United States Patent

[11] **3,632,969**

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[73] Assignee **Texas Instruments Incorporated**
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[54] **ELECTRONIC PRINTHEAD PROTECTION**
14 Claims, 17 Drawing Figs.

[52] **U.S. Cl.** ..... **219/216,** 346/76 R
[51] **Int. Cl.** **H05b 1/00**
[50] **Field of Search** ..... 219/216, 388, 543; 346/74, 76, 107, 108, 49; 178/30; 101/93 R, 93 C; 197/151, 172; 340/174.1 F; 179/100.2 A

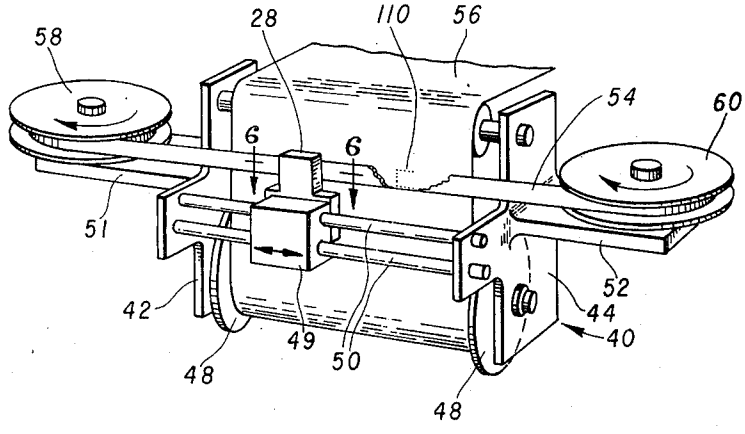
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ABSTRACT: Disclosed herein is a thermal display system including a plurality of very small air-isolated semiconductor mesas or bodies, each of which contains a heater element so that when the heater element is energized a "hot spot" is formed at the top surface of the mesa to provide a localized dot of heat. By interposing a thin, flexible wear-resistant material, such as, for example, a thin paper or high-temperature plastic, between the mesas and a display medium, such as, thermal-sensitive paper, wear on the semiconductor mesas and residue buildup on and between the mesas may be substantially decreased.



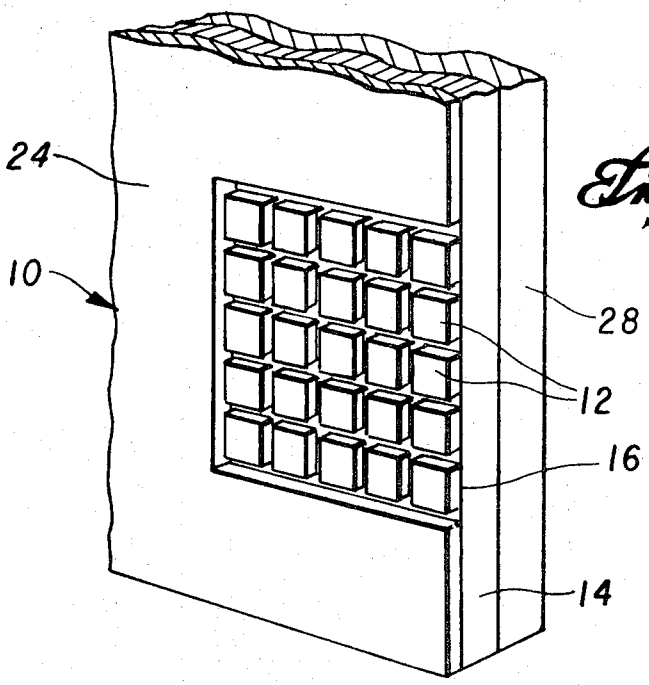


Fig. 1

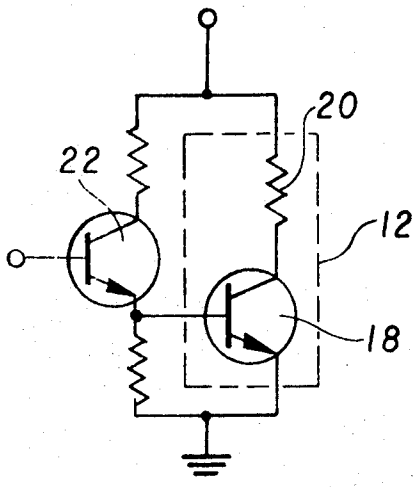


Fig. 2

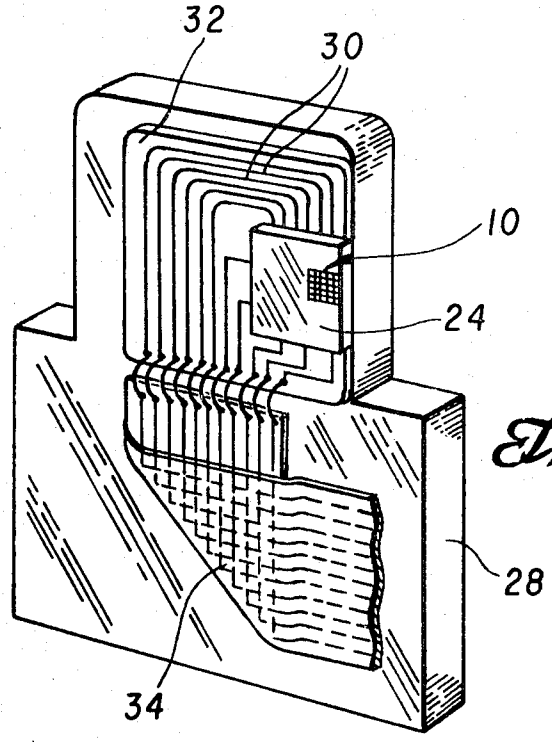


Fig. 3

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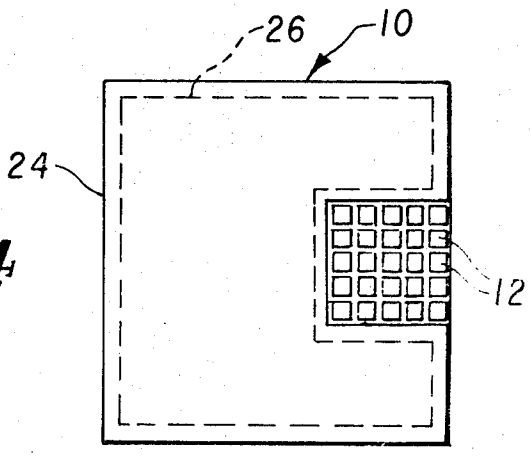


