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(54) Method and apparatus for thermally marking a record medium.

(57) The apparatus comprises a thermal print head comprising a row of electrodes 22 embedded in a layer 19 of insulating material sandwiched between two blocks 20, 21 which provides a common return conductor for currents from source 26. Each electrode is individually connectable via switches 25 to the source 26. The transfer ribbon 14 comprises a resistive layer 23 which is electrically contacted by both the electrodes 22 and the return conductor 20 and an inking layer 24 which contacts the record sheet 15. In use the head is moved along the ribbon 14 in the direction of the arrow 28 and the switches 25 selectively actuated to cause thermal transfer of ink from the layer 24 to the record sheet 15. The transfer is caused by heat generated in the layer 23 when local currents are established herein between the electrodes 22 and the return conductor 20.

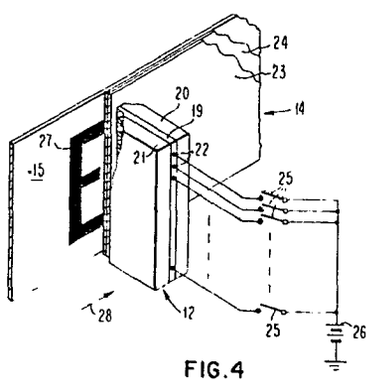

FIG.4

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METHOD AND APPARATUS FOR THERMALLY MARKING A RECORD MEDIUM

The invention relates to non-impact printing apparatus and methods and is more particularly concerned with methods and apparatus for thermally marking a record medium.

Various electrothermic marking or printing apparatus and methods have heretofore been proposed to momentarily heat selected areas of a ribbon for imaging a record medium, such as conventional paper or thermally sensitive paper.

U.S. patent No. 3744611 (Montanari) discloses an electro-thermic printing device in which a transfer medium is interposed between a print head and the record medium. The print head comprises a plurality of L-shaped electrodes the shorter legs of which pass through a slot in a plate, with clearance, and contact the transfer medium. By applying a voltage between selected electrodes and the plate, heating currents can be established in the transfer medium to cause selective marking of the record medium.

Montanari discloses a transfer medium comprising three layers. In a first construction the intermediate layer comprises a flexible insulating substrate coated with a resistive layer on the side facing the print head and with a thermotransferable ink layer on the side facing the record medium e.g. paper. In a second construction the intermediate layer comprises a flexible highly conductive substrate. Montanari states that the conductive substrate is necessary to form areas of high current concentration in order better to define the recording marks.

U.S. Patents 3,989,131 and 3,967,092 disclose a print head having buttons of resistive material deposited at discrete aligned points. The buttons are selectively heated by applying current to selected orthogonally arranged flat conductors supported on an insulated surface of the print head. A somewhat analogous arrangement is disclosed in U.S. Patent 3,855,448 wherein a print head has a series of resistive buttons that are selectively heated to apply heat through a heat-resistant layer to a thermally transferable layer for imaging a record. In apparatus of this type repeated heating of the relatively small buttons on the print heads results in greatly shortened head life because the resistive heating elements or buttons deteriorate quickly as a result of heating and abrasion.

U.S. Patents, 3,719,261 and 3,857,470 and 3,995,729 are illustrative of thermal eletric printing apparatus and methods employing conductive printing ink. For example, U.S. Patent 3,719,261 discloses a printing arrangement employing an endless tape coated with a highly conductive particulate material, such as copper, dispersed in a liquid ink. A plurality of conductor elements are embedded in the tape and arranged in a dot matrix pattern. A plurality of widely spaced electrodes are also provided in a print head and selectively energizable to cause current to flow between selected pairs of electrodes via corresponding selected conductor elements and thereby heat and melt the conductive ink to effect localized transfer of ink to a record medium.

The thermal printers and the methods of thermal printing known heretofore have had disadvantages and wide-spread every day usage has not occured for one reason or another. Thus, none of the prior art arrangements discussed herein has been used commerically to the Applicants knowledge. Accordingly it is an object of the Applicants invention to provide a commercially acceptable method of thermal printing and apparatus for performing that method.

