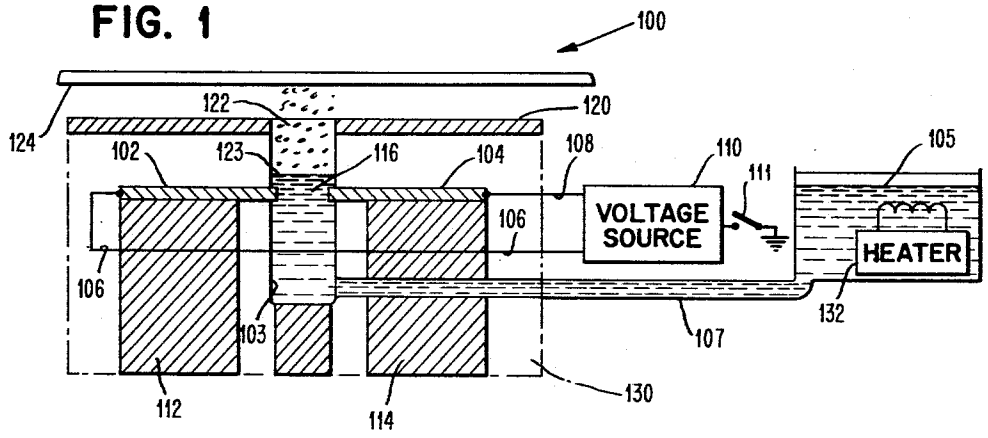
April 20, 1965 M. NAIMAN 3,179,042

SUDDEN STEAM PRINTER

Filed June 28, 1962

FIG. 1



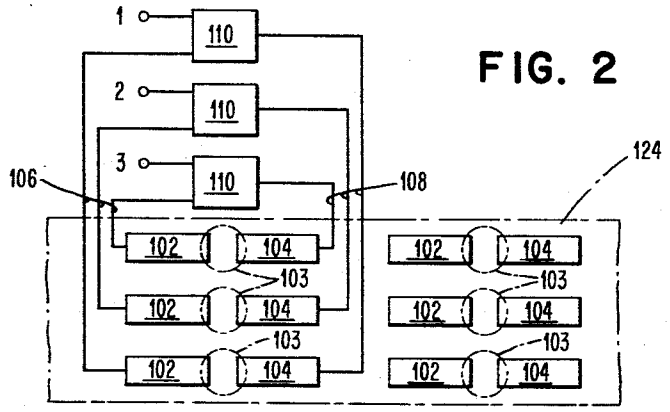
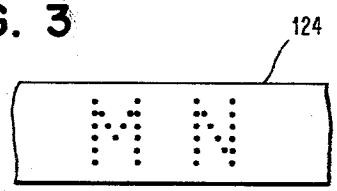


FIG. 2

FIG. 3



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SUDDEN STEAM PRINTER

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This invention relates to printing devices and more particularly to that type of printing device wherein there is no direct contact between a moving print means and the surface upon which the printing is placed.

Despite the advances in computer technology, such as making the arithmetic and other internal organs of the computer faster in operation, the computing systems as a whole have not increased greatly in speed of operation. This lack of overall speed increase is due to a large measure to the relatively low speeds of operation possible with conventional and so-called high-speed types of printing means used to provide a printed record of the computer output information. These printing devices, when compared to the speed of operation of the computer elements themselves, require relatively long period of time for selection of the character to be printed, movement of the character to contact a surface or the surface to contact the character and return to the normal intermediary condition. For example, if the printing device were a band printer, time would be required to move the band to a position wherein the character was in proper alignment for printing. Then more time would be consumed in moving the band to contact the paper or move the paper to contact the band and then allow the moving member to return to its normal intermediary condition, ready for the next print operation. In those types of systems in which the printing member is in constant motion, a period of time is required to allow the print member to move in its cycle sufficiently to permit the desired character to be presented to the surface to be printed upon. The time required for movement to permit contact and the return to a normal condition will be similar to that of the band printer described above. Further, due to the fact that the paper is permitted to move, during the print operation, usually in a direction transverse to the direction of movement of the print mechanism the special positioning techniques are required to prevent the individual characters from "walking" up or down the surface as a row across the width of the surface is printed.

Also, due to the use of light weight bands to support or carry the desired printing characters, care must be taken to provide proper back-up for the bands regardless of whether they are moved or merely struck by a moving paper depending upon the type of band printer employed.

Thus, it is obvious that if it were possible to reduce the time required to position a character or allow it to rotate until the proper character was presented as well as the time required to move the character or paper the overall speed of operation of the print apparatus and in turn, that of the computational system would be greatly increased.