Fig. 4

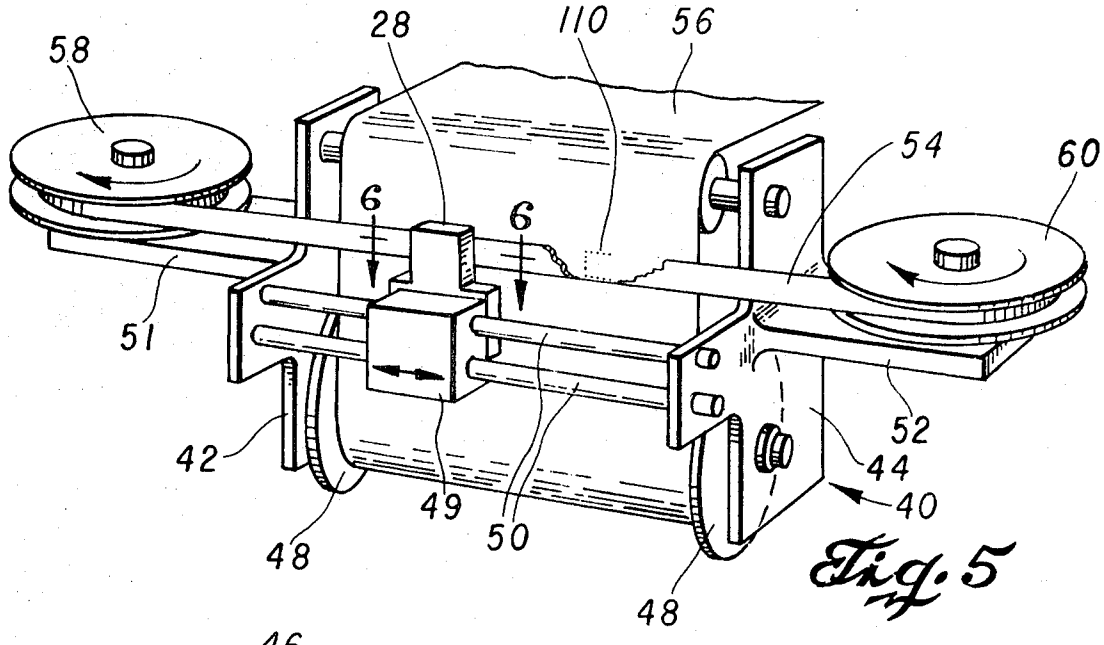


Fig. 5

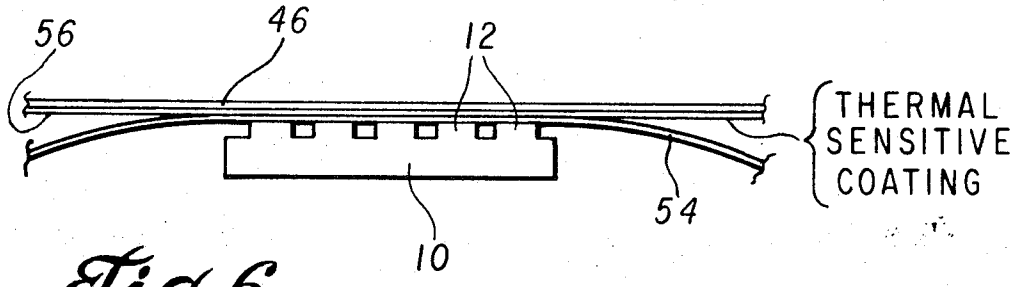


Fig. 6

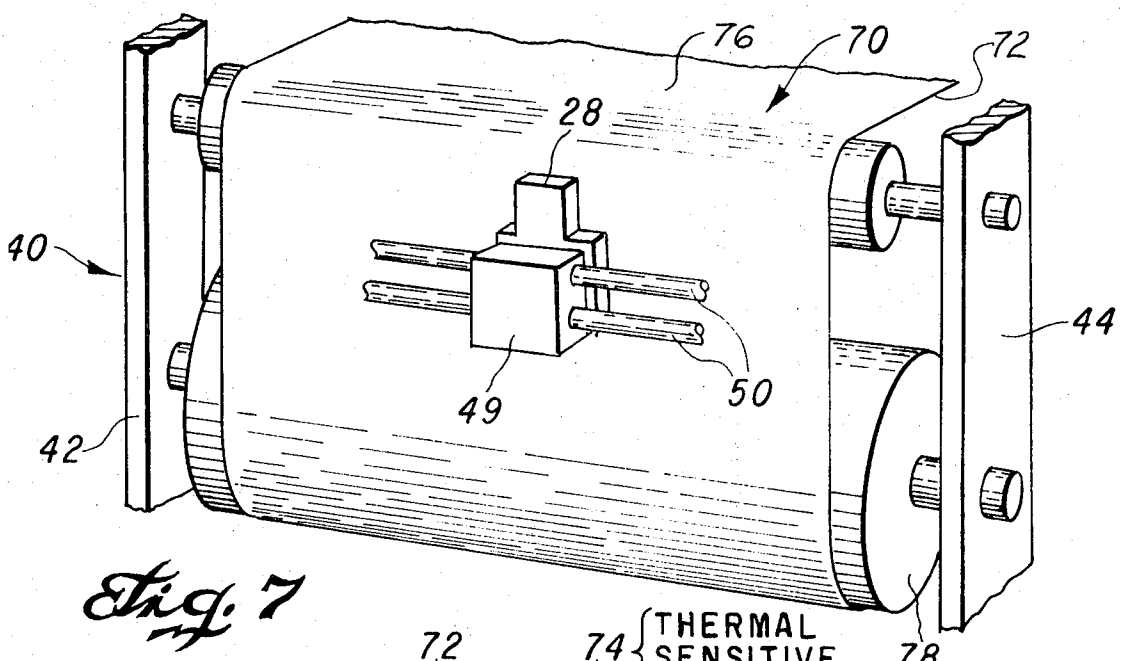


Fig. 7

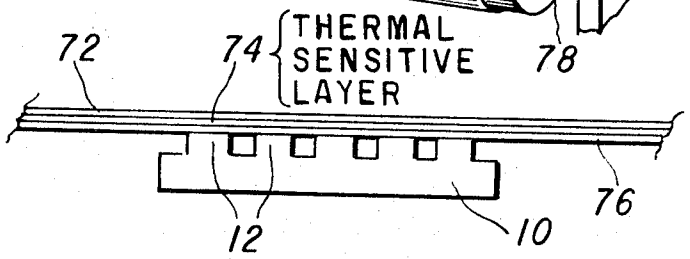


Fig. 8

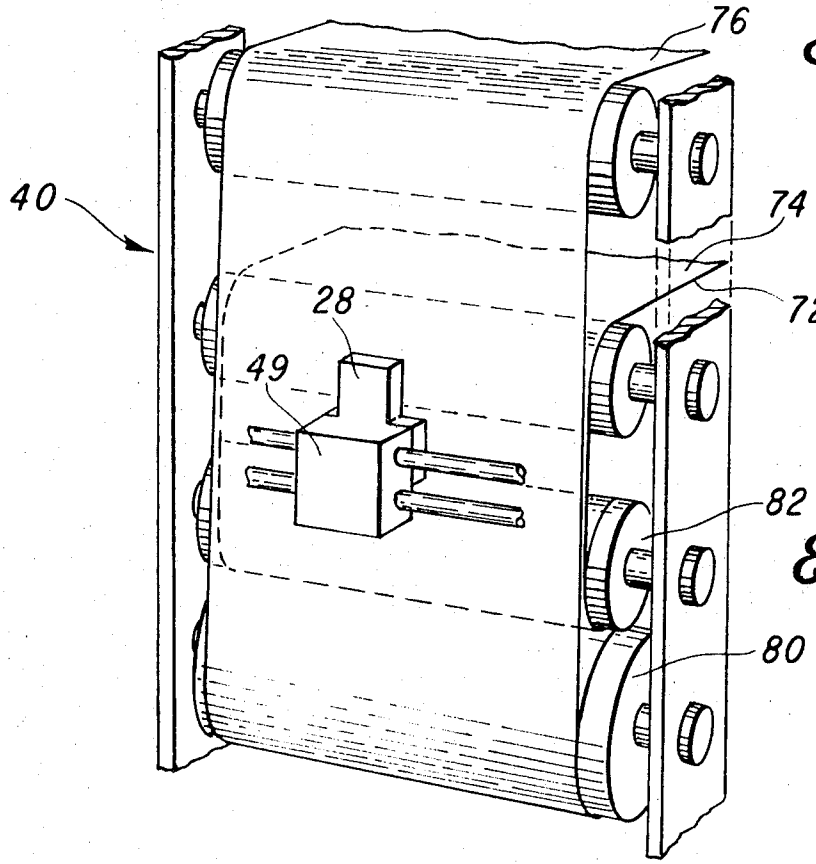


Fig. 9

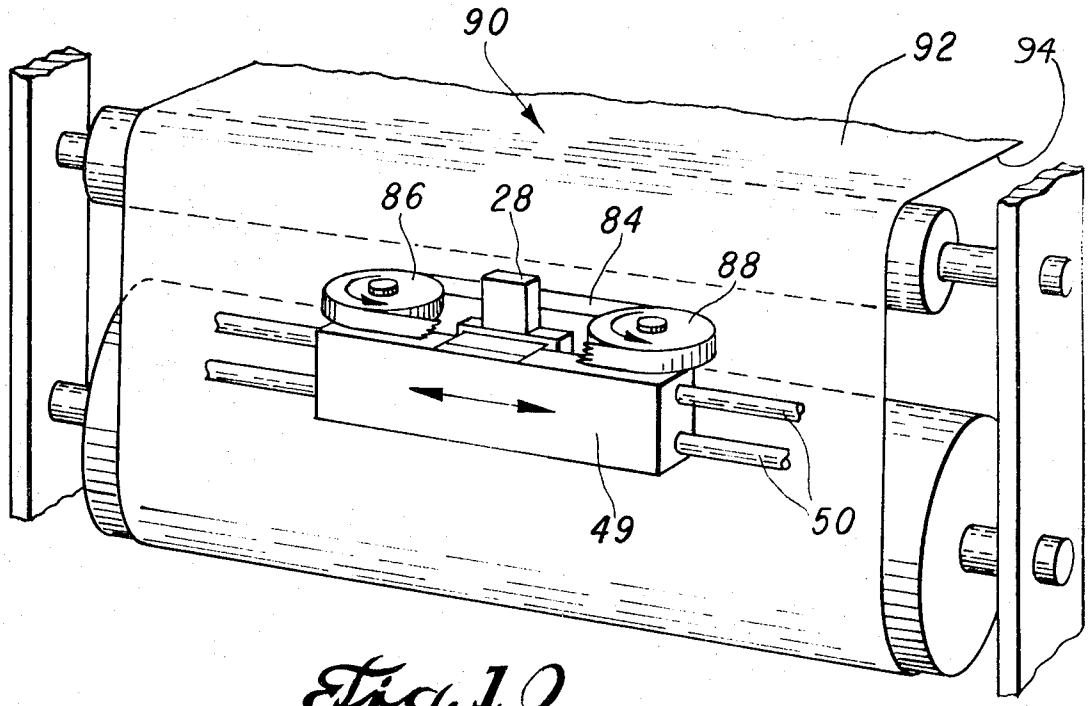

90
92
94
86
28
84
88
49
50

Fig. 10

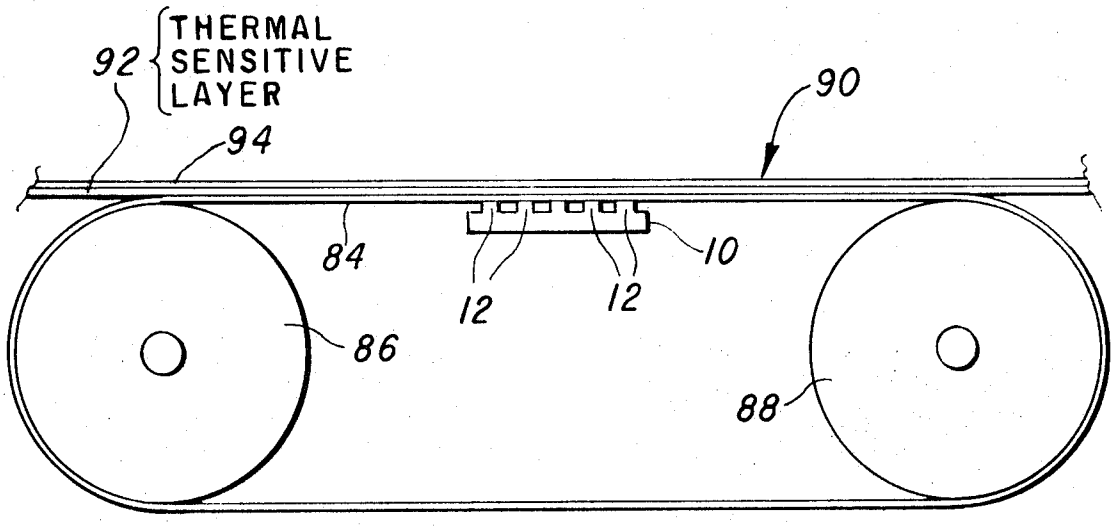

92
THERMAL SENSITIVE LAYER
94
90
84
10
12
12
86
88

Fig. 11

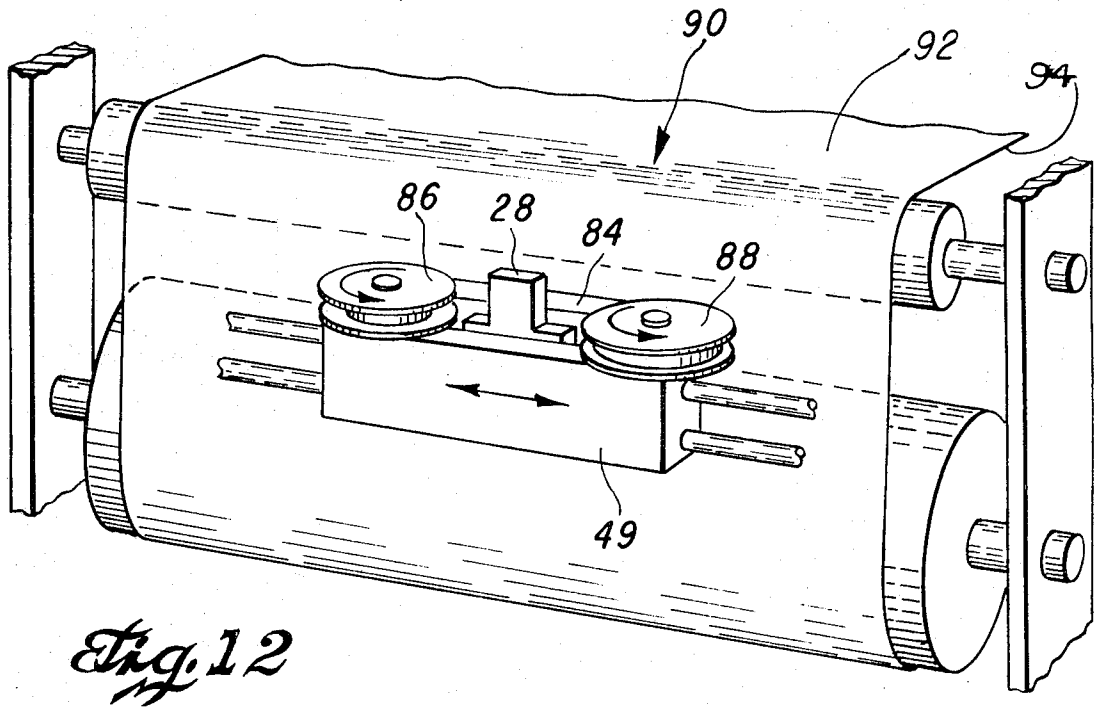

90
92
94
86
28
84
88
49

Fig. 12

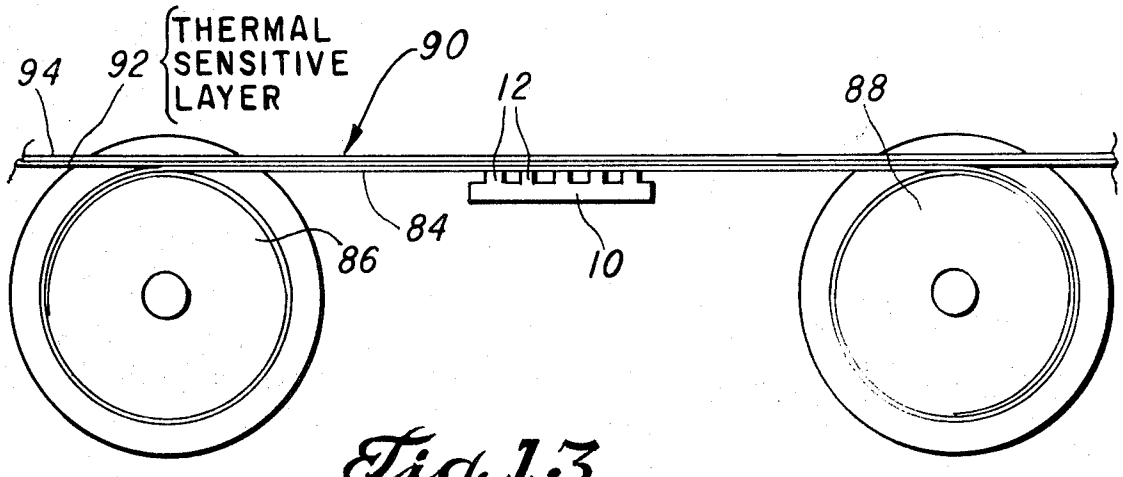

THERMAL SENSITIVE LAYER
94
92
90
12
88
84
86
10

Fig. 13

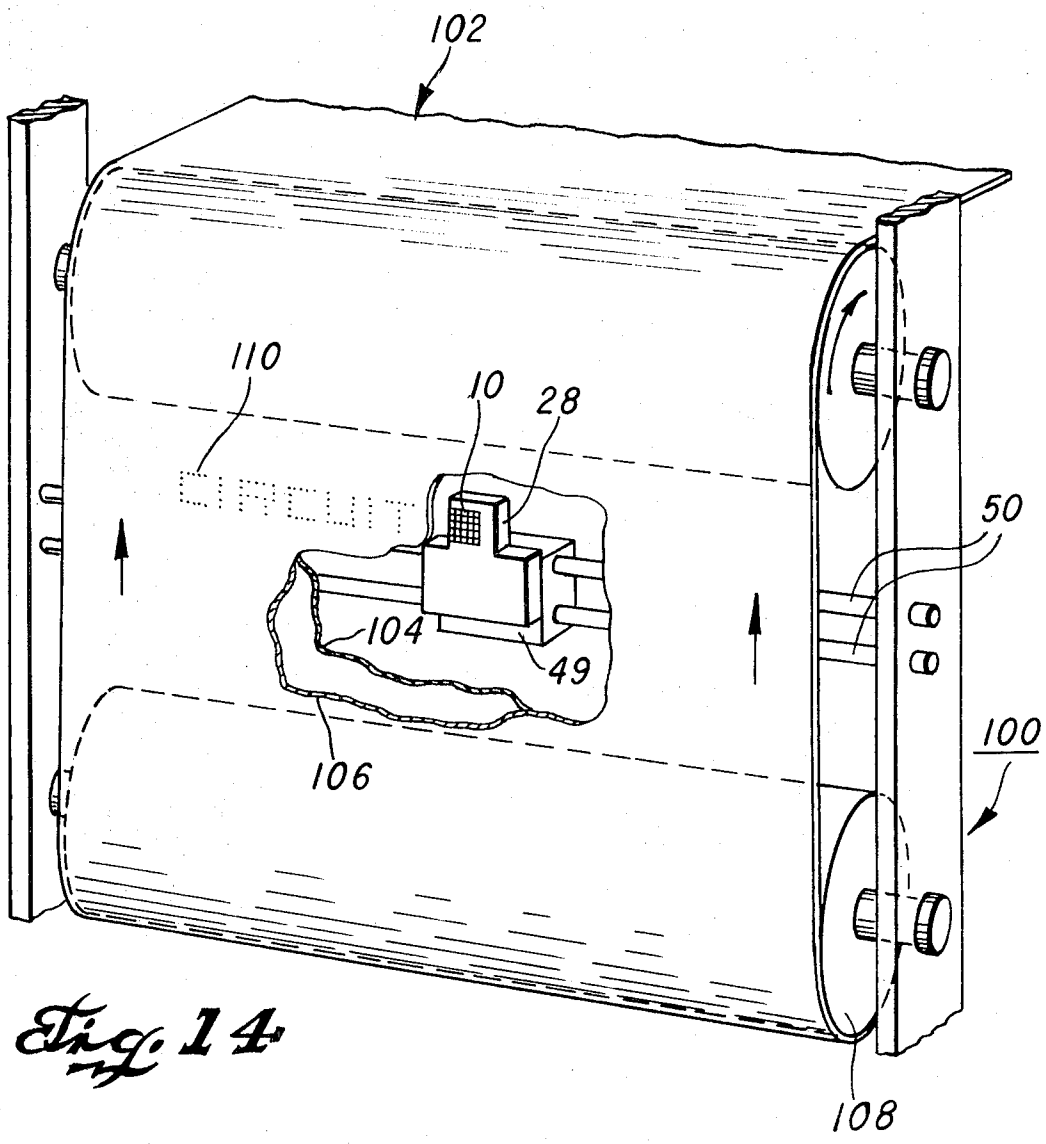

102
110
10
28
CIRCUIT
50
104
49
106
100
108

Fig. 14

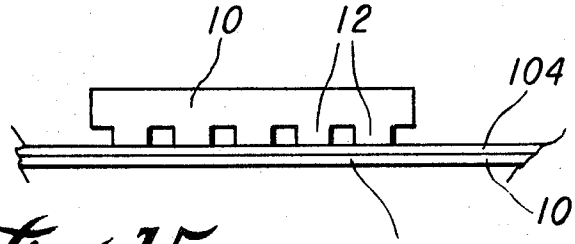

10
12
104
106
THERMAL-SENSITIVE LAYER

Fig. 15

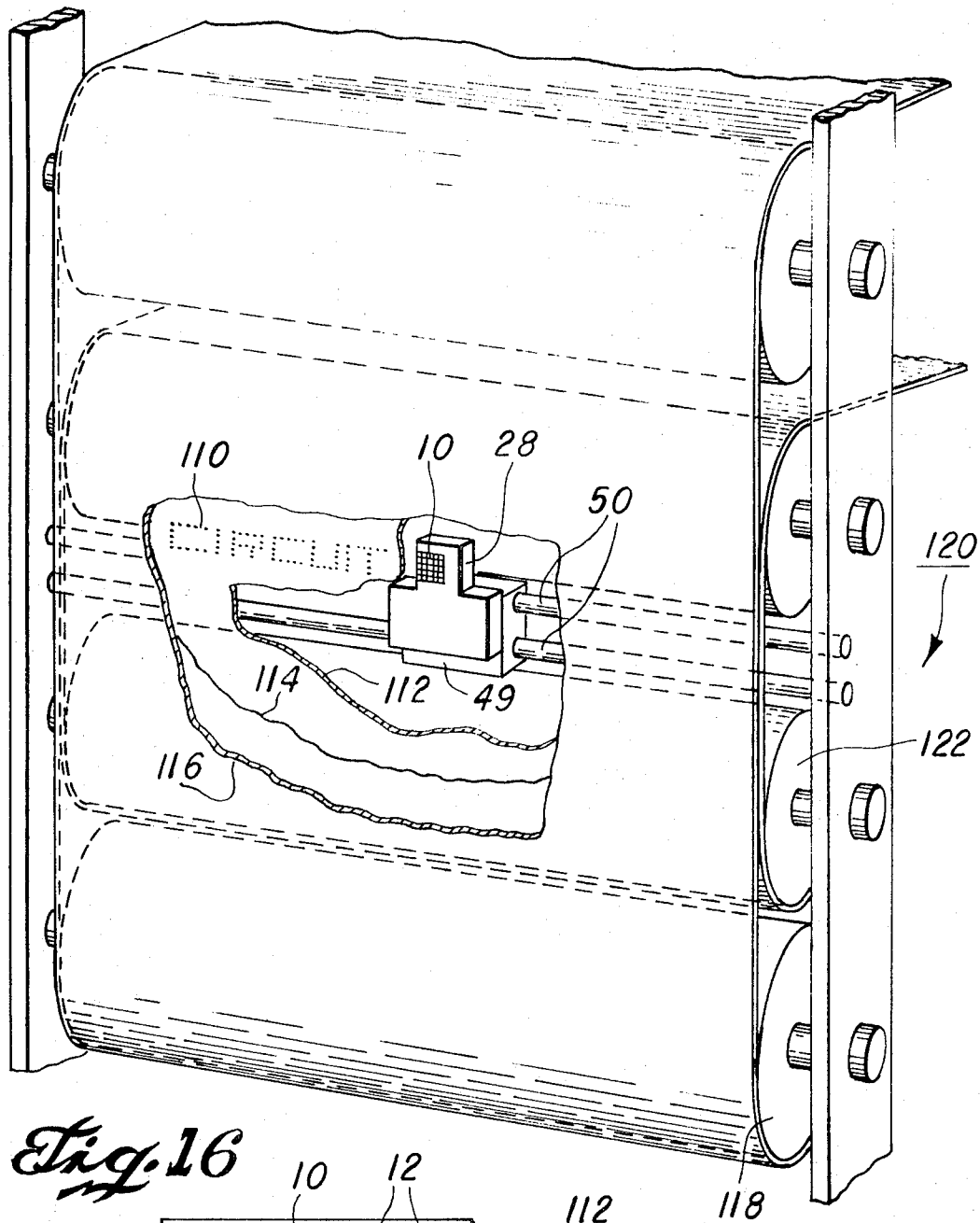

110
10
28
50
120
114
112
49
116
122
118

Fig. 16

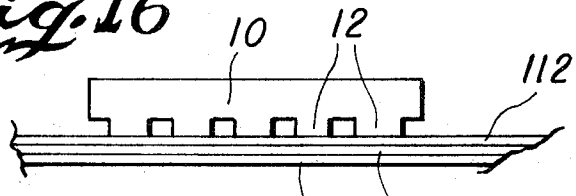

10
12
112
116
114
HEAT TRANSFERABLE COATING

Fig. 17

ELECTRONIC PRINTHEAD PROTECTION

This invention relates generally to electronically controlled thermal display systems, and more particularly to a method and apparatus for decreasing wear and residue buildup in such display systems.

