United States Patent

[11] **3,596,285**

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Skokie, Ill.

[54] **LIQUID METAL RECORDER**
6 Claims, 3 Drawing Figs.

[52] **U.S. Cl.** **346/75,** 118/324
[51] **Int. Cl.** **G01d 15/18**
[50] **Field of Search** 346/1, 75, 21, 76; 118/70, 324

[56] **References Cited**

UNITED STATES PATENTS

1,882,043	10/1932	Schroter	346/75 X
2,384,515	9/1945	Wise	346/21
3,298,030	1/1967	Lewis et al.	346/75

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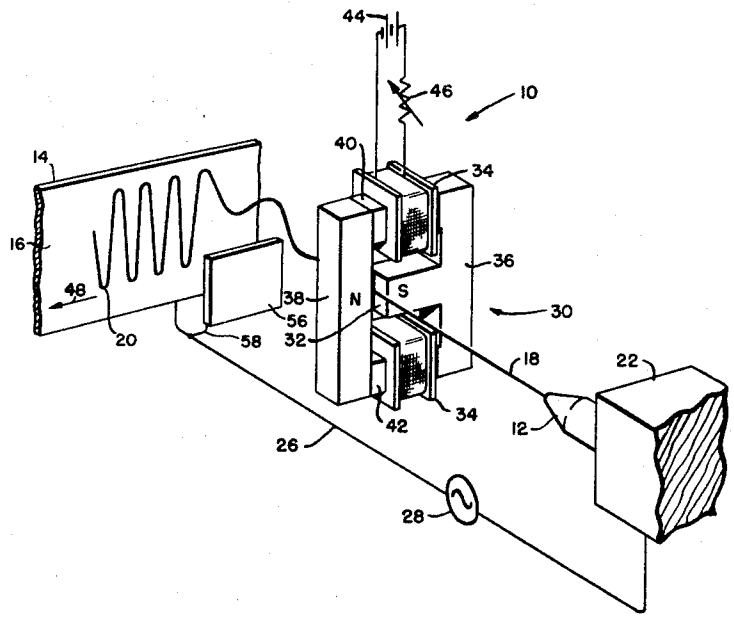
ABSTRACT: An uninterrupted stream or continuous liquid bridge of an electrically conductive ink is propelled under pressure against a carrier for marking thereon. Symbol formation is effected through the agency of magnetic deflection resulting from interaction of a pair of magnetic flux fields of relative variable intensities. A first of the flux fields is induced about the ink stream by passing a current through it as it travels across the span between the nozzle from which it has been ejected to the carrier; and the second field is disposed about the first. In a preferred embodiment, the ink is an electrical conductor, being a metal or metallic composition with a melting point, such that it will flow at printing temperature but will solidify as it contacts the carrier. By providing an impervious or imperforate endless carrier, for example, of metal fabrication a formed symbol may be removed therefrom to enable reuse of the carrier and metal salvage.



