conventional manner, and, accordingly, the details of the mounting are not shown. It is important that it be electrically insulated from whatever brush mount is used for brush **14**. The signal from brush **16** is carried to the control system by wire **18**. Wire **19** is connected as close as is reasonably practicable to workpiece **9** and provides the return lead for the control system.

The detail of the control system is not shown, as it may accord in general with the system disclosed in the above-identified application of Keeleric et al., Serial No. 381,278.

Briefly, it comprises a voltage-responsive circuit adjustable to set the level of maximum voltage and also a spark-responsive circuit adjustable to set the level of response to spark signals. Connection to the voltage-responsive circuit is made by directly conductive connections. Connection to the spark-responsive circuit is made through wires **21** and **23** and through capacitors **25** so as to isolate the spark-responsive circuit from any direct current. In this respect, the circuit is slightly different from that disclosed in the above-identified application of Keeleric et al., Serial No. 381,278, which shows the spark signal as derived across a shunt or from a doughnut or toroidal coil.

The two control circuits are linked by wires **27, 28** and **29** to feed a combined signal into an alternating-current voltage control system which controls the potential of alternating current fed to a rectifier by means of saturable core reactors, thyratrons or similar means. The alternating current is fed to the rectifier and is there rectified, and the direct current from the rectifier is fed through cables **11** and **12** to the electrolytic grinding circuit as above described.

Referring now to Fig. 2, there is shown a schematic representation of the front view of a conventional surface grinder. The grinding electrode **2** is mounted on the spindle **1** by a spanner nut **3***a*. Tube **4** and nozzle **5** are provided to direct electrolyte into the work area. The chuck **7** is shown fragmentarily and is intended to be mounted on the conventional, movable work table of a surface grinder. Control connection, wire **19**, is shown connected directly to the workpiece **9**. Control connection, wire **18**, is connected to a special pick-up system. This consists of a spring finger **16***a* mounted on insulating block **33** by means of screws **31**. Insulating block **33** is pivotally mounted on stud screw **35**, which is fastened to the head of the machine or to a bracket projection mounted thereon. In insulating block **33** there is provided a sector slot **39** adapted to receive clamping screw **37**. A knurl adjustment screw **41** is arranged in screw-threaded relationship to bracket **43**, which is also mounted to the head of the grinder.

By the means described above it is possible to adjust spring finger **16***a* to run in very close proximity to grinding electrode **2** but without making actual mechanical contact with it, for if mechanical contact were made the abrasive particles in the electrode would grind away the material of spring finger **16***a*. Because a film of electrolyte adheres to the grinding electrode it is possible to secure an accurate voltage reading through this film of electrolyte provided spring finger **16***a* projects into the solid liquid film. Since the current requirements of the control system are deliberately kept at a very low level, the voltage drop through the film of electrolyte is so small as to be of no consequence. It is desirable that the spring finger pick up its signal from the grinding electrode just as close as possible to the point where the electrode is in contact with the workpiece **9**. The spring finger **16***a* is narrower than the working width of the grinding electrode **2** and, thus, if the direction of movement of the workpiece in grinding is taken toward the spring finger there will be no interference between it and the workpiece even though the spring finger be projected very close to the point of tangent contact between the wheel and the workpiece. The drawing shows the spring finger **16***a* at a greater distance from the workpiece than is desirable merely because in this way a clear representation of the structure may be shown.

The tip of spring finger **16***a* may advantageously be coated with platinum or rhodium or similar material which is resistant to attack by the electrolyte either in normal chemical reaction or in any slow electrolytic action arising from the necessity of having some small current passing between the spring finger and the grinding electrode.

The arrangement of Fig. 2 is particularly desirable where the grinding electrode is not in itself an excellent conductor, as, for example, where the matrix material is porous or is made of conductive vitrified ceramic material. It may sometimes happen that the electrical drop through the grinding electrode is quite substantial and good results cannot be obtained unless the amount of this drop is taken into account in the control circuits.

It will be understood that the particular embodiments above described are subject to considerable variation without departing from the spirit of the invention, and it is not intended to limit the invention to the specific embodiments shown and described.

What I claim is new and desire to secure by Letters Patent is:

1. In an electrolytic grinding system a grinding machine having a rotating spindle and mounting means for a workpiece, insulating means electrically isolating the spindle from the workpiece, a grinding electrode mounted on the grinding machine spindle, means for supplying electrolyte to a working surface of the grinding electrode so that electrolyte passes between the workpiece and the grinding electrode, an electric supply system for supplying a direct-current potential between the grinding electrode and a workpiece, said electric supply system including control circuit means tending to maintain a constant voltage and control circuit means adapted to reduce the voltage in response to sparking between the grinding electrode and the workpiece, power cable connections from the electric supply system connected respectively to the mounting means for the workpiece and to a power brush system making contact with the spindle, wire connecting means connecting both said control circuit means respectively to the mounting means for the workpiece and to the spindle, said connecting means including an auxiliary brush not carrying power electrically insulated from the power brush means and mounted to run against the spindle of the machine.

