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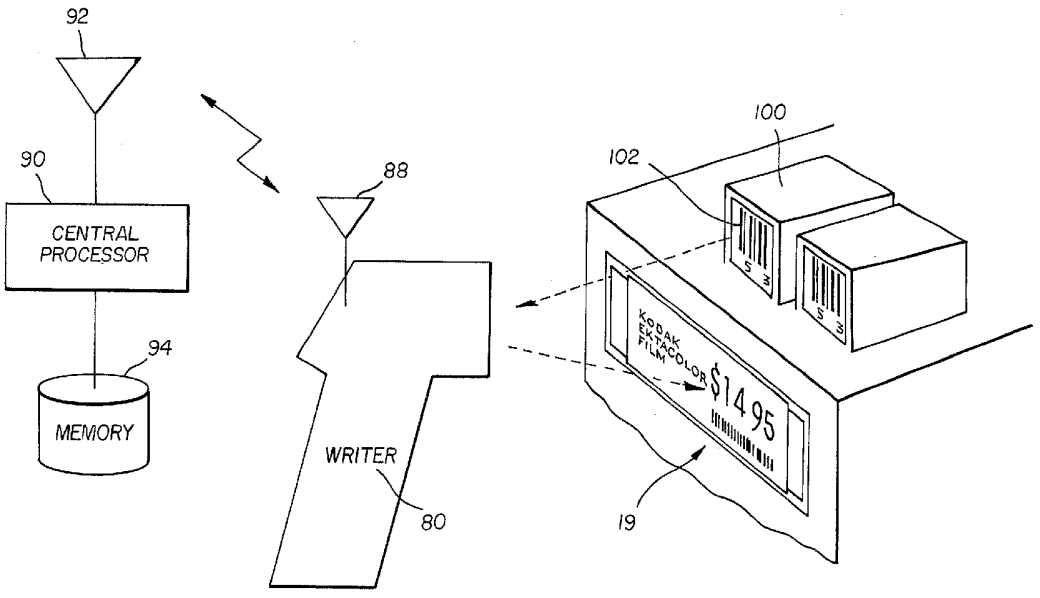

(57) Abstract: A display system includes a light writable display associated with an identification code and arranged to receive an image wise pattern of light to form an image on the display; a display writer for producing the image wise pattern of light for writing the image on the display; a scanner connected to the display writer for sensing the identification code; and a processor linked to the scanner and the display writer and responsive to the identification code for programming the display writer to write an image associated with the identification code.

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APPARATUS FOR UPDATING MEMORY DISPLAY

FIELD OF THE INVENTION

The present invention relates to an apparatus for updating memory displays.

BACKGROUND OF THE INVENTION

Retail stores offer goods for sale and need to provide customers with information on item pricing. Price labels typically provide information describing an item, the price for that item, and a machine readable code for the item, typically in UPC bar code format. The price of items often changes rapidly, requiring that printed retail labels be manually changed. Items that are on sale often have a larger secondary label, called a shelf-talker, that highlights items on sale for customers. The process of writing and changing retail pricing is costly, primarily in the labor required to replace tags. Systems have been proposed to address the problem of using digital data transmission to electrically changeable retail labels known as Electronic Shelf Labels (ESL).

US 5,448,226, issued September 5, 1995 to Failing, Jr. et al. describes an ESL system having a plurality of electronic price labels fitted into rails. The rails provide power and communication to each label. Connection to the rail can be provided through direct electrical connection to a conductor in the rail or a radio frequency (RF) interface. The label can be powered though direct electrical connection to power conductors in the rail, a battery or solar cell. Such a system requires expensive complex electronic and communication structures.

US 6,186,555, issued February 13, 2001 to Rawlings describes paper shelf-talkers that can be attached to conventional paper shelf labels to identify items on sale. Adhesive strips are applied to a perforated substrate that is printed to align text with the adhesive label. Attaching such a shelf-talker to a label requires the assembly to be discarded when pricing is changed. US 5,771,005, issued June 23, 1998 to Goodwin III describes an auxiliary electronic display that can be attached to an electronic price label (sic). The auxiliary display acts as an electronic shelf talker to identify special prices on goods.

US 6,130,603, issued October 10, 2000 to Briechle provides a good

reference for current Electronic Shelf Labels. Independent modules contain a power supply, antenna and controller. The controller is attached to a conventional liquid crystal display that requires periodic refreshing to maintain an image. Displays in ESLs currently display data on simple seven segment numeric data. An internal power supply expends about half its power maintaining the display image and the other half of the power maintaining the RF link. Such displays have limited display resolution, and must incorporate expensive and bulky controller and transmission electronics. Such displays further must incorporate a power supply which further increases cost and size.

US 5,751,257 issued May 12, 1998 to Sutherland shows an electronic shelf label having first and second substrates. Sutherland omits the expensive controller and power portions of the ESL, using a programming device translated across a series of pins and to write segments of an electronic display formed between the two glass substrates. The Sutherland apparatus requires the device to be positioned at a specific initial position, and translate specific sequence and rate to update the shelf tag. The information displayed in the Sutherland apparatus is limited to low resolution images.

There is a need therefore for an improved display system having a low cost rewritable shelf label with high resolution.

SUMMARY OF THE INVENTION

The need is met according to the present invention by providing a display system that includes a light writable display associated with an identification code and arranged to receive an image wise pattern of light to form an image on the display; a display writer for producing the image wise pattern of light for writing the image on the display; a scanner connected to the display writer for sensing the identification code; and a processor linked to the scanner and the display writer and responsive to the identification code for programming the display writer to write an image associated with the identification code.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic view of a label writing system in accordance with the present invention;

Fig. 2 is a partial perspective view of a display incorporated into a

label in accordance with the present invention;

Fig. 3 is a schematic sectional view of optical states of cholesteric material in accordance with the present invention;

Fig. 4 is a plot of the response of a polymer dispersed cholesteric material, originally in the planar state, to constant flash unit lamp energy and various voltages;

Fig. 5 is a side view of a label in accordance with the invention;

Fig. 6 is a front view of a written label in accordance with the present invention;

Fig. 7 is a schematic view of a label and a writer in accordance with the invention;

Fig. 8 is a schematic view of a writer employed with the present invention;

Fig. 9 is a schematic view of a writer scanning an object identity code according to the present invention;

Fig. 10 is a schematic view of a writer obtaining label information for a specific object identity code from a central processor using wireless transmission according to the present invention; and

Fig. 11 is a schematic view of a writer writing a display using label information for a specific object according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Fig. 1 is a schematic view of a label writing system in accordance with the present invention. A label **19** displays information about an object **100.** Objects **100** can be objects for retail sale or inventory items. Objects **100** have an associated object identity code **102.** The code **102** can be attached to individual items or adjacent to a set of one or more objects. Scanner/writer **80** contains means to scan an identification code **102** and write label **19.**

Scanner/writer **80** has means to scan an object identity code **102** and select label image data for label **19** associated with a specific object **100.** Scanner/writer **80** further contains memory means to create label image data associated with an identification code **102** or access such data via writer antenna **88** to retrieve label image data from a central processor **90** using a conventional

wireless network. Central processor **90** receives requests for label image data from processor antenna **92** from the wireless network. Central processor **90** retrieves label image data from central memory **94**, and transmits the data via processor antenna **92** to the scanner/writer **80** that made the request.