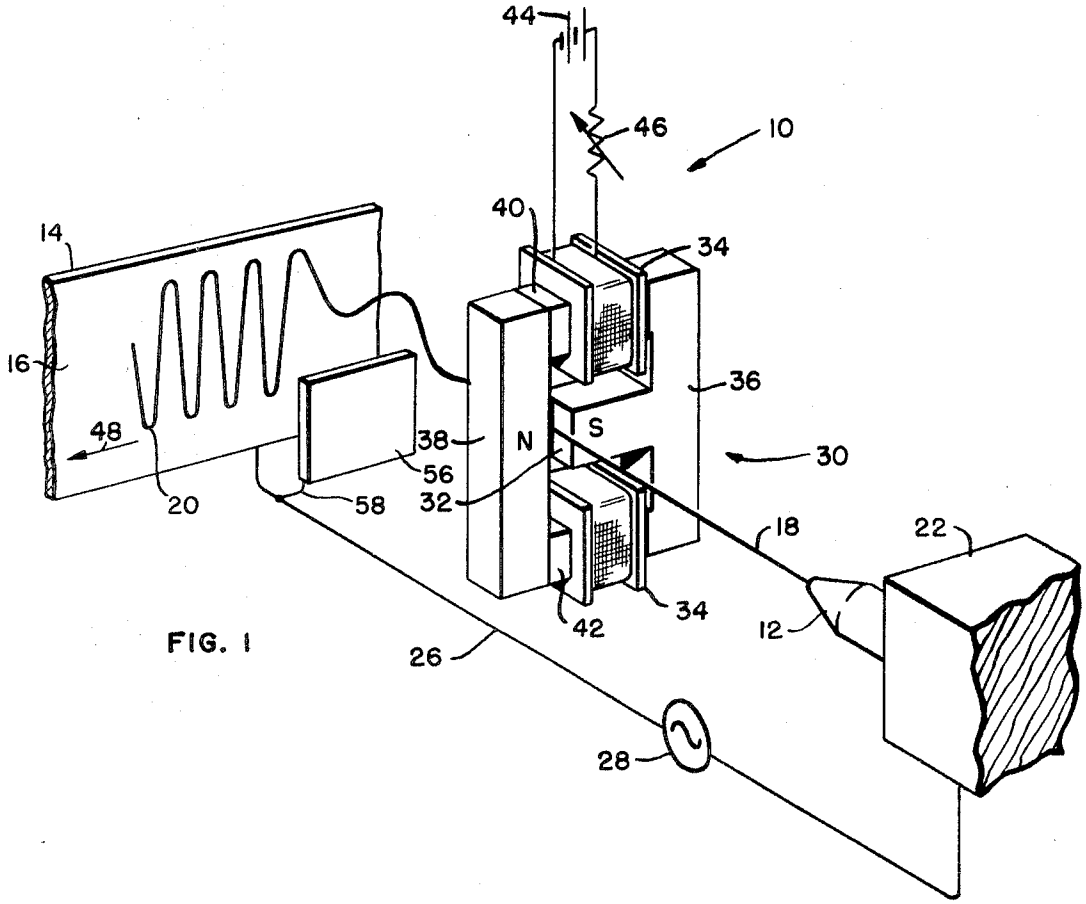


FIG. 1

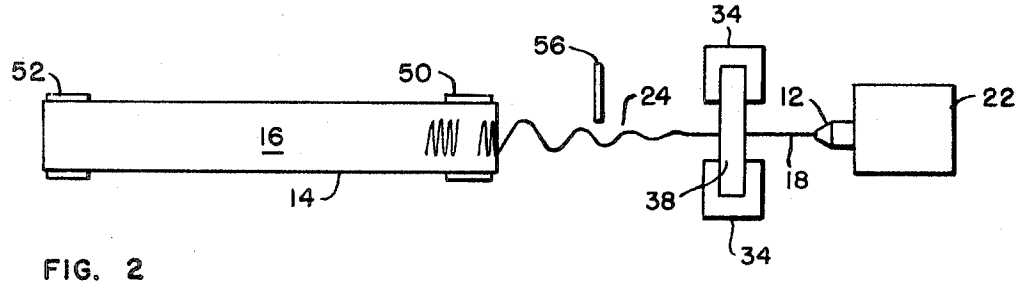


FIG. 2

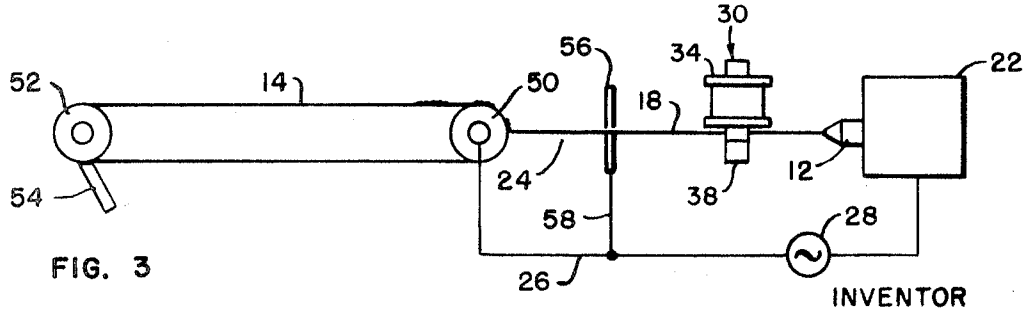


FIG. 3

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LIQUID METAL RECORDER

BACKGROUND OF THE INVENTION

The present invention relates to printing and the like with an ink stream controlled by an electrical phenomenon and moved across a span from a source onto a target surface of a carrier.