It is known in the art to fabricate an electronic display system comprised of a plurality of very small air-isolated semiconductor mesas or bodies mounted on a ceramic chip by a thermally insulating layer of epoxy. According to one form, each of the mesas includes a diffused resistor in the collector circuit of a diffused transistor. Current through the collector resistor is controlled by a pulse applied to the base of the transistor, thus raising the mesa to an elevated temperature, thereby causing a "hot spot" to appear on the face of the mesas. The mesas may be selectively energized by a character-generating logic circuit in a manner to reproduce the character which may be viewed by changing the color of thermochromic material or by changing the color of a thermally sensitive paper disposed adjacent to the mesas or printheads. The typical type of heat-sensitive paper consists of a suitable paper, usually 0.002 to 0.003 inch thick, to which a heat-sensitive chemical is applied. Normally the chemically coated side of the paper is in contact with the printhead. With the mesas or bodies of the printhead in intimate contact with the chemically coated side of the thermal-sensitive paper, wear of the mesas as a result of the chemical coating abraiding the head as the thermal-sensitive paper is advanced is a problem. Furthermore, adhering of the paper to the printhead due to the reaction between the chemical coating and the heated dots is another problem. This sticking necessitates an additional drive force requirement for advancing the thermal-sensitive paper and can further produce dislocation or flaking of chemical particles from the coating of the paper to the printhead which causes a residue buildup on the printhead. This residue acts as a thermal barrier and may cause erroneous printing or no printing at all over a long period of time. This residue buildup can also cause thermal bridging between the mesas and is another source of erroneous printing.

Accordingly, it is an object of this invention to provide a method and apparatus for reducing wear and residue buildup on electronic printheads.

Another object of the invention is to provide a means for reducing sticking of the display medium to the electronic printhead.

Other objects, features and advantages of the invention may be best understood by reference to the following detailed description when read in conjunction with the accompanying drawings in which like reference numerals indicate like parts and in which:

FIG. 1 is an enlarged view of an electronic printhead;

FIG. 2 is a schematic circuit diagram of a heater element of the thermal printhead of FIG. 1;