Accordingly the Applicant's invention provides a method of thermally marking a record medium comprising interposing a transfer medium between a print head and the record medium and selectively establishing heating currents in the transfer medium to cause selective transferance of thermally transferable material from the transfer medium to the record medium, said method being characterised by the use in combination of a transfer medium consisting only of a resistive layer in contiguous surface contact with a layer comprising the thermally transferable material, with a print head comprising a group of selectively and individually energisable electrodes and a common return conductor both electrically contacting the resistive layer for heating current flow therebetween solely by way of and through the resistive layer.

The Applicant's invention also provides apparatus for thermally marking a record medium using a transfer medium consisting only of a resistive layer in contiguous surface contact with a layer comprising a thermally transferable material, said apparatus comprising means for supporting a record medium to be marked, a thermal print head disposed at a record marking station, means for supporting the transfer medium with a portion thereof interposed between the print head and a supported record medium and said apparatus being characterised in that the print head comprises a group of electrodes embedded in a layer of insulating material secured to a block of conducting material forming a common return current path for heating currents established, in use, in the resistive layer of the transfer medium between selected electrodes and the common return conductor, and means for selectively establishing heating current flow between individual electrodes and the common conductor.

Brief Description of Drawings

In the accompanying drawings forming a material part of this disclosure:

FIG. 1 is a perspective view of a printing apparatus embodying the invention;

FIG. 2 is a horizontal sectional view, to enlarged scale, through a print head, ribbon and record medium forming part of the apparatus shown in FIG. 1;

FIG. 3 is another horizontal sectional view, also to enlarged scale, of the print head, but in perspective and taken from a different angle; and

FIG. 4 is a fragmentary perspective view, to enlarged scale and from a still different angle, of the components shown in FIG. 2, together with illustrative electrical circuitry schematically indicated therein.

Best Mode for Carrying Out the Invention

The printing apparatus embodying the invention is shown illustratively associated with a typewriter-like printing apparatus 10 comprising a conventional keyboard 11. The keyboard controls, by means of a coding device (not shown) of known type, a print head 12. Print head 12 is mounted in a carriage 13 that is movable transversely of apparatus 10 but parallel to the feed path of a ribbon 14. Print head 12 presses ribbon 14 against a record medium 15 that is backed up by a platen 16. As in conventional typewriters, ribbon 14 is unwound from a supply reel 17 and wound onto a take-up reel 18, and record medium 15 is fed upwardly in a direction at right angles to the directions of movement of ribbon 14 and print head 12.

As best shown in FIGS. 2 and 3 and according to the invention, print head 12 comprises a relatively thin insulating layer 19 that is interposed between and bonded to facing flat surfaces of two rectangular plate-like elements 20, 21. A plurality of printing electrodes 22 are embedded within insulating layer 19 such that the tip ends 22a (FIG. 3) of the electrodes are vertically spaced equal distances apart and exposed through the active end 12a of the print head; i.e., the end which contacts the resistive ribbon 14.

According to a feature of the invention, ribbon 14 consists solely of a resistive layer 23 and a layer 24 of thermally transferable marking material, such as heat fusible ink or the like. The active end 12a of print head 12 presses against resistive layer 23 with a force sufficient to maintain layer 24 in effective contact with the record medium 15 while it is backstopped in contact with platen 16.

Referring now to FIG. 4, the printing electrodes 22 are connected to, and selectively energizable by, any suitable means. For sake of simplified illustration, this energizing means is depicted as a plurality of selectively closable switches 25 (one for each electrode 22) connected to a common voltage source 26.

In operation, upon closure of one of the switches 25 and consequent energization of the corresponding printing electrode 22, current will flow (as shown in FIG. 2) from said electrode via the resistive layer 23 to the common return-path providing element 20. Element 20 is suitably connected by means (not shown) to a reference potential, such as ground. As current flows through layer 23, the I2R effect will cause heating of that portion 23a of the layer 23 that extends from the tip end 22a of the electrode 22 to the adjacent end of the return-path providing element 20. This localized heating of the resistive layer 23 by the current-resistance effect will cause melting of the thermally transferable material in the continguous portion 24a of layer 24 and, thereby, form an image 15a on record medium 15.

By concurrent energization of selected ones of the printing electrodes 22 during movement of print head 12 in the direction of arrow 28 relative to ribbon 14 and record medium 15, a desired pattern, such as 27, can be imprinted on the record medium.