Heretofore known processes of the indicated type, fall into two classes in most of which a printing stream comprises a succession of drops. In one class, formation of a symbol character or pattern comprising a display is effected by electrostatic stream deflection. In the other, stream deflection for character or pattern formation is by electromagnetic means. The present invention is concerned only with the latter class.

While the art of printing with a stream according to heretofore known processes and using heretofore known means enables production of hundreds of lines of acceptable characters per minute, control of the path of individual drops in a succession by presently known technology falls short of an optimum level. In consequence printing of characters with fine or distinct outlines has not been uniformly obtainable. Moreover, sophisticated and expensive equipment is required for drop management to obtain even present levels of character definition.

The problems of stream control are minimized in a conventional process by spacing a drop supply source and a carrier apart only s short distance. In practice such distance does not generally exceed a quarter inch. Such spacing places a limit on the size of a display which cam be made efficiently using heretofore known processes of the indicated type.

It is an object of the present invention to print with a clear outline by a process in which a stream of ink is electromagnetically controlled for forming intelligence on a carrier.

It is another object of the invention to increase the size of characters and the like which can be generated in an economically practical process of the indicated type over the maximum size available using heretofore known apparatus. Thereby, large displays of the type used, for example, for providing a continuous record of market transactions, such as are exhibited in a board room of a stockbroker's office, can be produced continuously.

But in terms of material requirements for such large and continuous displays, if consumed at theretofore known rates, but increased in proportion to increase in size, the high cost would severely limit any widespread enjoyment of a process or apparatus satisfying the foregoing objects.

It is therefore an additional object of the invention to minimize use to materials in a process of the indicated class.

It is a further object of the invention that materials employed in such process be salvaged for reuse.

SUMMARY OF THE INVENTION

To achieve the foregoing, and other objects which will become apparent from ensuing description, and in accordance with the invention, in one aspect, an electrically conductive liquid ink in a bridge is caused to flow between a source and a carrier across a span in a process for printing. The bridge is electromagnetically deflected while the ink is flowing to form an intelligence symbol on the carrier. To effect the process, means are provided for completing an electrically conductive circuit through the ink stream and between a nozzle from which the ink is projected and the carrier.

According to another aspect of the invention, a combination for writing and the like comprises a carrier for displaying an intelligence pattern and an arrangement for removing the pattern from the carrier. An electrically conductive marking stream has an end impinged on the carrier. An induced magnetic field is disposed about the stream; and means are provided for electromagnetically changing the position of stream impingement on said carrier for printing the pattern.

DESCRIPTION OF THE DRAWINGS

In the ensuring detailed description of the invention, reference is had to the accompanying drawings wherein:

FIG. 1 is a schematic in perspective of a magnetic deflection apparatus embodying certain features of the invention.

FIG. 2 is a top plan view of the apparatus in scheme form.

FIG. 3 is a side elevational view of the apparatus in scheme form.

DETAILED DESCRIPTION OF THE INVENTION

Referring now more particularly to the drawings, printing apparatus generally designated **10** comprises a jet or stream forming head or nozzle **12** and a carrier **14** spaced from said nozzle by a span **24**. A surface **16** defines the carrier. It is aligned with the nozzle for blocking the path of a bridge or stream **18** of an ink from the nozzle to the end that it will be marked with an intelligence symbol, character or patter **20** at a printing station. In the preferred embodiment, the carrier is endless and is arranged for continuous movement past the station, for example, in the direction of arrow **48**.

