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Borden, Jr.

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[54] **THERMAL PRINTING SYSTEM**

[75] Inventor: **Howard C. Borden, Jr.**, Atherton, Calif.

[73] Assignee: **American Micro-systems, Inc.**, Santa Clara, Calif.

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[52] **U.S. Cl.** .... **346/76 R,** 219/216

[51] **Int. Cl.** **G01d 15/10**

[58] **Field of Search** .... 346/76 R; 178/30; 235/61.9; 219/216

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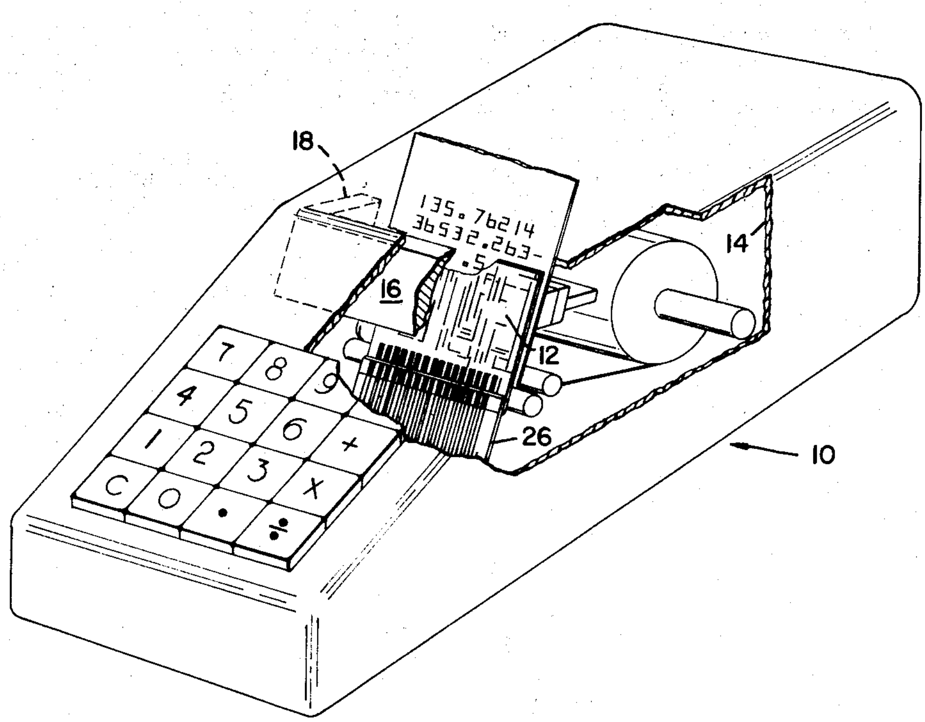
Primary Examiner—Joseph W. Hartary
Attorney—Roger W. Erickson

[57] **ABSTRACT**

A thermal printer for electronic calculators or other computing devices comprises a multi-layer print head with a metallized layer on one outer surface formed as a series of master characters each comprised of a plurality of segments which are electrical resistance elements that extend between end contacts. These contacts are connected to an intermediate or buried metallized layer within the ceramic body which in turn provides for interconnections with another metallization layer including input ground and driver lead contact pads formed on the other outer surface of the ceramic body. A logic control sub-system for the printer receives signals from a driver output such as a calculator computing circuit and thereby controls the electrical energy furnished to the various character segments on the print head to heat them and produce the appropriate printout when the print head is in contact with heat sensitive paper. This sub-system stores the information received from the driver output and then utilizes the stored information in a multiplexing or time sharing arrangement to energize sequentially groups of preselected segment portions of all the master characters during a series of separate consecutive time periods of the print cycle.