According to important features of the invention, the configuration of print head 12, as above described, permits high resolution imprinting on a record medium by use of a ribbon that consists solely of a resistive

layer that contacts the print head and a thermally transferable layer that contacts the record medium. Also, the printing electrodes 22 are so disposed and embedded in the insulating layer 19 as to be separated from the adjacent flat surface of element 20 by a distance X. This distance X should not exceed the distance between adjacent printing electrodes 22 in order to insure high resolution printing by minimizing the degree of overlap of the respective spot images 15a. This distance X is preferably of the order of about 0.5 mil. The resistivity of the resistive layer 23 of ribbon 14 is preferably of the order of about 0.5 to 1.0 ohm-centimeter. Moreover, elements 20, 21 preferably are bevelled, chamfered or rounded such that they are of minimum width adjacent their respective active ends to minimize abrasion of the ribbon 14.

It should be noted that print head 12 may, if preferred, be used with equal effectiveness with a ribbon consisting solely of a resistive layer (like 23) if the record medium is of the thermally sensitive type.

It will thus be seen that the printing apparatus comprises a print head that provides a return path in close proximity to the printing electrodes so that the current path is short and insures localized heating of the resistive layer. This provides good printing resolution without the necessity of a conductive layer in the ribbon.

While the invention has been particularly shown and described with reference to the preferred embodiments thereof, it will be understood by those skilled in the art that the foregoing and other changes in form and details may be made therein without departing from the spirit, scope and teaching of the invention. Accordingly, the apparatus and method herein disclosed are to be considered merely as illustrative, and the invention is to be limited only as specified in the claims.

CLAIMS

1. A method of thermally marking a record medium (15) comprising interposing a transfer medium (14) between a print head (12) and the record medium (15) and selectively establishing heating currents in the transfer medium to cause selective transferance of thermally transferable material from the transfer medium to the record medium, said method being characterised by the use in combination of a transfer medium (14) consisting only of a resistive layer (23) in contiguous surface contact with a layer (24) comprising the thermally transferable material, with a print head (12) comprising a group of selectively and individually energisable electrodes (22) and a common return conductor (20) both electrically contacting the resistive layer (23) for heating current flow therebetween solely by way of and through the resistive layer.

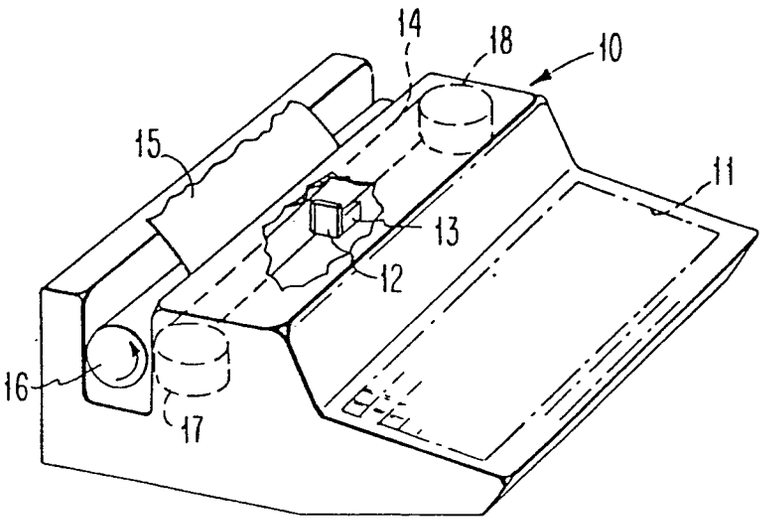
2. A method as claimed in claim 1, further characterised by the use of a print head having the electrodes grouped so that the spacings between adjacent electrodes are similar and each such spacing is substantially equal to or greater than the spacing between each electrode and the common return conductor.

3. Apparatus for thermally marking a record medium (15) using a transfer medium (14) consisting only of a resistive layer (23) in contiguous surface contact with a layer (24) comprising a thermally transferable material, said apparatus comprising means (16) for supporting a record medium (15) to be marked, a thermal print head (12) disposed at a record marking station, means for supporting the transfer medium (17, 18) with a portion thereof interposed between the print head (12) and a supported record medium (15) and said apparatus being characterised in that the print head (12) comprises a group of electrodes (22) embedded in a layer of insulating material (19) secured to a block (20) of conducting material forming a common return current path for heating currents established, in use, in the resistive layer (23) of the transfer medium (14) between selected electrodes (22) and the common return conductor (20), and means (25, 26) for selectively establishing heating current flow between individual electrodes and the common conductor.