As briefly stated, this invention makes possible a system of printing whereby many of the steps required in printing by known conventional printing devices are eliminated thereby increasing the overall speed of operation. These steps are:

(1) Positioning of the print member whether by direct movement or by allowing it to rotate until the correct character position is reached.

(2) Contact between character and paper whether the print member is moved to contact the surface or the surface is moved to contact the print member; and

(3) Reset or return of the print member to its neutral or normal position.

The invention employs a matrix composed of individual print means each of which may print an individual dot. By proper selection of the location and number of these dots, there will be printed a particular character or letter in discontinuous form upon the printing surface. The density of the dots making up the letter or character may be as great as desired simply by arranging for a larger or smaller matrix. Each of the individual print means which produces a single dot is made in the form of an individual ink steam generator which upon proper excitation will cause a droplet of ink to be deposited upon the surface of the paper. The individual ink steam generating devices consist of a pair of electrodes which are emersed in an ink so as to produce a high I^2R loss, that is a high power loss. Upon the application of a voltage to these electrodes a current will be passed through the ink contained between said electrodes causing the generation of heat which in turn will vaporize that portion of the ink contained between the electrode tips, which vapor will tend to expand exerting a sufficient pressure upon the ink directly above it, to force individual droplets of ink from the tube to the surface of the material to be printed upon. The droplets being guided and confined to an area of the material as determined by the size and shape of the tube opening. Each of these actuating devices may in turn be connected to an electronic matrix which can be operated in accordance with the pattern or character which is desired to be printed. Thus there is no direct contact between a moving print member and the surface to be printed upon as in conventional print devices, there is only the indirect type of contact which results from a contact of the printing ink or fluid with the surface to be printed upon.

It is therefore an object of this invention to provide a novel form of print means wherein no direct contact is made between a moving printing device itself and the surface upon which the printing is to be placed.

It is another object of this invention to provide a novel printing device not employing pre-formed characters but rather employing a device wherein a particular form of the character or symbol may be selected at will.

It is another object of this invention to provide a novel printing device the individual unit of which consists of an ink steam generating unit.

It is a further object of this invention to provide a printing device which operates on the principle of steam generation.

It is yet another object to provide a printing system with an increased speed of operation.

It is a further object of this invention to provide a printing device which employs the principles of steam generation to propel the printing ink.

Other objects and features of the invention will be pointed out in the following description and claims and illustrated in the accompanying drawings, which disclose, by way of example, the principle of the invention, and

the best modes which have been contemplated for carrying it out.

In the drawings:

FIGURE 1 illustrates a device constructed in accordance with the basic concept of the invention;

FIGURE 2 shows an arrangement for placing the devices constructed in accordance with FIGURE 1 in a matrix for printing composite letters or symbols;

FIGURE 3 shows the manner in which the tape will appear after it has been printed with a device constructed in accordance with this invention.

Similar elements will receive similar reference characters in all of the respective figures.

Referring to FIGURE 1 there is shown an individual print element constructed in accordance with this invention designated generally as **100**. The device consists of a set of electrodes **102** and **104** connected by means of leads **106** and **108** to a voltage source **110**. The individual electrodes **102** and **104** are supported by a set of nonconducting supports **112** and **114** respectively, and are held in a position so as to provide a small gap **116** between the respective edges of the electrodes **102** and **104**. The ends of the electrodes **102** and **104** are placed within a tube **103** which tube is closed at its lower end. The upper end of the tube **103** is open, forming an aperture **122** which is placed either in direct contact or very close to the surface to be printed upon. The aperture **122** may be of any desired size or shape, however, for purposes of illustration in this example it will be considered to be of circular shape. Ink is supplied to the tube **103** by means of a duct **107** from an ink supply **105**. The characteristics of the ink are such that it can easily pass from the opening **122** of the tube **103**, but due to surface tension does not normally do so except under the influence of an external force. The ink is maintained near its boiling point by means of a heater **132** placed within the ink supply **105**. The ink is kept at this temperature to minimize the requirements of heat which the passage of current from electrodes **104** to **102** must produce in order to convert the ink to steam. This will of course allow the use of a smaller value voltage supply **110**. In a preferred form of the device the ink must have a high resistance to current flow, thus causing the generation of a great deal of heat to permit the gas expansions as set out above. An ink which has a water or solvent base will provide such a desired property. Alternatively a lower resistance ink may be used with a high current value to produce the required I^2R loss. Placed above the aperture and parallel to it is the surface of the material to be printed upon **124**.

