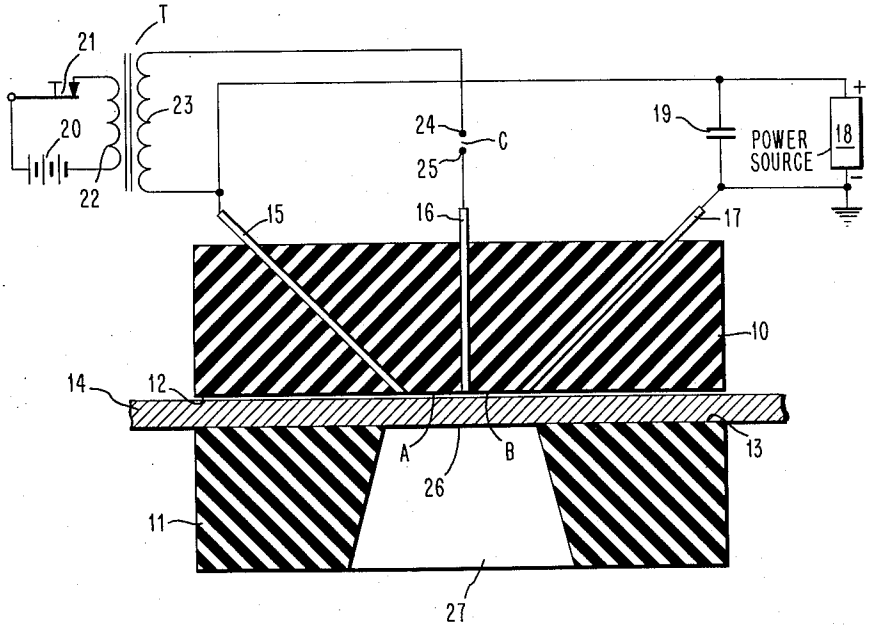
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HIGH SPEED MARKING APPARATUS

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INVENTORS

ERNEST D. LOUNSBERRY

BRUCE E. WENDLING

BY Henry E Otts Jr

ATTORNEY

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HIGH SPEED MARKING APPARATUS

Ernest D. Lounsberry, Endwell, and Bruce E. Wendling, Binghamton, N.Y., assignors to International Business Machines Corporation, New York, N.Y., a corporation of New York

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This invention relates to high speed marking apparatus, and relates more particularly to improvements in marking apparatus using the energy from a spark discharge to perforate, print or otherwise mark a member, such as a record card, tape, or thin metallic element.

In U.S. Patent 2,737,882, granted in 1956 to Early et al., there is disclosed a marking apparatus of the above general type. That apparatus comprises means for feeding a record tape with slight clearance between spaced surfaces of an electrode block and a die block formed of insulating material. The tips of one pair of electrodes are exposed through the surface of the electrode block and spaced from each other a preselected slight distance to provide an air gap along said surface. When a spark discharge is established across this air gap, an instantaneous increase in air pressure occurs within a confined area and the resultant shock wave propels the tape against an aperture in the die block to perforate the tape according to the configuration of the aperture. To produce this spark discharge, a triggering circuit is provided which includes another pair of electrodes separated by a control air gap. When an input pulse is applied to render a tetrode conductive, it completes a circuit from a high voltage source through a resistor and the tetrode to ground. As current flows through the resistor, a potential is developed across the control air gap and a second resistor that are arranged in series and shunt the first resistor. This potential is sufficient to break down the control air gap and thus permit current to flow via said gap, second resistor and the tetrode to ground. This current flow develops a potential across the first-mentioned gap between the first pair of electrodes, which gap is shunted by the second resistor; and this potential is sufficient to break down said gap to develop the energy for marking the tape.

With this arrangement, when the two air gaps break down, they are effectively connected in series. This makes for a relatively inefficient apparatus. Also, a relatively large number of components and relatively high voltages are required in an apparatus of the type just described.

The principal object of this invention is therefore to provide an improved high speed marking apparatus which is more efficient, more reliable, and safer than high speed marking apparatus heretofore proposed.

Another object is to provide an apparatus of the above general type wherein only one air gap is provided in the discharge path, and wherein the apparatus is triggered by breaking down a portion of said air gap.