Fig. 2 is a perspective of a display incorporated into a label in accordance with the present invention. Display **10** includes a flexible display substrate **15,** which is a thin transparent polymeric material, such as Kodak Estar film base formed of polyester plastic that has a thickness of between 20 and 200 microns. In an exemplary embodiment, display substrate **15** can be a 125-micron thick sheet of polyester film base. Other polymers, such as transparent polycarbonate, can also be used.

A first conductor **20** is formed on display substrate **15.** First conductor **20** can be tin-oxide, indium-tin-oxide (ITO), or a transparent organic conductor such as polythiophene, with ITO being the preferred material. Typically the material of first conductor **20** is sputtered or coated as a layer over display substrate **15** having a resistance of less than 1000 ohms per square. First conductor **20** can also be formed by printing a transparent organic conductor such as PEDT/PSS, PEDOT/PSS polymer, which materials are sold as Baytron® P by Bayer AG Electronic Chemicals. A portion **22** of first conductor **20** does not contain subsequent layers to provide exposed first conductor.

Cholesteric liquid crystal light modulating layer **30** overlays first conductor **20.** Cholesteric liquid crystal light modulating layer **30** contains cholesteric liquid crystal material, such as those disclosed in US Patent 5,695,682 issued December 9, 1997 to Doane et al. Such materials are made using highly anisotropic nematic liquid crystal mixtures and adding a chiral doping agent to provide helical twist in the planes of the liquid crystal to the point that interference patterns are created that reflect incident light. Application of electrical fields of various intensity and duration can be employed to drive a chiral nematic material (cholesteric) into a reflective state, to near transparent state, or an intermediate state. These materials have the advantage of having stable optical states in the absence of an electrical field. The materials can maintain a given optical state indefinitely after the field is removed. Cholesteric liquid crystal materials can be

formed using a two component system such as MDA-00-1444 (undoped nematic) and MDA-00-4042 (nematic with high chiral dopant concentrations) available from E.M. Industries of Hawthorne, N.Y.

In a preferred embodiment, cholesteric liquid crystal light modulating layer **30** is a cholesteric liquid crystal dispersed in de-ionized photographic gelatin. The liquid crystal material is mixed at 8% cholesteric liquid crystal in a 5% gelatin aqueous solution. The mixture is dispersed to create an emulsion having 8-10 micrometer diameter domains of the liquid crystal in aqueous suspension. The domains can be formed using the limited coalescence technique described in US 6,423,368 issued July 23, 2002 to Stephenson et al. The emulsion is coated over first conductor **20** on a polyester display substrate **15** and dried to provide an approximately 9-micrometer thick polymer dispersed cholesteric coating. Other organic binders such as polyvinyl alcohol (PVA) or polyethylene oxide (PEO) can be used in place of the gelatin. Such emulsions are machine coatable using coating equipment of the type employed in the manufacture of photographic films. A gel sub-layer can be applied over first conductor **20** prior to applying cholesteric liquid crystal light modulating layer **30** as disclosed in US 6,423,368 referenced above.

Fig. 3 is a schematic side sectional view of a chiral nematic material in a planar and focal conic state responding to incident light. In the figure on the left, after a high voltage field has been applied and quickly switched to zero potential, the liquid crystal molecules become planar liquid crystal **72**, which reflect portions of incident light **60** as reflected light **62**. In the figure on the right side of Fig. 2, upon application of a lower voltage field, the molecules of the chiral nematic material break into weakly forward scattering cells known as focal conic liquid crystal **74**. Increasing the time duration of a low voltage pulse creates optical states between reflective planar liquid crystal **72** and light scattering focal conic liquid crystal **74**.

A light absorber **35** is positioned on the side opposing the incident light **60.** Light absorber can be dark second conductor **40.** Light absorber **35** can be a thin layer of light absorbing, sub-micron carbon in a gel binder as disclosed in US 6,639,637 issued October 28, 2003 to Stephenson. As fully evolved focal-

conic liquid crystal **74**, the cholesteric liquid crystal is forward light scattering and incident light **60** is absorbed by light absorber **35** to create a black image. Progressive evolution towards the focal-conic state causes a viewer to perceive reflected light **62** that transitions to black as the cholesteric material changes from reflective planar liquid crystal **72** to a fully evolved light scattering focal-conic liquid crystal **74**. When the field is removed, cholesteric liquid crystal light modulating layer **30** maintains a given optical state indefinitely. The states are more fully discussed in US 5,437,811 issued August 1, 1995 to Doane et al.

Fig. 4 shows a plot of the response of a polymer dispersed cholesteric material, originally in the planar state, to constant flash unit lamp energy and various voltages. The curve for the masked material (filled boxes) is the same response of materials in the absence of the thermal pulse provided by flash unit **82**. The clear curve is the same display in the presence of the heat pulse from the flash unit combined with an electrical field. Hysteresis between the masked and unmasked curves, at approximately 20 and 60 volts are two conditions that permit writing of displays using a combination of light and electric field. Many operating states can be found to write displays. Such states are more thoroughly discussed in copending USSN 10/256,930 filed September 27, 2002 by Stephenson et al. The combination of high intensity light under an electric field permits high resolution images without patterning conductors. The process eliminates the need for many drives on many conductive traces.

Returning to Fig. 2, second conductor **40** overlays or can be light absorber **35**. Second conductor **40** has sufficient conductivity to provide an electric field between the first transparent conductor **20** and second conductor **40** strong enough to change the optical state of the cholesteric material in cholesteric liquid crystal light modulating layer **30**. Second conductor **40** can be formed, for example, by the well known technique of vacuum deposition for forming a layer of conductive material such as aluminum, tin, silver, platinum, carbon, tungsten, molybdenum, tin or indium or combinations thereof. The layer of conductive material can be patterned using well known techniques of photolithography, laser etching or by application through a mask.

In a preferred embodiment, second conductor **40** is formed by

screen printing a conductive ink such as Electrodag 423SS screen printable electrical conductive material from Acheson Corporation. Such screen printable conductive materials comprise finely divided graphite particles in a thermoplastic resin. Screen printing is preferred to minimize the cost of manufacturing the display. The light absorbing properties of the printed carbon material reduces the need for light absorber **35**.