4. Apparatus as claimed in claim 3 characterised in that a transfer medium consisting only of a resistive layer in contiguous surface contact with a layer comprising a thermally transferable material is supported by the transfer-medium-support-means with the resistive layer contacting the head electrodes and return conductor so as to establish a current flow path therebetween and with the transferable layer contacting the supported record medium.

5. A method of marking a record medium comprising the steps of providing a transfer medium consisting of a resistive layer and another layer comprising thermally transferable marking material; providing a print head comprising at least one printing electrode, and a return-path-providing element insulatingly disposed in close proximity to each electrode; interposing the transfer medium between the record medium and the print head with the resistive layer adjacent the print head; and selectively energizing said printing electrode(s) to cause current of at least a predetermined magnitude to flow between each selected printing electrode and element solely by way of the resistive layer to generate resistance heating in the resisitive layer and thereby heat the adjacent localized area of said other layer for causing transfer of marking material from the other layer to the record medium.

6. A method of marking a thermally sensitive record medium comprising the steps of providing a transfer medium consisting solely of a resistive layer; providing a print head comprising at least one printing electrode and a return-path-providing element insulatingly disposed in close proximity to each electrode; interposing the transfer medium between the record medium and the print head; and selectively energizing said printing electrode(s) to cause current of at least a predetermined magnitude to flow between each selected printing electrode and element solely by way of the resistive layer to generate resistance heating in the resisitive layer and thereby heat the adjacent localized area of the record medium for thermally sensitizing marking material in the record medium.


14
18
10
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11
13
12
16
17

FIG.1

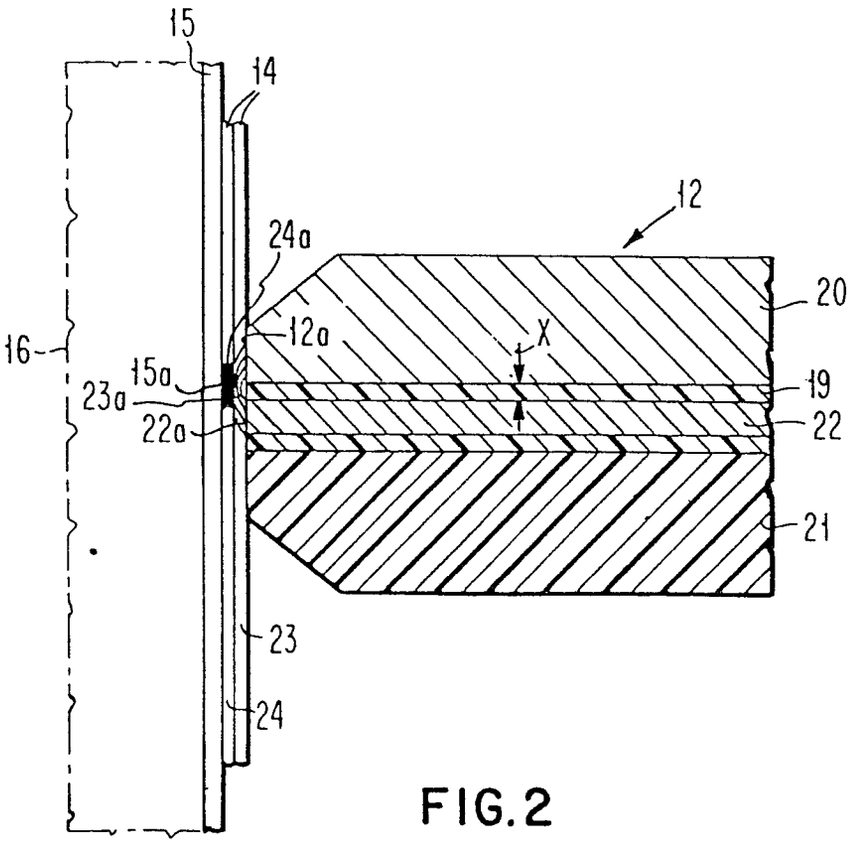
15
14
12
24a
20
12a
X
16
15a
19
23a
22
22a
21
23
24