According to the invention, three electrodes are molded into an electrode block so that their tips are exposed through the surface of the block and opposite an aperture or anvil in a die block. These tips are spaced such that the tip of one of the electrodes is disposed between the tips of the other or outer two electrodes. A high voltage source connected to these outer two electrodes develops a potential insufficient per se to break down the entire air gap between the tips of these outer electrodes, but sufficient to break down that portion of the gap between one of the outer electrodes and the intermediate electrode. A triggering circuit is employed to ionize one portion of the gap and thus effectively reduce the overall width of the gap to an extent where the high voltage source can and will effect a spark discharge

across the entire gap. The energy released by the discharge across the gap will cause a local increase in air pressure. The resultant shock wave will propel against the die block a member that is interposed between the electrode block and die block, and thus cause the member to be marked according to the configuration of the aperture or anvil in the die block.

With this arrangement, the triggering circuit comprises a pair of electrodes spaced to provide a control air gap which desirably is effectively shunted or bypassed once the triggering circuit breaks down one portion of the gap. Thus, the air gap between the tips of the two outer electrodes in the electrode block is the only air gap in the discharge path.

The foregoing and other objects, features and advantages of the invention will be apparent from the following more particular description of a preferred embodiment of the invention, as illustrated in the accompanying drawings, wherein the single figure is a diagrammatic view of a marking apparatus embodying the invention.

As shown in the drawing, the marking apparatus embodying the invention comprises an electrode block 10 and a backing block, such as a die block 11, which preferably are formed entirely of insulating material. Blocks 10, 11 have spaced surfaces 12, 13 through which a member 14 is feedable with slight clearance by suitable feed means (not shown). Member 14 may be record tape, a record card, or a thin metallic element which is to be punched, printed or otherwise marked.

Three electrodes 15, 16, 17 are molded or otherwise maintained positioned in the electrode block 10. The tips of these electrodes are exposed through surface 12 and arranged substantially in line to provide a marking air gap along said surface between the tips of the outer electrodes 15, 17. This air gap comprises portions A and B extending between the tip ends of intermediate electrode 16 and the outer electrodes 15 and 17, respectively. The opposite ends of outer electrodes 15, 17 are connected to a high voltage power source 18 which is shunted by an energy storage capacitor 19. The potential across the source and capacitor is insufficient in itself to break down the entire air gap A, B, but is capable of breaking down one of the portions A or B upon breakdown of the other portion.

A triggering circuit is therefore provided to break down one of the gap portions A or B. This circuit may comprise a battery 20 connected through a switch 21 to a primary winding 22 of a transformer T. One terminal of the secondary winding 23 of the transformer is connected to the outer electrode 15. The other terminal is connected to the intermediate electrode 16 via electrodes 24, 25, which are separated by an air gap C.

The air gap C is provided to isolate electrode 16 from electrode 15. This air gap prevents the potential applied to electrode 15 by the power source 18 from being conducted to electrode 16 through the low resistance of the secondary winding 23 of transformer T. Also, unless air gap C were provided, the electrodes 15, 16 would be at the same potential; and under such circumstances, an arc would be established across portion B of the main air gap between electrodes 16, 17 because, as previously stated, the potential developed by power source 18 is sufficient to arc across said portion B.

In operation, the capacitor 19 normally stores energy which is drawn upon when the entire air gap A, B breaks down. To mark the member 14, the switch 13 or other suitable gating means is opened. This causes a high voltage to be induced across the secondary winding 23 which is sufficient to break down the air gaps C and A in series. Now the capacitor 19 need only break down the air gap portion B, which it is capable of doing. Hence, the capacitor 19 discharges along the air gap A,

B creating an increase in air pressure within the confined space at said air gap. The consequent shock wave propels the member 14 toward the die block 11 and, in the embodiment shown, perforates a hole in the member corresponding to the cross section at 26 of an aperture 27 in the die block 11. The aperture 27 is preferably tapered, as shown in the drawing, and disposed below the member 14 to facilitate withdrawal, by gravity, of the material which is removed from the member during a punching operation.

By way of example only, the voltage of power source 18 may be 5000 volts D.C. Gap portions A and B may be adjusted so that each will break down at about 4000 volts D.C., with gap C to break down at about 5000 volts D.C. Transformer T should, under these conditions, produce a pulse greater than about 9000 volts.

