The present invention relates to improvements in sparking, for the formation of orifices, in general of small section, in metallic members. The invention involves the perforation of metallic parts by making electric sparks jump between an electrode and the part to be machined, the electrode and the part being immersed in a suitable liquid.

The invention has the particular objective of simultaneously forming a large number of orifices of the same diameter within a short time as possible.

According to one characteristic of the invention, use is made of two sets of electrodes each powered by a circuit of separate charges and discharges, so as to increase in great measure the number of discharges by the electrodes in a given time.

According to another characteristic of the invention, the apparatus effecting the displacement of the electrodes is subject to the control of the actuating means therefor in such a way that the distance between the electrodes and the part to be machined is controlled and kept at every moment at a suitable value.

It is another object of the invention to provide sets of electrodes, electrically insulated from one another but mechanically integral, which are driven by a movement of advance or retraction which is controlled by means of an electric device which takes into account the distances between the part to be machined and the electrodes of each set. The movement of the ensemble of electrodes is effected according to the requirements of the different sets of electrodes.

Generally, it has been determined that the regulation of the movement of the electrodes is greatly facilitated by a continuous or direct current supply for the circuit of each set of electrodes.

According to another characteristic of the invention, a vibratory motion is given to the member carrying the groups of electrodes at the start of the piercing operation. It has been determined that there is thus obtained a favorable effect, which seems to be due to the fact that this vibratory motion allows a better evacuation of the metallic residue resulting from the piercing operation.

The invention also contemplates application of the improvements described above, in whole or in part, to the production of orifices of very small diameter in a metallic wall having for its special objective the formation of extrusion orifices to obtain filaments and fibers from plastic materials.

The invention is concerned in particular with the obtention of orifices of very small diameter in the annular bands or walls which constitute the peripheral part of the rotating bodies utilized in the production of filaments or fibers by centrifugal projection of viscous plastic material through these orifices.

Other characteristics and advantages of the invention will appear from the description which follows in conjunction with the annexed drawing wherein FIG. 1 is a schematic illustration including a circuit diagram of a preferred embodiment which is given by way of example, and which is not to be construed as limiting; and FIG. 2 is a sectional view of a rotary body having a peripheral wall corresponding to the workpiece shown in FIG. 1.

As shown in the drawing, the piece to be machined or pierced is mounted on an insulated support and is placed in a vat or tank filled with a dielectric liquid.

The electrodes are arranged in two distinct groups mounted on a common insulating support. This support is integral with a head which is connected, by an appropriate mechanical transmission, to a reversible direct current motor capable of opposite directions of rotation. This control allows the ensemble of electrodes to be raised or lowered according to the direction of rotation of the motor. A vibrator is fixed on head 7.

The current supply to the ensemble of the device is obtained from a source of continuous current which may be connected between terminals and 11. The two groups of electrodes and 5 are connected independently to circuits comprising, respectively, condensers and the discharge from which effects the sparking. These circuits are supplied by the continuous current source through the intermediary of resistances 22 and 23, respectively.

The armature 9a of motor 9 is connected to the circuit of each group of electrodes by means of resistances 14 and 15, shunted by diodes 16 and 17, respectively. The diodes 16 and 17 function as electric valves by presenting an almost zero resistance for one direction of passage of the current and a very high resistance for the other direction. The armature 9a is also connected to a point 18 of a potentiometer 19 which is connected to the current supply 10, 11 by resistances 20 and 21.

The direction of connection of the motor is such that the electrode carrier 7 descends if the potential of the electrodes is lower than that of point 18, which corresponds to the case where the two groups of electrodes are separated from the part to be machined. On the contrary, if the potential of the electrodes is too high with respect to that of point 18, which corresponds to the case where the two groups of electrodes are in short-circuit with the part to be machined, the motor turns in the opposite direction, thereby effecting the ascent of the electrode carrier or support.

In the case where one of the electrodes comes in short circuit while the other set is in short-circuit with that part, the current initiated by this short-circuit passes directly across the corresponding diode without passing through the resistance in parallel with the latter. The result is that the current passes through the armature of the motor in the direction assuring the rise of the electrode carrier.