As used herein the term "printing" is not intended in a limited sense but includes writing or other symbol, character or pattern formation with an ink. The term "ink" as used in is intended to include not only dye or pigment-containing materials, but any flowable substance or composition suited for application to surface **16** for forming symbols, characters, or patterns of intelligence by marking.

Means for supplying ink under pressure comprises a reservoir **22** in fluid communication with nozzle **12**. The arrangement is such that ink will move from the nozzle **12** with sufficient force to impel it as across span **24** in a continuous uninterrupted liquid stream for impingement on said carrier for printing.

Nozzle **12** as well as carrier **14** are electrical conductors. In the illustrated embodiment the carrier is of impervious steel fabrication, its surface **16** being a black oxide of the type formed by anodization. Ink for stream **18** also is a conductor and, while it is flowing in a course or path across pan **24** for intelligence formation on carrier **16**, it comprises an electrically conductive bridge in a circuit completed by means, herein shown as a conductor **26**, and electrically connecting the nozzle and the carrier.

An alternating current generator **28** is shown arranged in series with conductor **26** and comprises means for providing an induced magnetic field about stream **18**. In the illustrated embodiment, a magnet **30** is arranged for providing a magnetic flux or second field about the stream. These fields are coacting or interacting and comprise means for deflecting the bridge or stream of ink **18**, the deflection being effected by coupling the induced magnetic field with the second magnetic field and varying their relative intensities.

To that end the magnet has a gap **32** arranged and proportioned for passing the stream **18**. Moreover, said magnet, as shown, is an electromagnet comprised of "E" laminations or core member **36** and "I" laminations or core member **38**, both of which may be conventional. A pair of series connected coils **34** are disposed about opposed legs **40** and **42** of member **36**. The coils are energized by means, such as a battery **44**, for inducing a fixed polarity in the magnetizable material of the core members. The arrangement is such that a pair of magnetic flux paths will be induced in said core members, polarized with north and south magnetic poles disposed, as shown in FIG. 1 by conventional designations "N" and "S", on opposite sides of gap **32**. The illustrated fixed polar arrangement may be reversed with equanimity.

If desired, the illustrated magnet may be replaced by a permanent magnet (not shown). However, the electromagnetic form may be preferred as it enables the intensity of its magnetic flux field to be varied by varying the direct current in its circuit through the agency of a variable resistence **46**, to produce stream deflection proportional to the instantaneous

current. On the other hand, if the intensity of the magnetic flux field of magnet **30** is fixed, the relative strengths of the interacting fields for effecting stream deflection will be adjusted by adjusting the level of current output of generator **28** in any well-known manner.

The preferred ink is characterized by viscosity and surface tension characteristics such that liquid continuity will be maintained over span **24** under the force with which it is moving in bridge or stream **18**. Implicit in such requirement is that the pressure applied to the ink in formation of said stream is sufficient to form a jet and to impart enough energy to carry the jet as a continuous liquid mass to surface **16** notwithstanding the deflective forces which are or may be applied. Furthermore, the color of the ink and the color of the carrier should be such that good optical contrast is formed therebetween following printing.

The preferred ink is of a "hot melt" type. That is to say, it will assume a solid phase at the temperature of carrier **14** and a liquid phase at some higher temperature. For most anticipated practical situations the melting point of the ink likely will not be above a level which can be tolerated normally by the human body; and the ink likely will be solid at room temperature, this being the temperature at which the carrier is expected to be employed for most operations.

The range of commercially available ink compositions which could meet the requirements of the invention are not known at the present time. However, satisfactory printing according to the invention has been achieved with a conductive metal alloy as ink. It is extremely hard at room temperature and adheres well to the surface of the carrier. Constituents, proportions, and melting points of the ink are set forth in the following chart:

Constituents	Bismuth	50 percent
	Lead	26.7 percent
	Tin	13.3 percent
	Cadmium	10 percent
Melting point		158° F.