2. In an electrolytic grinding system a grinding machine having a rotating spindle and mounting means for a workpiece, insulating means electrically isolating the spindle from the workpiece, a grinding electrode mounted on the grinding machine spindle, means for supplying electrolyte to a working surface of the grinding electrode so that electrolyte passes between the workpiece and the grinding electrode, an electric supply system for supplying a direct-current potential between the grinding electrode and a workpiece, said electric supply system including control circuit means tending to maintain a constant voltage and control circuit means adapted to reduce the voltage in response to sparking between the grinding electrode and the workpiece, power cable connections from the electric supply system connected respectively to the mounting means for the workpiece and to a power brush system making contact with the spindle, wire connecting means connecting both said control circuit means respectively to the mounting means for the workpiece and to the spindle, said connecting means including an auxiliary brush in the form of a spring finger mounted to run in close proximity to the grinding electrode and within the electrolyte on the grinding electrode at a point close to the area of working contact between the grinding electrode and the workpiece.

3. In an electrolytic grinding system having a grinding machine including a rotatable spindle and a mounting means for a workpiece, insulating means electrically isolating the spindle from the workpiece, a grinding electrode mounted on the grinding machine spindle, means for supplying electrolyte to a working surface of the grinding electrode so that electrolyte passes between the workpiece and the grinding electrode, an electric supply system for supplying a direct current potential between the grinding electrode and a workpiece, said electric supply system including control circuit means tending to maintain a constant voltage and control circuit means adapted to reduce the voltage in response to sparking between the grinding electrode and the workpiece, and power cable connections from the electric supply system connected respectively to the mounting means for the workpiece and to a power brush system making contact with the spindle, the improvement which comprises an auxiliary brush means electrically insulated from the power brush system and running against the spindle of the machine, and wire connecting means connecting both the control circuit means respectively to the mounting means for the workpiece and to said auxiliary brush means, whereby said auxiliary brush means carries no power, and direct current potential and sparking signals between the grinding electrode and the workpiece are transmitted to the control circuit means.

4. In an electrolytic machining apparatus, a shaping tool electrode, means for holding a workpiece, means for moving the workpiece mounting means and the tool electrode relatively, means for supplying electrolyte to the work gap between the workpiece and a working surface of the tool electrode, an electric supply system for supplying a direct current potential between the workpiece and the tool electrode, said electric supply system including a rectifier element and control circuit means tending to maintain a constant voltage and control circuit means responsive to sparking between the workpiece and the tool electrode and adapted to affect the voltage to terminate the sparking, and power cable connections from the electric supply system connected respectively to the workpiece mounting means and to the tool electrode, the improvement which comprises, signal connections feeding both control circuit means, said signal connections comprising wire connecting means from the workpiece and from the tool electrode to both control circuit means, said wire connecting means being connected to the workpiece and to the tool electrode closely adjacent the work gap so that direct current potential and sparking signals between the workpiece and the tool electrode are transmitted to the control circuit means.

5. In an electrolytic machining apparatus, a shaping tool electrode, means for holding a workpiece, means for moving the workpiece mounting means and the tool electrode relatively, means for supplying electrolyte to the work gap between the workpiece and a working surface of the tool electrode, an electric supply system for supplying a direct current potential between the workpiece and the tool electrode, said electric supply system including a rectifier element and control circuit means for controlling the voltage to maintain the desired voltage at the work gap between the workpiece and the tool electrode, and power cable connections from the electric supply system connected respectively to the workpiece mounting means and to the tool electrode, the improvement which comprises, signal connections feeding said control means, said signal connections comprising wire connecting means for the workpiece and from the tool electrode to the control circuit means, said wire connecting means being connected to the workpiece and to the tool electrode closely adjacent the work gap so that direct current potential and sparking signals between the workpiece and the tool electrode are transmitted to the control circuit means.

References Cited in the file of this patent

UNITED STATES PATENTS

2,772,232	Comstock et al.	Nov. 27, 1956
2,783,199	Comstock	Feb. 26, 1957

FOREIGN PATENTS

1,108,180	France	Aug. 24, 1955

OTHER REFERENCES

Storey: Journal of the Electrochemical Society, vol. 100, May 1953, pages 125C and 126C.

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,950,239 August 23, 1960

Lynn A. Williams

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

Column 6, line 38, for "for" read -- from --.

Signed and sealed this 4th day of April 1961.

(SEAL)

Attest: ERNEST W. SWIDER

Attesting Officer

ARTHUR W. CROCKER

Acting Commissioner of Patents