14 Claims, 8 Drawing Figures



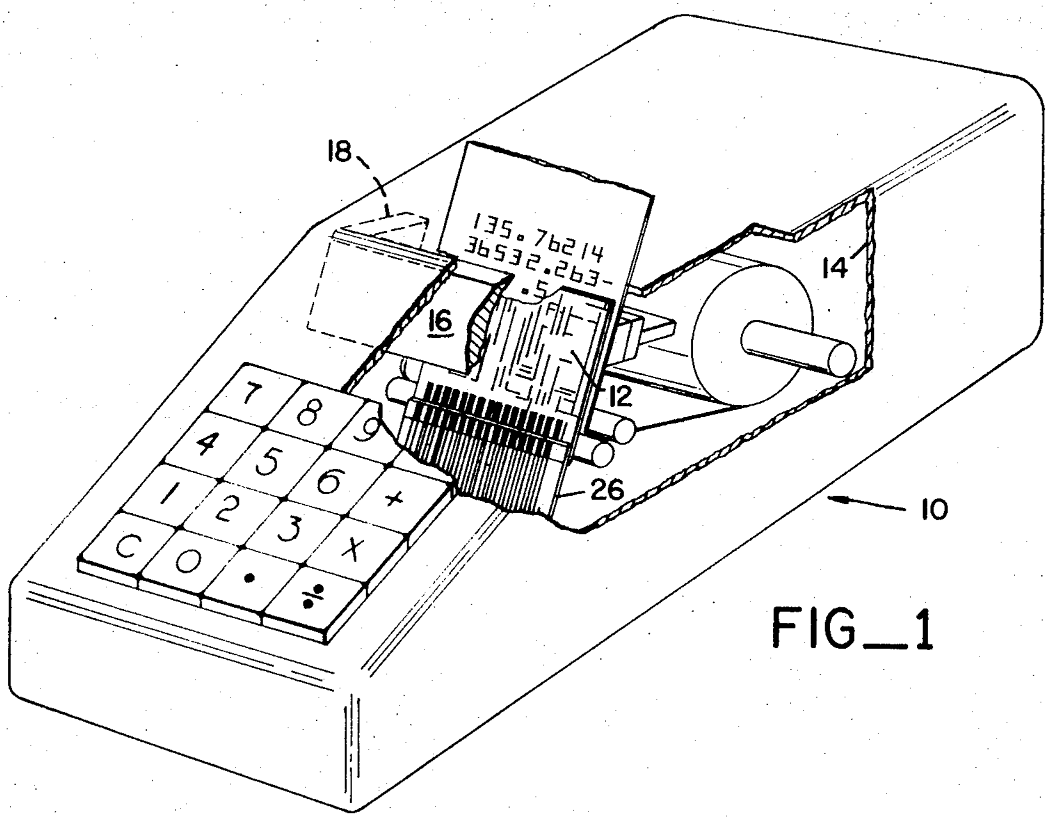


FIG_1

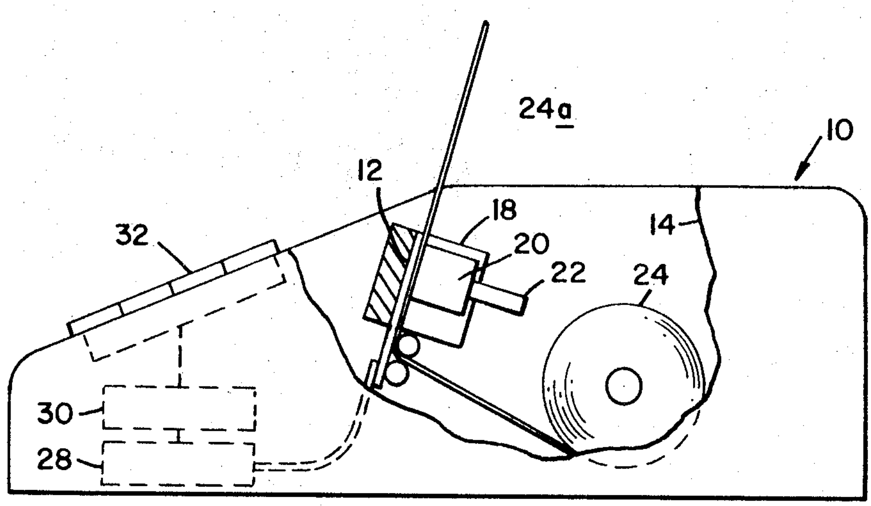


FIG_2

INVENTOR.