A jet stream of ink can be formed from a nozzle having an inside diameter of 0.003 inch with sufficient force to travel, undeflected, and in liquid continuity a distance of 3 feet, by applying 60 pounds of pressure per square inch to said alloy in a liquid phase in reservoir **22**. Effective printing has been achieved on a carrier of exemplary fabrication and 1 inch wide over a span **24** of 7.8 inches from a nozzle of such dimension. DC current providing a flux density of 4,200 Gauss across gap **32**, of 0.04 inch is adequate to deflect stream **18** from such nozzle with a generator **28** having a peak of three volts at 150 cycles per second.

While the disclosed arrangement is adapted for marking a continuous trace on surface **16**, separated characters or symbols also can be produced. To assist in such character formation masking means exemplified by shield **56** can be mounted at or adjacent the stream path at an intermediate position along span **24**. To maintain required electrical continuity, the shield is electrically connected to carrier **14** by conductor means **58**. By appropriate current control stream **18** selectively then can be deflected onto shield **24** for effectively blocking stream flow to the carrier.

For management of carrier **14**, it may be entrained about a driven roller **50** and a drive roller **52** which is spaced horizontally from the driven roller. Character removing means may comprise a blade or scraper **54** arranged in a fixed position spaced from the printing station such that its inner end is disposed at or adjacent surface **16** for removing the metallic characters or pattern **20**. The solid ink thus removed conveniently may be collected and reused by returning same to the reservoir which is adapted to be maintained at a temperature sufficiently high to melt the material and assure it s retention in a liquid phase as it passes across span **24** during a printing process.

I claim:

1. In a system for recording discernible patterns:
a carrier formed in a closed loop of material of a first color;
means for advancing said color;
means for impelling a stream of marking material in a color contrasting with said first color toward said carrier, said marking material characterized by the ability to adhere to said carrier;
means for diverting said stream to form discernible pattern on said carrier; and
means positioned along the path of travel of said carrier for removing said pattern.

2. In a system according to claim **1**, wherein said carrier is constructed of a first metal, and said stream of marking material comprises a molten second metal.

3. In a system for displaying intelligence patterns;
a conductive recording medium;
means for directing a stream of electrically conductive material of a color contrasting with the color of said recording medium toward said recording medium toward a point of impingement;
means for supplying a variable electric current indicative of intelligence through said stream and said recording medium to induce a varying magnetic field about said stream,
means reacting with the induced magnetic field about said stream for diverting said point of impingement of said stream on said recording medium to form intelligence patterns on said medium;
means for advancing said recording medium along a path relative to the point of impingement of said stream; and
means cooperating with the moving recording medium for removing the intelligence pattern from said medium.

4. In a system according to claim **3** wherein said recording medium is constructed of metal and said stream of electrically conductive material comprises molten metal.

5. An apparatus for generating a pattern of intelligence symbols which comprises:
a reservoir for receiving an electrically conducting liquid medium;
a nozzle connected to said reservoir in communication with said medium in said reservoir;
means for projecting a liquid stream of said medium in electric continuity from said nozzle;
an endless carrier of conductive and impervious material mounted for movement in a cyclic path in interceptive relation with said projected stream of conductive medium to receive an impingement of said stream on said carrier at a point of interception of said stream with said cyclic path of said carrier and to complete a conductive path from said nozzle through said stream to said carrier;
means for passing an electric current from said nozzle, through said stream to said carrier to establish a first magnetic field about said stream;
means reacting with the first magnetic field for magnetically deflecting said stream of conductive medium to vary the position of said point of interception of said stream on said carrier and to generate a pattern of intelligence symbols from said carrier; and
means mounted adjacent to said endless carrier for removing said pattern of intelligence symbols from said carrier to render said carrier ready to again accept information at the point of impingement of said stream on said carrier.

6. An apparatus as defined in claim **5** wherein said removing means comprises a scraper for physically engaging and removing the pattern from said carrier.

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(5/69)

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,596,285 Dated July 27, 1971

Inventor(s) JOHANNES F. GOTTWALD

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 1, change "ensuring" to --ensuing--.

Column 4, line 9, change "color" to --carrier--.

Column 4, line 14, change "pattern" to --patterns--.

Signed and sealed this 8th day of August 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

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