FIG. 3 is an isometric view partially broken away of an electronic printhead and carriage assembly therefor usable in a thermal printer according to the present invention;

FIG. 4 is an enlarged front view of the electronic assembly shown in FIG. 3;

FIG. 5 is an isometric view of an electronic thermal printer utilizing the electronic printhead and carriage assembly shown in FIG. 3;

FIG. 6 is a top view of the printhead, thin, flexible material and display medium;

FIGS. 7–17 are additional embodiments and views according to the present invention illustrating various configurations of the thin, flexible material with respect to the printhead and display medium.

Referring now to FIGS. 1–4, a thermal printhead of the type, for example, described and claimed in various aspects in copending U.S. Pat. application, Ser. No. 671,821, filed Sept. 29, 1967, entitled "Integrated Heater Element Array and Drive Matrix and Method of Making Same," assigned to the assignee of the present application, is indicated generally by the reference numeral **10**. The printhead **10** is composed of a

5×5 matrix of semiconductor mesas or bodies **12**, which are thermally isolated from one another by airgaps, as best seen in FIG. **1**, and which are bonded to a ceramic chip or substrate **14** by a thermally insulating epoxy layer **16**. A transistor **18** and a resistor **20** (see FIG. **2**) are diffused into the interior of each mesa or body **12** adjacent the epoxy layer **16**. A buffer transistor **22** (see FIG. **2**) for each of the 25 mesas **12** is diffused into the face of semiconductor chip **24**, generally within the area designated by the dotted outline **26** (see FIG. **4**), the printhead circuits and the buffer circuits being interconnected by thin metallic film leads (not illustrated) on the surface of the semiconductor mesas **12** and the chip **24** adjacent the epoxy layer **16**. The ceramic chip **14** is then bonded to a metallic heat sink **28**. The leads from the bases of the buffer transistors **22** terminate around the periphery of the semiconductor chip **24**, and are bonded to leads **30** on a printed circuit templet **32** mounted on the heat sink. The leads **30** on the printed circuit templet are soldered to the leads of a multilead strap **34** which, in turn, are interconnected to character-generating logic circuits (not shown). The printhead assembly as illustrated in FIGURE **3** may be utilized in a thermal printer such as the one illustrated in FIG. **5**.