The presence of light absorber **35** permits second conductors to be formed of reflective materials. Second conductors **40** can be formed of metal, for example, by vacuum deposition of conductive materials such as aluminum, chrome or nickel. Second conductors **40** are formed by screen printing a reflective and conductive formulation such as UVAG© 0010 from Allied Photochemical of Kimball, Michigan. Such screen printable conductive materials comprise finely divided silver in ultra violet curable resin. After printing, the material is exposed to ultra violet radiation greater than 0.40 Joules/cm/^{1}2, the resin will polymerize in 2 seconds to form a durable surface. The fast cure process time is advantageous in manufacturing.

Alternatively, second conductors **40** can be formed by screen printing thermally cured silver bearing resins. An example of such a material is Acheson Electrodag© 461 SS, a heat cured silver ink. In the case of reflective second conductor **40**, light absorber **35** can be used as a light absorbing layer that provides alternative colors, as described in copending USSN 10/455,050 filed June 5, 2003 by Stephenson et al.

The use of a flexible support for display substrate **15**; unpatterned first conductor **20;** machine coated cholesteric liquid crystal light modulating layer **30;** and unpatterned second conductor **40** permits the fabrication of a low cost flexible display. The opto-electrical writing process eliminates the need for attached, expensive electronics. Small displays according to the present invention can be used as electronically rewritable tags for inexpensive limited rewrite applications.

Fig. 5 is a side view of a label **19** in accordance with the invention. Display support **17** carries a display **10.** Display support **17** can be a sheet of material having printed support contacts **16.** Display support **17** can be made of

paper or white plastic and can have an area to carry printed information. Two support contacts **16** are positioned under first conductor **20** and second conductor **40** respectively, and extend outside the perimeter of an attached display **10.** A display **10,** formed in accordance with Fig. 4 is positioned over support contacts **16** and bonded to display support **17** so that support contacts **16** provide an exposed electrical connection to display **10.** In a preferred embodiment, an anisotropic adhesive, such 3M 9703 Electrically Conductive Tape is used, which permits electrical conduction through an adhesive but not across the adhesive.

Anisotropic adhesives consist of a conductive particle having a diameter near the thickness of adhesive binder, and dispersed at a concentration that does not conduct laterally. When display **10** is pressed onto support contacts **16**, conductive particles form an electrical connection between conductors on the back of display **10** and support contacts **16.** The adhesive can be thermally cured with an applied pressure to provide a permanent connection between conductors on the back of display **10** and support contacts **16.**

Fig. 6 is a front view of a label in accordance with the present invention. Two support contacts **16** are exposed for front connection of an electric field to first conductor **20** and second conductor **40** within display **10.** The use of a flexible display support **17** and display **10** permit printing into areas of label **19.** An additional area of display support **17** is free of display **10** to permit writing of printing **14** on display support **17.**

Ink jet printers are useful in this application because ink jet print heads are spaced from a dye receiving surface by 1.00 millimeter. Display **10** is typically less than 0.25 millimeters thick and is flexible, permitting display assembly **17** to pass through an ink jet printer an not interfere with the motion of an ink jet head over display assembly **17.** Display support **17** can further include and adhesive backing and release liner. Such structures are more thoroughly discussed in copending USSN 10/134,185 filed April 29, 2002 by Stephenson et al.

Fig. 7 is a schematic view of a label and light writer used with the present invention. Writer controller **81** acquires image data corresponding to an image to be printed on display **10.** Masking display **83** receives image data from writer controller **81** and creates and image wise pattern of light transmitting and

light blocking areas that correspond to the desired image pattern. Masking display **83** can be a simple twisted-nematic (TN) or super-twisted-nematic (STN) liquid crystal display of conventional design. Pixels on masking display **83** can be formed in an array of uniform pixels, or contain electrodes patterned to conform to types of specific images, such as seven segment digital images. Writer controller **81** provides an electrical field to writer contacts **86** which are pressed against support contacts **16** to provide an electrical field to display **10.** Flash unit **82** is triggered by writer controller **81** in conjunction with application of the electrical field to form a pattern wise image on display **10** using masking display **83.** By using the masking display to write onto a simple unpatterned label, an image having the higher resolution of the masking display can be provided on the label without the need for complex electrode structures in the label and corresponding contacts in the writer, thereby significantly reducing the cost of the label.

An example of a display useful as a masking display in the present invention is a dot-matrix super-twisted-nematic (STN) display, part number TM 13164 BCHG-I from Tianma Corporation in Taiwan. The display has an array of 63 by 131 pixels at a 0.50 mm pitch. The display has a 4:1 contrast ratio, which provides modulation of high intensity light sufficient to create an image-wise pattern of high intensity light across display **10.** Fig. 8 is a schematic view of a hand held scanner/writer **80** used with the present invention. As shown in Fig. 9, scanner **84** in scanner/writer **80** can determine an object identification code **102.** Scanner **84** can be a conventional bar code reader that can read a bar code from an object to determine the object identification code. Alternatively, scanner **84** can be an radio frequency (RF) tag scanner that retrieves object identification code **102** from an object having an attached RF data storage element. Writer controller **81** can contain internal memory means that provides a label image for one or more object identification codes **102,** or can use writer antenna **88** to access label data wirelessly from an external data source. Scanner/writer **80** further incorporates flash unit **82** to provide high intensity light. High intensity light emitted by flash unit **82** is masked by a masking display **83** connected to writer controller **81.** Writer contacts **86** are connected to writer controller **81** to permit application of an electric field in conjunction with flash unit **82** to electro-optically writer data image

associated with object identification code **102** to display **10.**

Fig. 9 is a schematic view of the scanner/writer scanning an object identity code. Writer controller is activated to acquire an object identification code **102.** Object identification code **102** can be received as an optical or radio signal from storage means attached or unattached to object **100.** Fig. 10 is a schematic view of the scanner/writer **80** obtaining label information for a specific object identity code **102** from a central processor **90** using wireless transmission. Writer controller **81** obtains an object identification code **102** as shown in Fig. 9 and transmits the object identification code **102** though a wire (not shown), or wirelessly through writer antenna **88,** to central processor **90.** Central processor operates on the object identification code **102** to retrieve a label image from memory **94.** Image data can contain pricing information, date and time information, a quantity or location data. Central processor **90** can transmit the image data back to scanner/writer **80** wirelessly using processor antenna **92** to both receive and send data. Fig. 1 is a schematic view of scanner/writer **80** imprinting display **10** using label information for an object identification code **102.** Writer controller **81** contains image data for an object identification code **102** and is prepared to write to label **19.** Scanner/writer **80** and label **19** are brought together using conventional means. In a first case, label **19** can be removed from a holder (not shown) and inserted into the body of scanner/writer **80.** In a second case, scanner/writer **80** or portions containing flash unit **82,** masking display **83** and writer contacts **86** are pressed against label **19.** Contacts **85** of scanner/writer **80** are pressed against support contacts **16** to provide an electrical field to display **10.** Masking display **83** is brought into alignment with an area to be written onto a display **10** attached to label **19.** Sensors connected to writer controller **81** can verify that the correct alignment has been made between label **19** and scanner/writer **80.**