It is to be noted that in this apparatus the 9000-volt potential induced by the opening of the inductive circuit is not as hazardous as a capacitor charged to 9000 volts, because of the relatively low energy available from the inductive circuit. Also, the marking or punch air gap A, B is the only air gap in the discharge path because the air gap C is effectively bypassed during ionization of the gap A, B. Also, with this apparatus no heater supply is required for vacuum tubes. Moreover, no air supply is needed to remove residual ions because no voltage is applied across the gap C until the triggering circuit is to be pulsed. Also, there will be no large power losses such as in previously proposed arrangements employing resistors and vacuum tubes which tend to limit current flow. Also, there is maximum current flow during the marking operation. This is desirable because the energy produced is proportional to I^2R, where R is the resistance of the air gap when the shock wave is produced.

Thus, the apparatus is not only more efficient and safer but it requires fewer operating parts than apparatus heretofore proposed. It also can operate at lower voltages and punch larger holes than is possible with arrangements heretofore proposed.

It has been found that large clean holes can be punched in record cards coated with plastic, such as an epoxy resin. These holes can be very reliably sensed by solar cell type sensing units.

While the invention has been particularly shown and described with reference to a preferred embodiment thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. Apparatus for marking a markable member, comprising means providing respective spaced surfaces defining a space for receiving the member with slight clearance; two electrodes having ends exposed through one of said surfaces to provide an air gap along said space between said ends; a third electrode having an end exposed through said one surface at a point between the ends of said two electrodes; and circuit means including a source of potential connected to said two electrodes and developing a voltage insufficient in itself to ionize said air gap, and means to produce a voltage sufficient to ionize that part of the air gap between said third electrode and one of said two electrodes and thus enable the source to complete the ionization of said gap, thereby to produce a shock wave of sufficient magnitude to drive the member into a portion of the other surface opposite said electrodes to cause the member to be marked according to the configuration of said portion.

2. Apparatus for perforating a member, comprising means providing respective spaced surfaces defining a space into and through which the member is movable with slight clearance; two electrodes having ends exposed through one of said surfaces to provide an air gap along said space between said ends; a third electrode having an end exposed through said one surface at a point substantially equidistant between the ends of said two electrodes; an opening formed in the other surface substantially opposite the ends of said electrodes; and circuit means including a source of potential connected directly to said two electrodes and developing a voltage insufficient in itself to break down said air gap and means to induce a voltage sufficient to break down the part of the air gap between the ends of said third electrode and one of said two electrodes and thus enable the voltage across said source to break down the remaining part of said gap, thereby to produce a shock wave of sufficient magnitude to drive the member into said other surface and cause the member to be perforated according to the configuration of said opening.

3. The combination according to claim 2, wherein the third electrode is substantially coaxially aligned with the axis of the opening, and said two electrodes project generally toward each other and are disposed at substantially equal angles to said axis.

4. In an apparatus for marking a member positionable between surfaces of an electrode block and a backing block, the combination of three electrodes having spaced tips exposed through the surface of the electrode block and arranged substantially in line to provide an air gap between the outer electrodes which constitutes the only air gap in the discharge path, a source of potential connected to the outer electrodes and developing a voltage insufficient in itself to break down the air gap, a triggering circuit connected to the intermediate electrode and one of the outer electrodes, and means for developing a voltage in the triggering circuit sufficient to break down that part of the air gap between the intermediate electrode and one of the outer electrodes to effectively reduce the width of said gap and permit the source to complete the breakdown of said gap, thereby to produce a local increase in pressure across said gap of sufficient magnitude to drive the member into a portion of the surface of the backing block opposite said electrodes to cause the member to be marked according to the configuration of said portion.

5. The combination according to claim 4, wherein said source of potential comprises a capacitor, and a power supply source shunt connected across the capacitor for storing energy therein.

6. The combination according to claim 4, wherein the triggering circuit comprises a transformer having a secondary winding connected to the intermediate electrode and said one outer electrode, two other electrodes separated by a second air gap and interposed between said winding and one of said other electrodes, normally closed control means, and a source of energy series-connected with the primary winding of the transformer through said control means when closed, said control means being operable to an open position to induce a temporary voltage across the secondary winding sufficient to break down the second air gap and said part of the first-mentioned air gap.

7. The combination according to claim 4, wherein the intermediate electrode is disposed substantially normal to said portion, and the tips of the outer electrodes extend toward each other such that the outer electrodes are disposed at substantially equal angles to the axis of said intermediate electrode.

No references cited.