FIG. **5** illustrates an electronic thermal printer utilizing the present invention and indicated by the reference numeral **40**. Two end plates **42** and **44** provide the support for feeding the display medium comprised of support material **46** and display coating **56** which may be, for example, 3M Co. thermal paper No. 504, from a large roll fed from spool **48**. The thermal-sensitive layer **56** on paper support **46** faces the thermal printhead. The electronic printhead and carriage therefor, indicated generally by the reference numeral **28** (and shown in detail in FIG. **3**), is secured to driving mechanism **49** which is slidably mounted on cylindrical rods **50** and a conventional stepping motor in mechanism **49** (not shown in detail) steps the carriage from left to right after the character print portion of the print cycle, and upon completing the printout of a line drives the printhead carriage back to the left-hand margin position. Supports **51** and **52** are connected to end plates **42** and **44**, respectively. A thin, wear-resistant material **54**, which may be, for example, paper or high-temperature, flexible plastic, is interposed between the carriage **28** and the display medium **46**. This material **54** may be polyester (Mylar) or fluorinated ethylene propylene (FEP Teflon), for example, and is moved as a ribbon past the carriage **28** by takeup reel **58** and feed reel **60** located on supports **51** and **52**, respectively. Another example of a film which has been tried successfully is a 0.00025-inch amber polyimide film made by DuPont under the trade name KAPTON, which has a service temperature of 400° C. The operating temperatures of a printhead will vary dependent upon the printout speed required and the thermal paper utilized. With the illustrative printhead used the film **54** should be capable of service temperatures of 250° C. or greater, since the operating temperature of printhead **10** varies between 175° to 225° C. However, the service temperature may be less if it is replaced after being used. For some purposes, it may be desirable for the film or material **54** to be transparent or partially translucent.

FIG. **6** illustrates the respective positions of the printhead **10** and mesas **12** with regard to the display medium **46** and the thin, flexible material **54**.

In the operation of the electronic printer illustrated in FIG. **5**, the electronic carriage assembly **28** is successively stepped across the display medium **46** from left to right by a motor in mechanism **49**. At each successive position, selective mesas **12** are energized thereby producing hot spots at the surface of the mesas. The heat generated by the selective mesas is coupled through the thin, flexible material **54** which, in turn, causes an information representation to form on the thermally sensitive display medium **46**. This printing cycle is repeated until the printout for the particular line is completed, at which time the carriage assembly **28** is returned to the left-hand margin position, the thermal-sensitive display medium **46** advanced one line by advance means (not shown) and fed by

spool 48, and the takeup reel 58 is appropriately advanced by means (not shown) to allow additional unused portion of the material 54 to contact printhead 10. Tests to date indicate that with the use of a thin, wear-resistant material 54 interposed between the printheads 12 and the thermal-sensitive display medium 46, wear on the printhead is minimized, the mesas 12 do not stick to the thermal-sensitive coating 56 on the display medium 46, and do not react with the heated hot spots, and further reduce the loose particle type of residue to an acceptable level.

FIGS. 7 and 8 illustrate another embodiment of printer 40 utilizing the present invention in which the display medium 70 is composed of a support material 72, a thermal sensitive coating 74, and a thin, wear-resistant material 76 physically attached (either permanently or semipermanently) to said thermal-sensitive coating 74 and dispensed from feed reel 78. It will be noted that when the wear-resistant material 76 is paper and the width of the paper support material 72 is substantially the same as the paper wear-resistant material 76, the supply of paper 70 may be fed from spool 78 such as to allow either the paper surface 72 of 76 to be adjacent to printhead 10 thereby eliminating any possible errors in loading the paper on spool 78.

In operation the printer 40 utilizing the present invention operates in the same manner as described hereinabove with regard to the printer described in FIG. 5. The thin, wear-resistant material 76, if permanently attached to the thermal-sensitive paper, may be transparent or provide an easily viewable contrast with the information representation formed on the thermal-sensitive coating 74 when the mesas 12 are selectively energized. The material 76 may be semipermanently attached to the thermal-sensitive coating 74 in such a manner that at a later time the material 76 may be removed from the coating and support material 74 and 72, respectively.

FIG. 9 shows still another embodiment of the printer 40, whereby the thin, wear-resistant material 76 is fed from spool 80 and the thermal sensitive paper 72 and 74 is fed from a separate spool 82. The wear-resistant material 76 is interposed between the printhead and the thermal-sensitive coating 74. In cross section, the relationship of the printhead 10, wear-resistant material 76, thermal-sensitive coating 74 and support material therefor 72 is identical to that illustrated in FIG. 8.

FIGS. 10 and 11 illustrate another embodiment of the present invention in which the wear-resistant material 84 is in the form of an endless loop encircling reels 86 and 88. The reels 86 and 88 are integral with mechanism 49 and are rotated in the direction indicated by gear means (not shown in detail) located in mechanism 49. The wear-resistant material 84 is located between the thermal printhead 10 and the display medium 90 and more particularly between the mesas 12 and the thermal-sensitive coating 92 on support material 94.

In operation, the mechanism 49 steps the carriage 28 across the display medium 90 from left to right, and at the same time, the reels 86 and 88 advance the wear-resistant material 84 across the printhead 10. Accordingly, the wear-resistant material 84 is placed against the display medium 90 as the head 10 slides over that portion to print, and as the head passes over that portion the material 84 will then pass over and around reel 86. Accordingly, there is no relative motion at the time of printing between the printhead 10 and the display medium 90.

FIGS. 12 and 13 disclose a set of reels 86 and 88 on mechanism 49 between which is interconnected a wear-resistant material 84. Takeup reel 86 advances the wear-resistant material past the printhead 28 in a manner similar to that described with regard to the printer of FIG. 5.

In the embodiments illustrated in FIGS. 7–13, the wear-resistant material may be comprised of the same material described with regard to FIG. 5.