Writer controller **81** first transmits image data corresponding to an image for object identification code **102** to masking display **83.** Writer controller **81** then applies an electrical field across display **10** using writer contacts **86** and fires flash unit **82** to imprint the label image on masking display **83** onto display **10.** Scanner/writer **80** can be disengaged from fixed labels, providing an inexpensive

electrically rewritable ESL. A label **19** that has been removed from a holder can be disengaged from scanner/writer **80** and re-mounted onto the holder. The method and apparatus of this invention provides low cost, simple and rapidly written shelf labels with high information content. The scanner/writer provides a simple and accurate means for identifying an object associated to be labeled and for retrieving an image for the label associated with the object. The labels are inexpensive, having a few simple, unpatterned, mass produced layers. The writing apparatus itself is simple, requiring a low cost flash unit system, an inexpensive masking display and a 2 wire electrical exciter for the display **10.** Separating the drive from the display permits many inexpensive labels **19** to be written by a single, simple display writer **90.**

PARTS LIST

10 display
14 printing
15 display substrate
16 support contacts
17 display support
19 label
20 first conductor
22 exposed portion of first conductor
30 cholesteric liquid crystal light modulating layer
35 light absorber
40 second conductor
60 incident light
62 reflected light
72 planar liquid crystal
74 focal conic liquid crystal
80 scanner/writer
81 writer controller
82 flash unit
83 masking display
84 scanner
86 writer contacts
88 writer antenna
90 central processor
92 processor antenna
94 central memory
100 object
102 object identification code

WHAT IS CLAIMED IS:

1. A display system, comprising:

a) a light writable display associated with an identification code and arranged to receive an image wise pattern of light to form an image on the display;

b) a display writer for producing the image wise pattern of light for writing the image on the display;

c) a scanner connected to the display writer for sensing the identification code; and

d) a processor linked to the scanner and the display writer and responsive to the identification code for programming the display writer to write an image associated with the identification code.

2. The display system claimed in claim 1, wherein the identification code is a UPC (Universal Product Code).

3. The display system claimed in claim 1, wherein the identification code is on a holder for the light writable display.

4. The display system claimed in claim 1, wherein the light writable display is a shelf tag.

5. The display system claimed in claim 1, wherein the light writable display is a product label.

6. The display system claimed in claim 1, wherein the light writable display is a shelf talker.

7. The display system claimed in claim 1, wherein the identification code is on a light writable display.

8. The display system claimed in claim 1, further comprising a central processor containing display information associated with the identification code that is linked to the scanner and the display writer by a wireless communication link.

9. The display system claimed in claim 1, wherein the light writable display includes: a pair of conductors, at least one conductor being transparent; a layer of cholesteric liquid crystal material disposed between the conductors, the cholesteric liquid crystal material having multiple stable optical

states at zero electrical field; and a light absorber for forming an image wise thermal pattern in the cholesteric liquid crystal sufficient to change the optical state of the cholesteric liquid crystal in response to an image wise pattern of light.

10. The display system claimed in claim 9, wherein the light writable display is attached to a support having contacts for making contact with the conductors on the light writable display and for providing external access to the conductors.

11. The display system claimed in claim 10, wherein the support includes a printable surface.

12. The display system claimed in claim 11, wherein the identification code is printed on the printable surface of the support.

13. The display system claimed in claim 10, wherein the display writer includes: a light source for producing a flash unit of light of sufficient intensity to generate sufficient heat in the light absorber to change the optical state of the cholesteric liquid crystal; an electronically programmable mask located between the light source and the display for defining the image wise pattern of light; a display drive connectable to the contacts for generating an electric field between the conductors for changing the optical state of the cholesteric liquid crystal; and a controller connected to the light source and the display drive for controlling the intensity of the electrical field and actuating the light source to create an image on the display.

14. The display system claimed in claim 10, wherein the contacts are conductive ink.

15. The display system claimed in claim 10, wherein the conductive ink is carbon in a polymer binder.

16. The display system claimed in claim 10, wherein the display is attached to the support by the conductive ink.

17. The display system claimed in claim 10, wherein the display is attached to the support by an anisotropic conductive adhesive providing electrical connection between the conductors of the display and the contacts on the support.

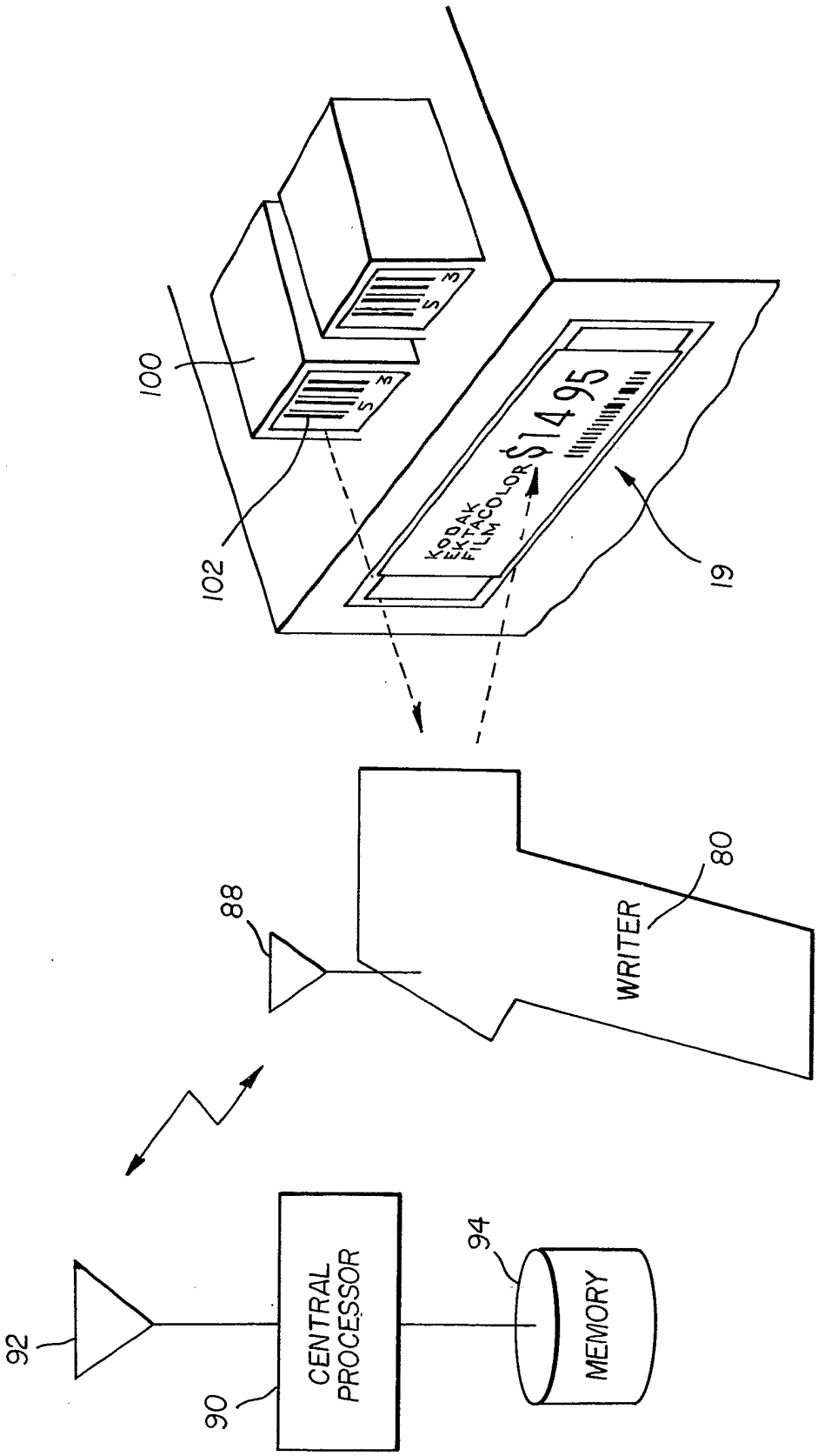
18. The display system claimed in claim 10, wherein the support has an adhesive backing.