At the beginning of the sparking operation, the electrodes are preferably subjected to vibrations by means of a vibrator mounted on the electrode carrier. Thus it is that if the time of machining is about three minutes, the vibrations are produced only during about one minute at the start of the operation. The vibrator can be dependent on any desired time-controlled device. Thus, a synchronous motor may be used which starts rotation at the beginning of the sparking operation and which advances a cam through the intermediary of a speed-reducing mechanism. This cam establishes the power supply for the vibrator at the start of the operation and acts to cut off this supply at the end of a predetermined time.

The assembly can be completed by a relay which acts on point 18 of the connection of the armature of motor 9 to the potentiometer to control the rotation of the motor in the direction corresponding to the ascent of the electrodes, which has the effect of withdrawing the electrodes from the holes already formed and of removing the waste.

FIG. 2 shows a rotary body or centrifuge having a peripheral wall in which is adapted to be formed a plurality of orifices of very small diameter at a plurality
of levels, for example, nine, by the displacement of the workpiece relative to the electrodes 4 and 5. Such apertured rotary bodies are well known in the prior art, as exemplified by U.S. Patent No. 3,205,055, September 7, 1965.

In the embodiment described above, a single source of supply is utilized for the ensemble of the groups of electrodes. Electrically independent sources may also be utilized for providing the power supply.

We claim:

1. A spark-machining apparatus for producing perforations of small cross-section in a metallic workpiece comprising a tank adapted to contain a dielectric liquid, means for supporting said workpiece within said tank, two sets of wire electrodes of small cross-section having the ends thereof cooperating with said workpiece, each set being insulated from the other, a common carrier for said electrodes, a single power source connected through a separate voltage-dropping impedance to a separate spark discharge circuit connected between each set of wire electrodes and said workpiece to disintegrate the metal of the workpiece at the points of said discharges, and means for controlling the movement of said carrier to maintain substantially constant the displacement of said ends of the electrodes from the part of the workpiece undergoing machining comprising an electric motor which is variably controlled through separate blocking rectifiers by the average spacings of the ends of either set of electrodes from the operation of the workpiece undergoing machining.

2. A spark-machining apparatus for producing perforations of small cross-section in a metallic workpiece comprising a tank adapted to contain a dielectric liquid, means for supporting said workpiece within said tank, two sets of wire electrodes of small cross-section having the ends thereof cooperating with said workpiece, each set being insulated from the other, a common carrier for said electrodes, a separate spark discharge circuit connected between each set of wire electrodes and said workpiece to generate spark discharges between said ends of said wire electrodes and said workpiece to disintegrate the metal of the workpiece at the points of said discharges, and means for controlling the movement of said carrier to maintain substantially constant the displacement of said ends of the electrodes from the part of the workpiece undergoing machining comprising an electric motor which is variably controlled through separate blocking rectifiers by the average spacings of the ends of either set of electrodes from the operation of the workpiece undergoing machining.

3. An apparatus as set forth in claim 2 wherein said direct current electric motor includes an armature, connections from each separate set of electrodes to said armature, each comprising in said voltage-dropping impedance a resistance and a diode in parallel thereto functioning as an electric valve to bridge the short-circuit occasioned by the contact of the ends of one set of electrodes with the workpiece with the motor armature so that the latter rotates in a direction to back off the ends of the electrodes from the workpiece.

4. An apparatus as set forth in claim 3 including vibrating means connected to said electrode carrier.

5. An apparatus as set forth in claim 3 including vibrating means for said electrode carrier, and a timer control for operating said vibrating means.

6. A spark-machining apparatus for producing perforations of small cross-section in a metallic workpiece comprising a tank adapted to contain a dielectric liquid, means for supporting said workpiece within said tank, two sets of wire electrodes of small cross-section having the ends thereof cooperating with said workpiece, each set being insulated from the other, a common carrier for said electrodes, a separate spark discharge circuit connected between each set of wire electrodes and said workpiece to generate spark discharges between said ends of said wire electrodes and said workpiece to disintegrate the metal of the workpiece at the points of said discharges, a single source of direct current connected through a separate voltage-dropping impedance to each separate spark discharge circuit for energizing said spark discharge circuits, and means for controlling the movement of said carrier to maintain substantially constant the displacement of said ends of the electrodes from the part of the workpiece undergoing machining comprising an electric motor which is variably controlled through separate blocking rectifiers by the average spacings of the ends of either set of electrodes from the operation of the workpiece undergoing machining.

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