HOWARD C. BORDEN, JR.
BY
Owen, Wickersham & Erickson
ATTORNEYS

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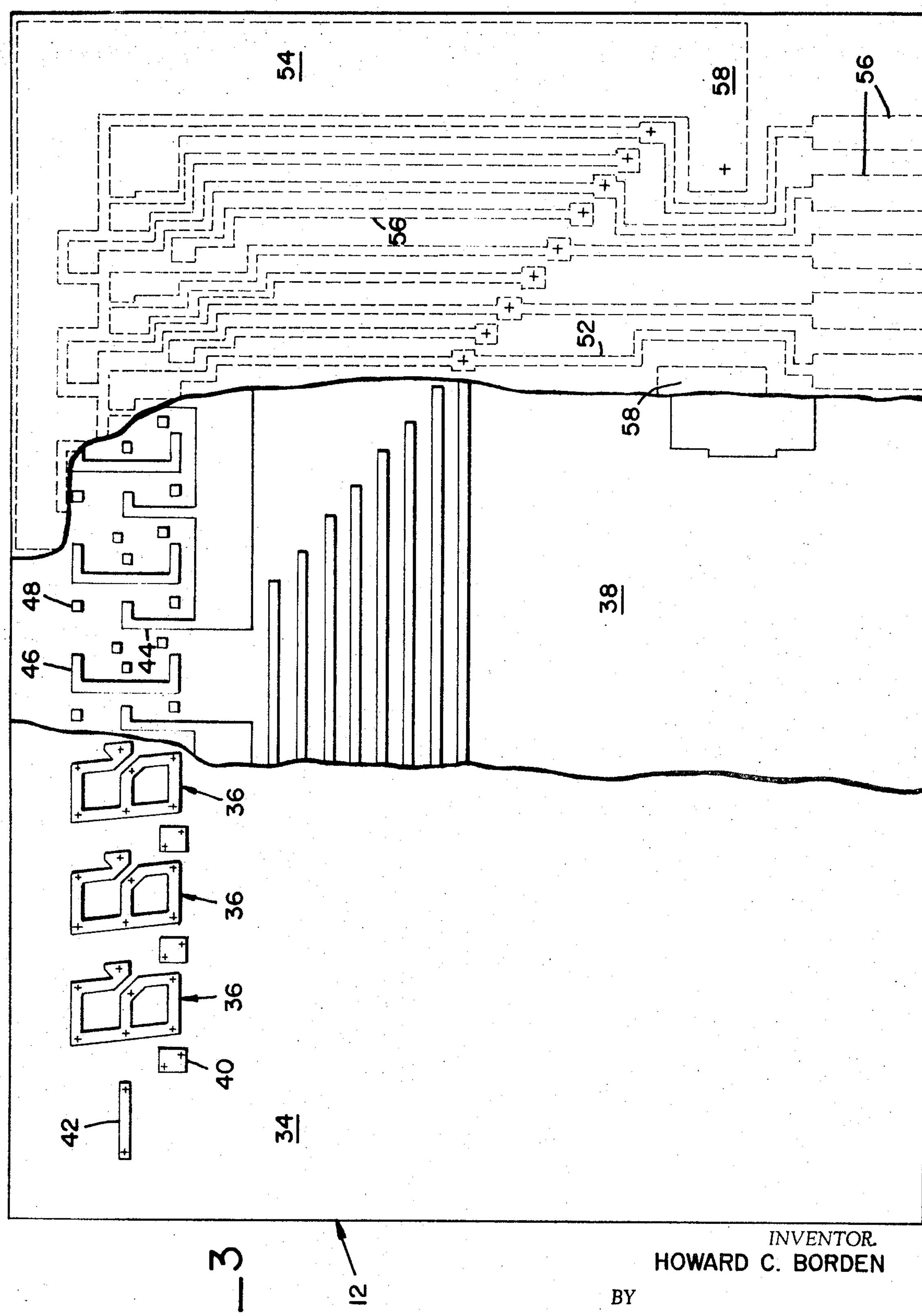