FIG. 14 illustrates another embodiment of a printer 100 utilizing the present invention with the thermal printhead 10 and carriage therefor 28 positioned on the back side of display medium 102. The carriage assembly 28 is attached to mechanism 49 and slidably mounted on slide 50 in the same manner as previously described with regard to FIG. 5. To prevent residue buildup and abraiding of the mesas or bodies of the printhead 10, a thin, flexible material 104 is in contact with said printhead 10 and also forms the support material for a thermal-sensitive coating 106 which is integral with said support material 104. The display medium 102 is fed from a feed spool 108.

By selectively energizing the mesas 12 of printhead 10, the heat generated by said mesas is thermally transferred through said support material 104 to form an information representation 110 on said thermal-sensitive coating 106. This embodiment has the advantage of enabling an operator in utilizing the printer to immediately view what is being printed; this feature is particularly desirable in a multicharacter thermal printhead machine (that is, when a plurality of printheads are positioned in a linear array across the display medium 102 to print out a line at a time). With a multicharacter array, there would be no moving head printer as illustrated in FIG. 14, but a plurality of fixed heads printing out a line at a time simultaneously. With a line of printheads on the side opposite from that shown in FIG. 14, the information representation 110 would be concealed until the complete line was printed out. However, using the back side printing technique, the complete information representation 110 is immediately viewable even with a complete line of fixed printheads. A paper which has been successfully tested utilizing the back side printing technique described with regard to FIG. 14 is 3M Co., J2 thermal-sensitive paper.

FIGS. 16 and 17 disclose another electronic printer 120 utilizing a thermal printhead 10 attached to carriage 28 and mounted to mechanism 49. Mechanism 49 is slidably mounted on rods 50, as hereinabove described. The display medium 112, which is next to printhead 10 may be sensitized, but in its preferred embodiment, display medium 112 may be, for example, a nonsensitized paper. An energy or thermally transferable coating 114 (for example, a carbon composition such as a wax mixed with carbon particles or other suitable pigment) and support material therefor 116 is adjacent the display medium 112. The support material 54 may be a thin, flexible material, such as, paper or a plastic, such as polyester (Mylar), polyethylene, polyimide (H-film), or the like, and is distributed from feed spool 118. The display medium is fed from spool 122. The coating 114 and support therefor 116 may be, for example, conventional rolls of carbon paper and the display medium 112 may be nonsensitized paper which is permanently or semipermanently attached to the carbon paper (composed of coating 114 and support 116).

In operation, the printhead 10 moves from left to right and moves across the back side of display medium 112 and accordingly is not in intimate contact with a rough abraiding or residue buildup-type surface. By selectively energizing the mesas 12, selective hot spots at the surface of the mesas are produced. The heat generated by the selected mesas passes through the display medium 112 which, in turn, causes the thermally transferable coating 114 (such as the carbon coating beforementioned) to transfer onto the display medium 112 which, as previously stated, may be sensitized or nonsensitized paper passing in contact therewith. Accordingly, the heat from the selected mesas 12 is thermally coupled through display medium 112 to the thermally transferable coating 114. With a carbon and wax composition, for example, selective heating of mesas 12 softens the wax making it "sticky" at the outer surface of thermally transferable coating 114 enabling it to transfer to the display medium 112 and adhere thereto thereby forming an information representation 110 on said display medium 112. The printing cycle is repeated until the printout for the particular line is completed.

It is to be understood that the above-described embodiments and methods are merely illustrative of the invention. For example, the 5×5 array of mesas is given herein as being illustrative only since any number or shape of the array may be chosen depending upon the character of the information

desired to be displayed on the display medium. Numerous other arrangements may be derived by those skilled in the art without departing from the spirit and scope of the invention as defined by the appended claims.

What is claimed is:

1. A thermal display system comprising in combination a thermal printhead having thermal elements therein, a thermal-sensitive layer, a support member for said thermal-sensitive layer, and a thin, flexible paper between said thermal elements and said thermal-sensitive layer associated with said thermal-sensitive layer, to protect said thermal printhead, said thermal printhead adapted for printing images on said thermal-sensitive layer.

2. A thermal display system according to claim 1 wherein said paper material is affixed to said thermal-sensitive layer and support member.

3. A thermal device according to claim 2 wherein said paper material is permanently affixed to said thermal-sensitive layer and said support member.

4. A thermal display system comprising in combination a thermal printhead having thermal elements thereon, a thermal-sensitive layer, a support member for said thermal-sensitive layer, a thin paper material between said thermal elements and said thermal layer to protect said thermal elements, and means for moving said printhead and said paper material together over said thermal-sensitive layer, said thermal printhead adapted for printing on said thermal-sensitive layer.

5. A thermal display system according to claim 4 wherein said moving means includes rollers which said paper material engages and said paper material is an endless loop.

6. A thermal display system according to claim 4 wherein said moving means comprises takeup and feed reels and said paper material is a ribbon interconnected between said reels.

7. A thermal display system comprising in combination a substrate, an array of semiconductor bodies upon one surface of said substrate, said array being so arranged so that select ones of said bodies define a form of information representation, heater elements within each of said bodies, means for selectively energizing said heater elements thereby to heat said select ones of said bodies, a thermal-sensitive layer, a support member for said thermal-sensitive layer, and a thin paper material between said semiconductor bodies and said thermal-sensitive layer associated with said thermal-sensitive layer which conducts heat therethrough to allow said information representation to form on said thermal-sensitive layer upon the select energization of said select ones of said bodies.

8. A thermal display system according to claim 8 wherein said paper material is affixed to said thermal-sensitive layer and said support member.

9. A thermal system according to claim 8 wherein said paper material is permanently affixed to said thermal-sensitive layer and said support member.

10. A thermal display system comprising in combination a substrate, an array of semiconductor bodies upon one surface of said substrate, said array being so arranged that select ones of said bodies define a form of information representation, heater elements within each of said bodies, means for selectively energizing said heater elements thereby to heat select ones of said bodies, a thermally transferable coating, a support material integral with said thermally transferable coating, and a display medium between said semiconductor bodies and said thermally transferable coating.

11. A thermal display system according to claim 10 wherein said thermally transferable coating is a carbon composition.

12. A thermal display system according to claim 10 wherein said support material is paper.

13. A thermal display system according to claim 10 wherein said support material is plastic.

14. A thermal display system according to claim 10 wherein said display medium is attached to said thermally transferable coating and said support material.

* * * * *