19. The display system claimed in claim 10, wherein the polymer dispersed material is a dried emulsion of cholesteric liquid crystal in gelatin.

20. The display system claimed in claim 1, wherein the scanner is a bar code scanner.

21. The display system claimed in claim 1, wherein the scanner is a radio frequency tag scanner.

22. The display system claimed in claim 1, wherein the scanner and the writer are included in a hand held unit.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102
19
KODAK
EXTACOLOR
FILM
$14.95
88
WRITER
80
92
CENTRAL
PROCESSOR
90
94
MEMORY

FIG. 1

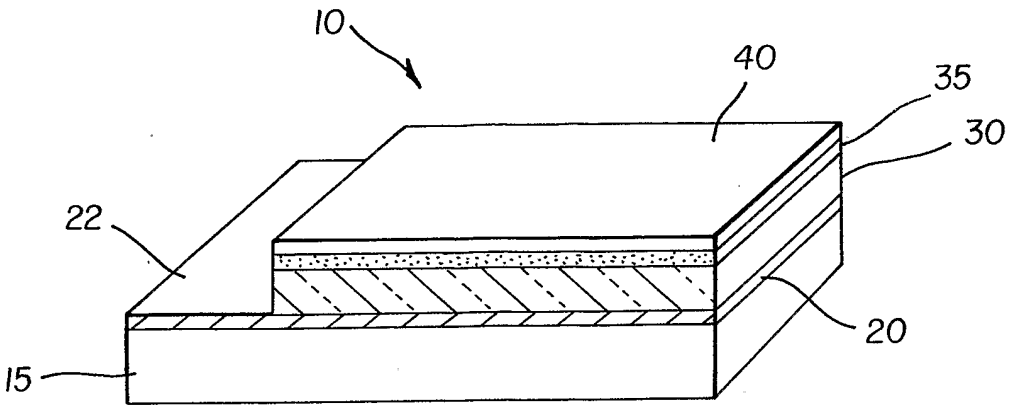

FIG. 2

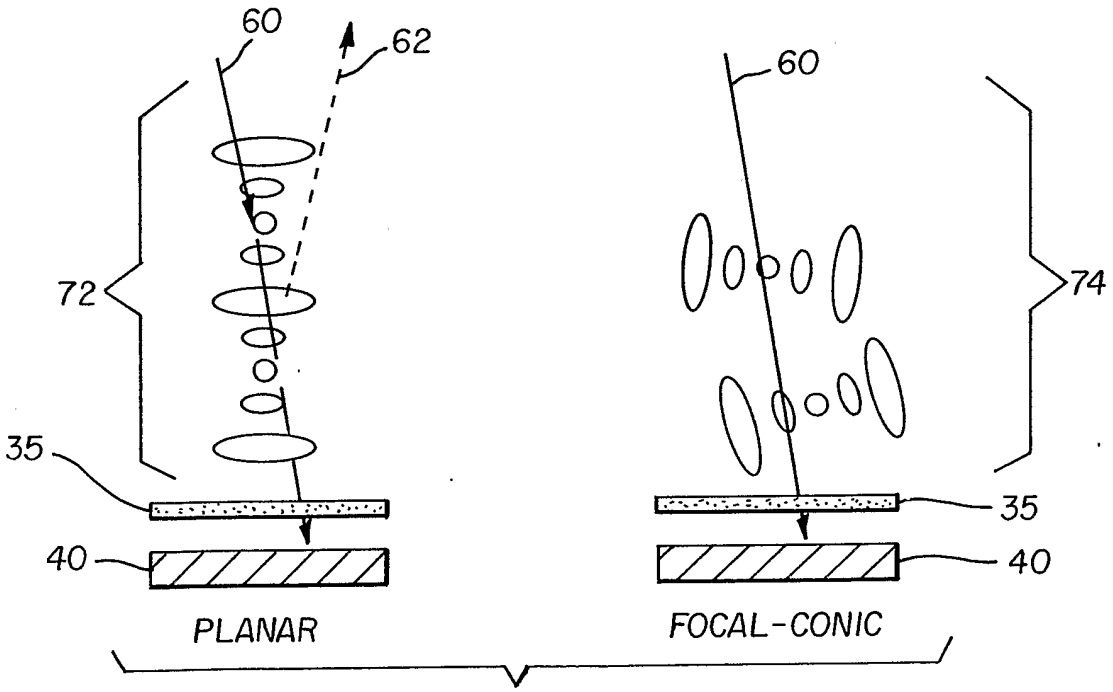

FIG. 3

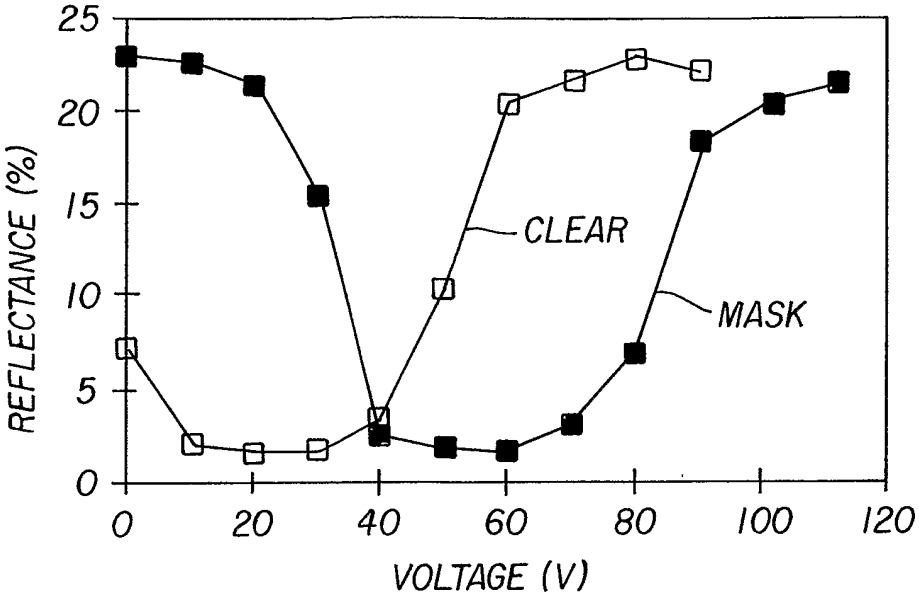
25
20
15
10
5
0
REFLECTANCE (%)
CLEAR
MASK
0
20
40
60
80
100
120
VOLTAGE (V)

FIG. 4

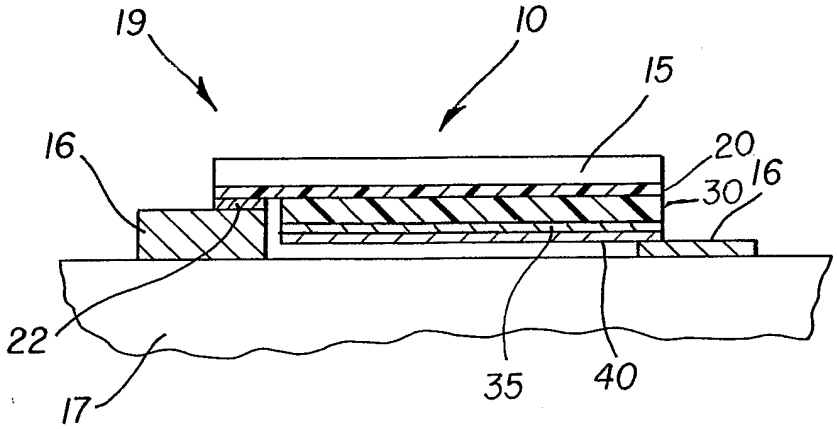
19
10
15
16
20
16
30
22
17
35
40

FIG. 5

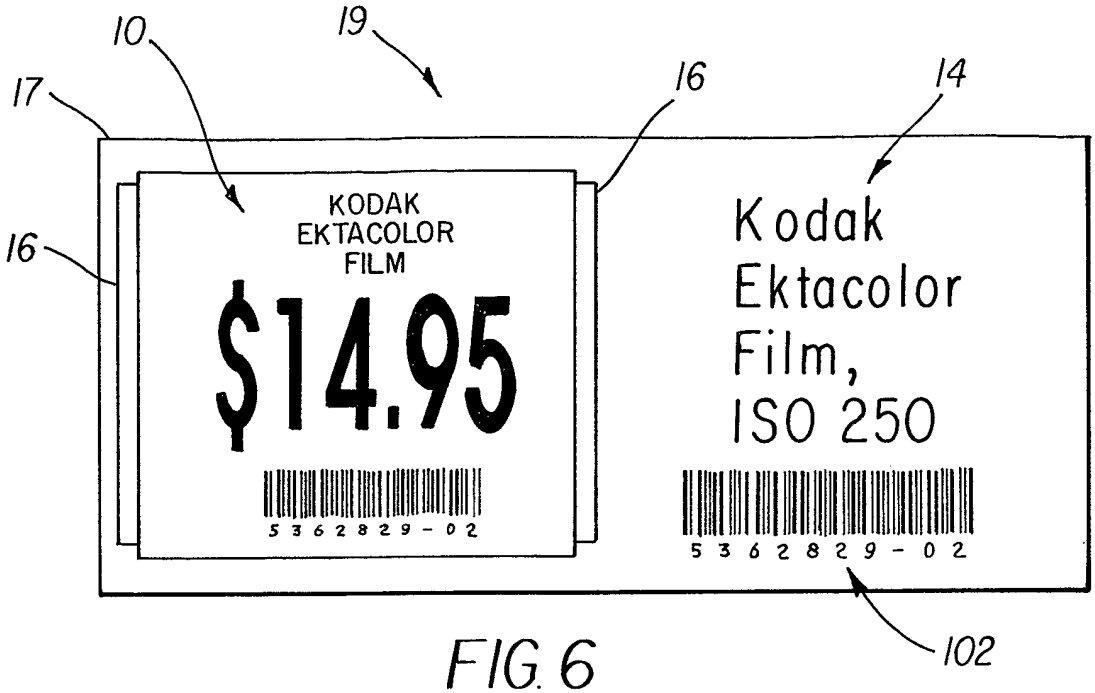
19
10
17
16
14
16
KODAK
EKTACOLOR
FILM
$14.95
5362829-02
Kodak
Ektacolor
Film,
ISO 250
5362829-02
102

FIG. 6

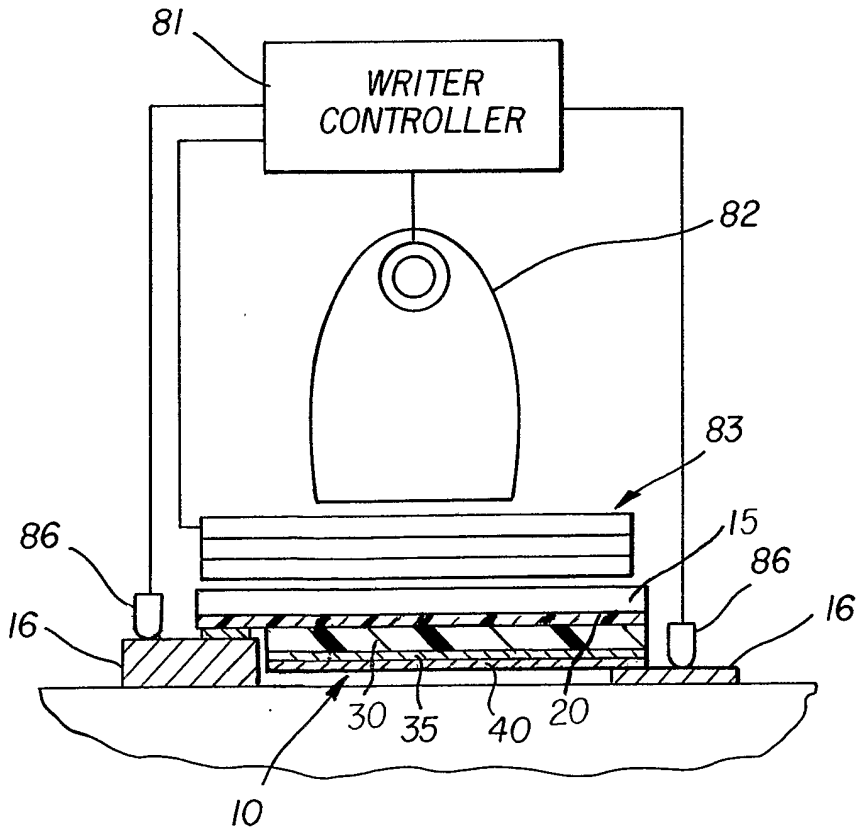
81
WRITER
CONTROLLER
82
83
86
15
86
16
16
30
35
40
20
10