FIG.2

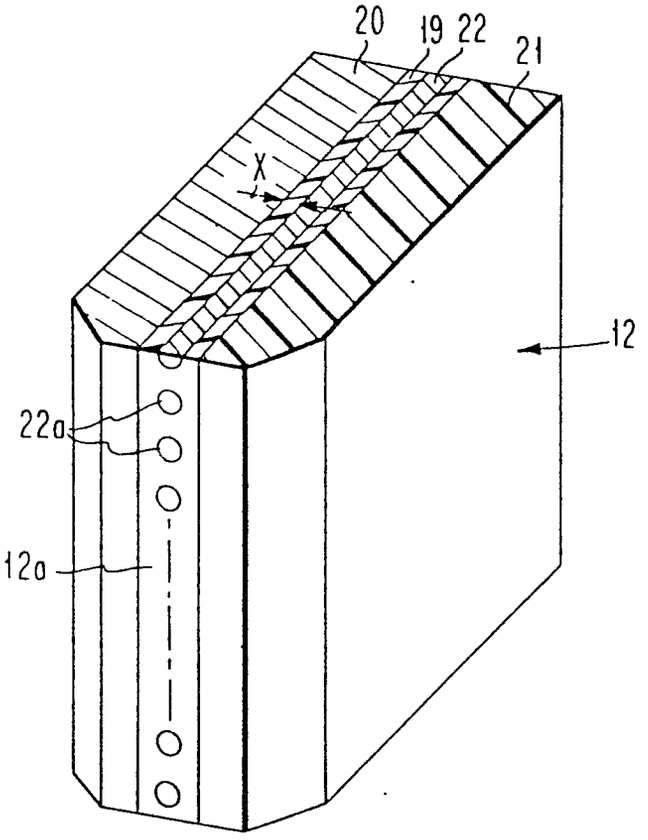

FIG.3

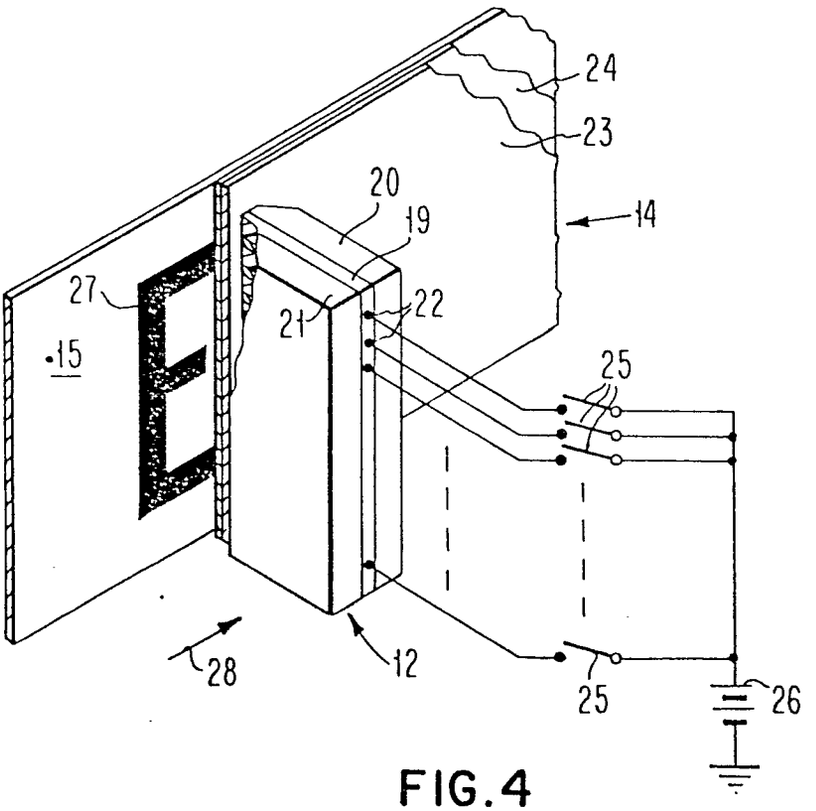

FIG.4