In operation, when it is desired to print an individual spot by means of the ink steam printing device it is first necessary to operate the voltage source **110** by closing the switch **111** to apply via the lines **106** and **108** a voltage to the electrodes **102** and **104**. In completing the open circuit between the electrodes **104** and **102** through the gap **116** and the ink contained therein, a great deal of heat will be generated due to the high resistivity of the high I^2R loss of ink as set forth above. This large amount of heat generated due to the characteristics of the ink will cause the ink within the area of the gap **116** to become vaporized, ionized and cause any trapped gases, as well as the gas formed to expand. As a result of this sudden expansion of the gases between the electrodes a great deal of force is exerted upon the ink directly above the level of the electrodes. (The level of the ink in the tube **103** being maintained above the electrode level as shown in FIGURE 1 by the level identified as **123**). This ink is thus propelled out of the open aperture of the tube in the form of individual droplets. Because of the restricted area of the material **124** close to the aperture the droplets are concentrated and thus produce a well-defined spot.

Referring now to FIGURE 2 there is shown a top view of a matrix employing a plurality of the steam generating devices as shown in FIGURE 1. As can be seen from the figure the electrode pairs **102** and **104** are arranged in a path along the width and the length of the printing area. Each of the individual pairs of electrodes **102** and **104** are connected by their respective leads **106** and **108** to a voltage source **110**. Each voltage source in turn is connected by a lead to a terminal designated **1**, **2** or **3**. Thus, if the terminal **3** were actuated the voltage source **110** connected thereto would apply to the respective lines **106** and **108** voltages which in turn would attempt to pass a current through the gap **116** of the top left-most pair of electrodes **102** and **104**. In the manner described above at a drop of ink would be printed upon the surface of a tape or paper placed above the arrangement shown. Further, if all three terminals **1**, **2** and **3** were actuated at the same time, it would be possible to get a character similar to the character **1** appearing across the width of the tape composed of three individual dots. If this matrix shown, were extended to include all the remaining electrode pairs it would be possible to have a character generated, upon operation of the proper terminals, which extended in both dimensions, that is along the length and width of the printing area. The terminals of the printing matrix may in turn be connected to switches **111** such as shown in FIGURE 1, to a keyboard, or encoder or selection matrix. A matrix which may be employed with the printer of the invention can be found in High-Speed Computing Devices by the staff of Engineering Research Associates, Inc. and published by the McGraw-Hill Book Company, Inc. (1950) at page 43.

Although the arrangement shown in FIGURE 2 consists of a small number of ink steam generating units it should be understood that the number may be increased in either direction to provide as large a character as is desired as well as to provide a character composed of as many dots along each dimension as is desired.

Referring now to FIGURE 3, there is shown a portion of a surface **124** which has been printed by devices arranged in accordance with this invention and in a matrix arrangement similar to that shown in FIGURE 2.

While a relatively small matrix of printing elements has been shown in the respective FIGURE 2, larger matrixes may be constructed or a plurality of these matrixes may be employed without departing from the inventive concepts disclosed herein. It will be understood that various omissions and substitutions and changes of the form and detail of the device illustrated in its operation may be made by those skilled in the art, without departing from the spirit of the invention.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. Printing means of the type wherein no force is exerted between a character forming means and the surface to be printed upon comprising: a plurality of ink tubes placed adjacent and perpendicular to said surface to be printed upon, said tubes being sealed at one end and open at the end adjacent said surface; an ink supply, said ink being capable of passing current, and having a high I^2R loss, where I^2 is the square of the current and R is the resistance of the ink to current flow; connecting means connecting said ink supply to said ink tubes for filling said ink tubes with ink to a predetermined level; a plurality of electrical means, each of said electrical means being mounted in a separate one of said ink tubes below the surface of said ink level in said tubes and operable to cause a portion of the ink in its associated tube to be vaporized; means having a plurality of apertures mounted intermediate said ink tubes and said surface, each aperture being associated with a single one of said electrical means, to direct and shape the portion of ink vaporized by its associated electrical means to impinge upon said surface; and means adapted to receive selection signals

to selectively operate each of said plurality of electrical means whereby the desired printed characters are produced upon said surface.

2. A printing means as set forth in claim 1 wherein a means is placed in said ink supply to preheat the ink in said ink supply.

3. A printing means as set forth in claim 1 wherein each of said electrical means is a pair of electrodes.

4. A printing means as set forth in claim 3 wherein a means is placed in said ink supply to preheat the ink in said ink supply.

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