FIG. 7

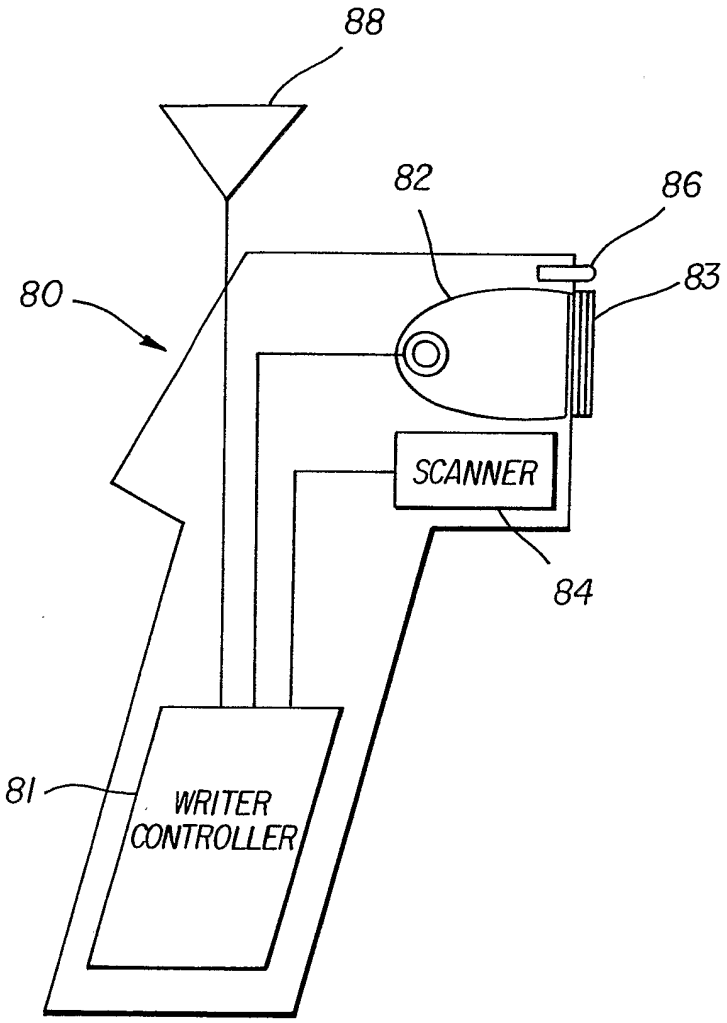

FIG. 8

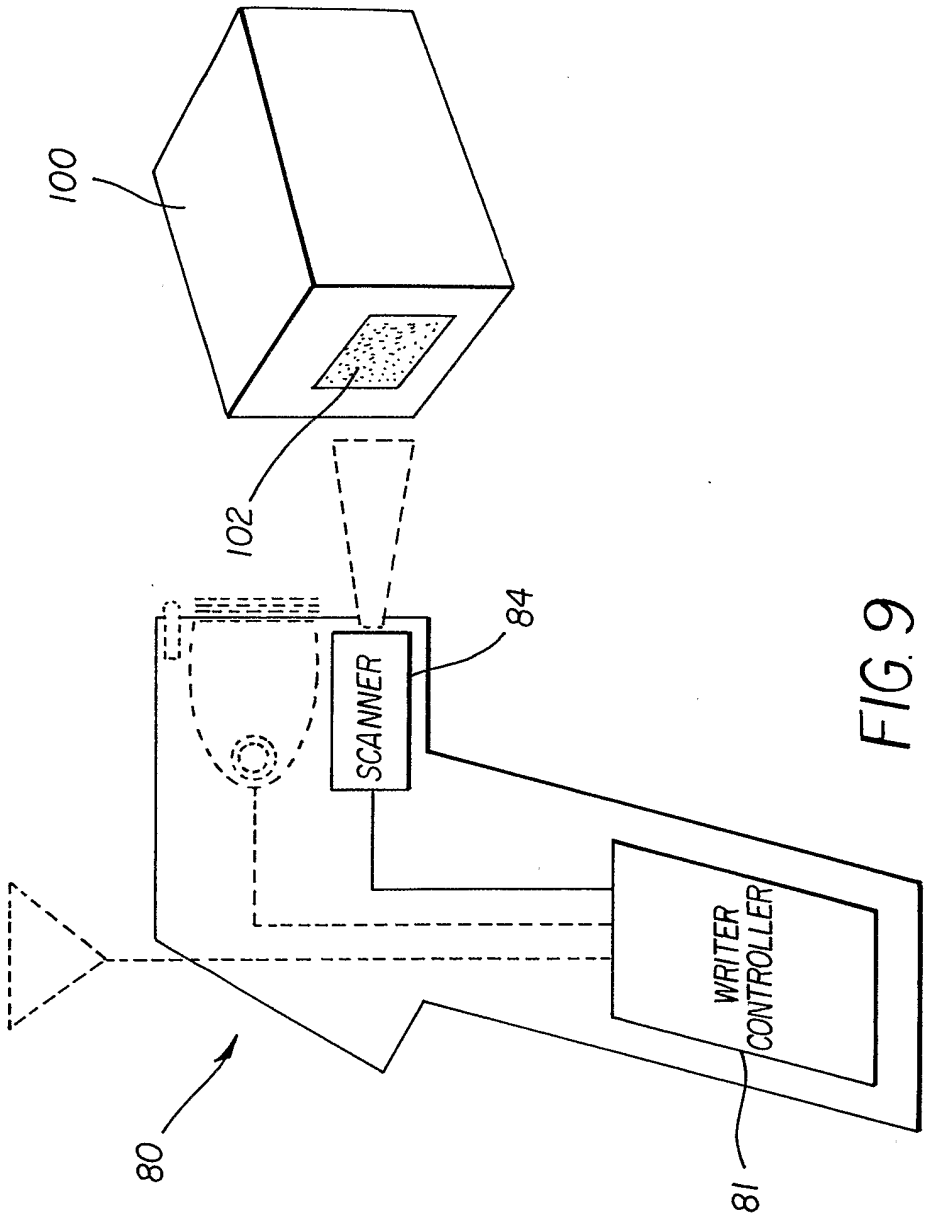

FIG. 9

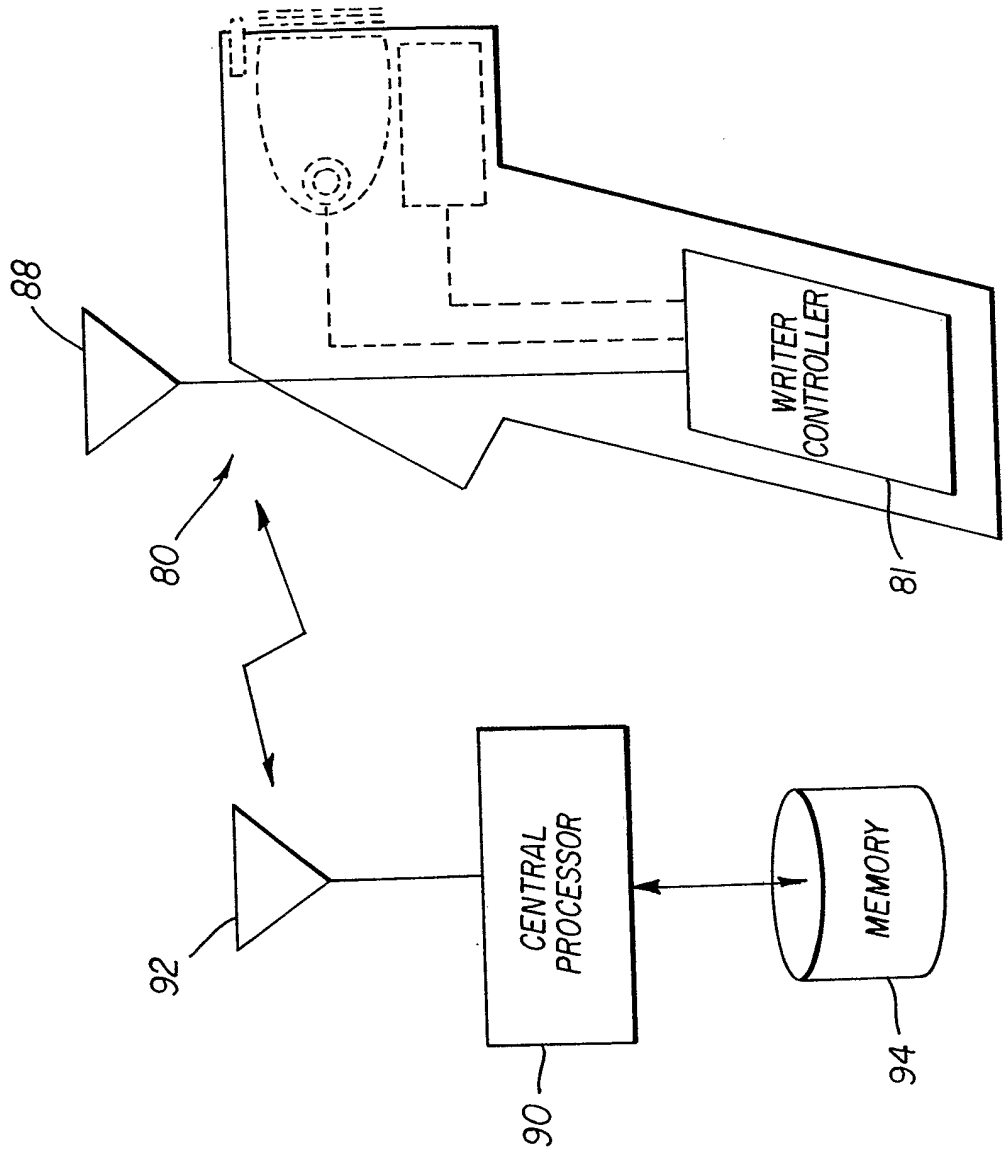
88
WRITER CONTROLLER
81
80
92
CENTRAL PROCESSOR
MEMORY
90
94

FIG. 10

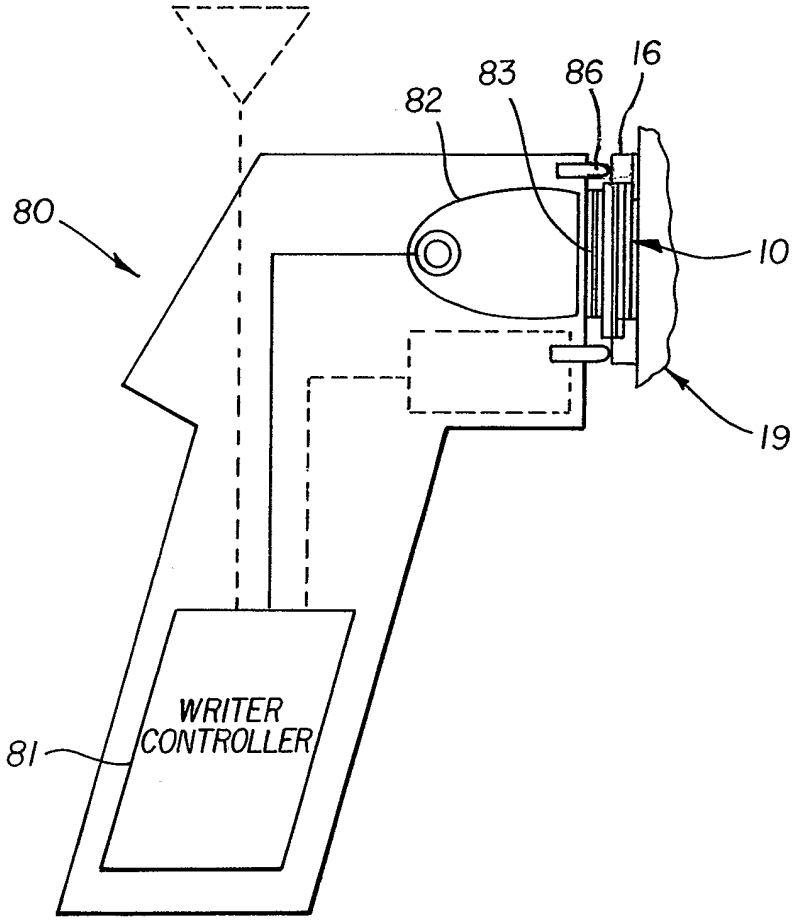

FIG. 11