FIG_3

INVENTOR.
HOWARD C. BORDEN

BY

Owen, Wickersham & Erickson
ATTORNEYS

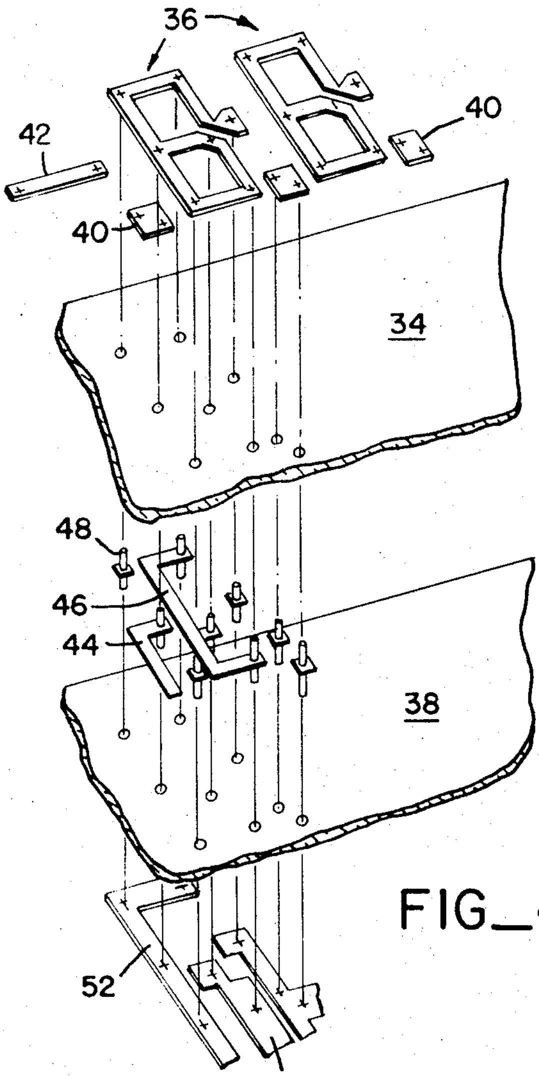

FIG_4

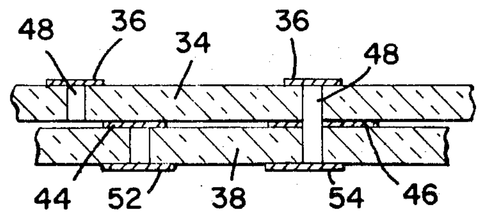

FIG_5

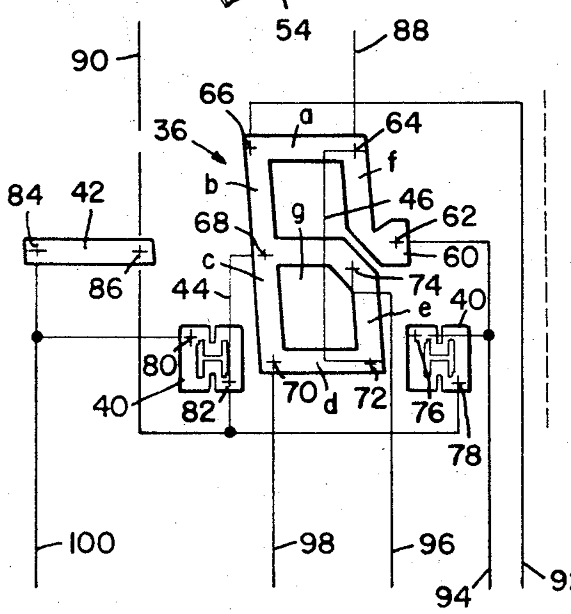

FIG_6

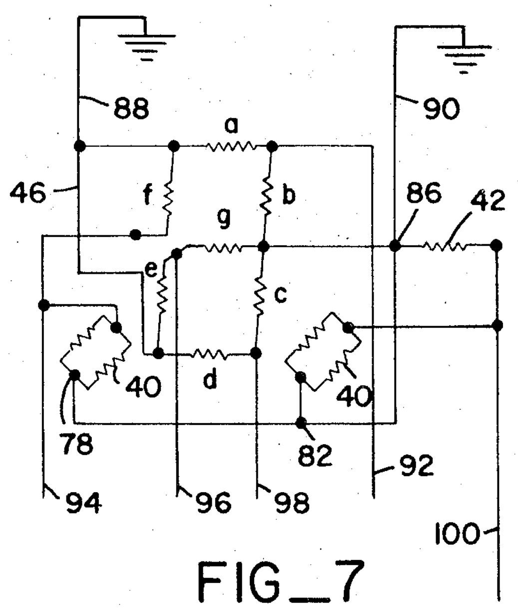

FIG_7

INVENTOR.
HOWARD C. BORDEN

BY

Owen, Wickersham & Erickson
ATTORNEYS

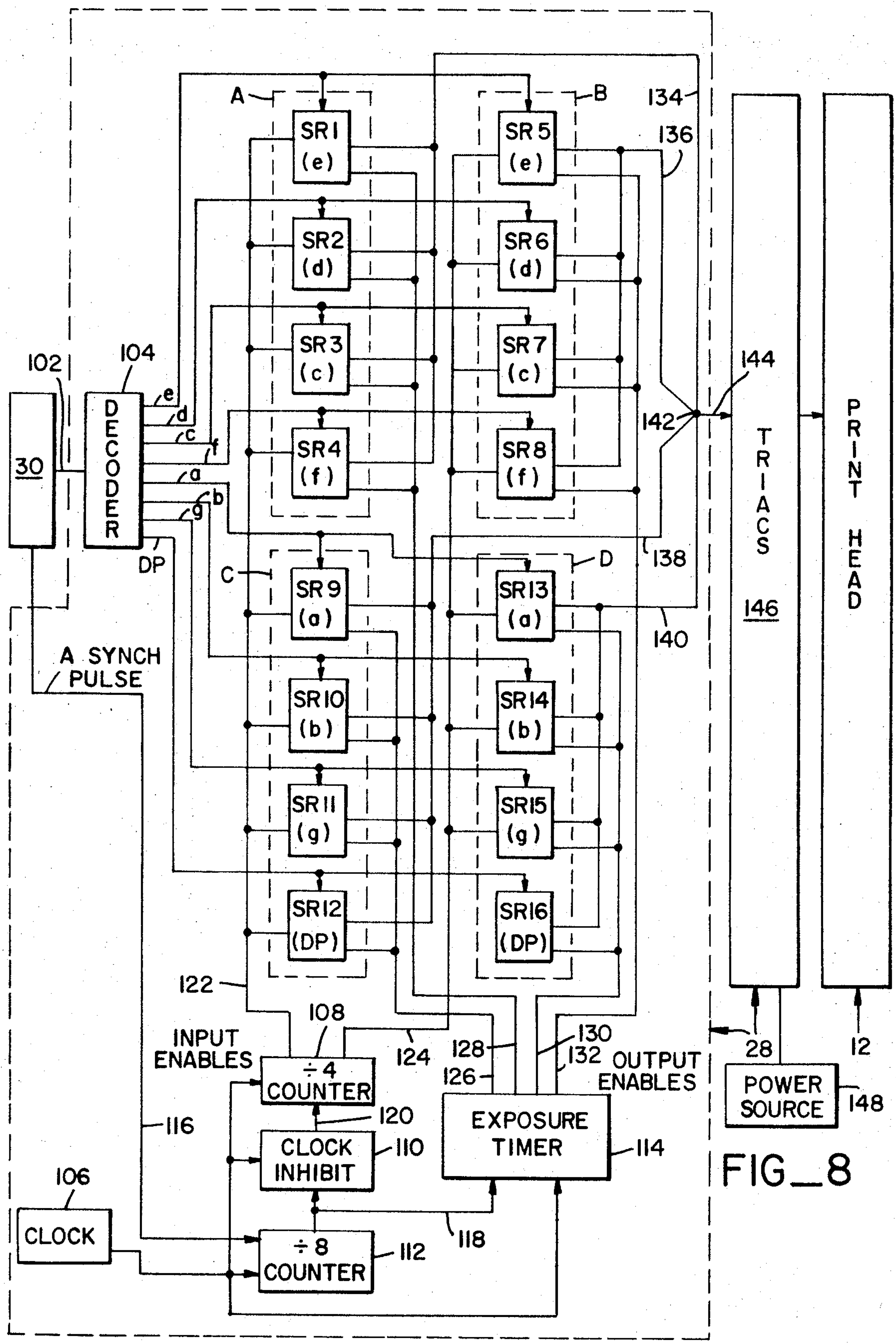
30
102
104
DECODER
e
d
c
f
a
b
g
DP
A
B
C
D
SR1 (e)
SR2 (d)
SR3 (c)
SR4 (f)
SR5 (e)
SR6 (d)
SR7 (c)
SR8 (f)
SR9 (a)
SR10 (b)
SR11 (g)
SR12 (DP)
SR13 (a)
SR14 (b)
SR15 (g)
SR16 (DP)
134
136
138
140
142
144
TRIACS
146
PRINT HEAD
A SYNCH PULSE
122
108
INPUT ENABLES
÷4 COUNTER
124
128
126
130
132
OUTPUT ENABLES
120
CLOCK INHIBIT
110
EXPOSURE TIMER
114
116
106
CLOCK
÷8 COUNTER
112
118
28
12
POWER SOURCE
148

FIG_8

THERMAL PRINTING SYSTEM

This invention relates to a thermal printing system for electronic computing measuring or recording apparatus such as electronic calculators.

While many electronic calculators employ light-producing display devices to provide a temporary readout, it is often desirable, if not essential, to provide a printed readout that can serve as a permanent and tangible record. Mechanical printers are not entirely satisfactory in many instances because they are mechanically complicated, often noisy and slow, as well as being bulky and expensive.

One general object of the present invention is to overcome the disadvantages of mechanical printers by providing a thermal printer for electronic calculators or computing devices that is completely noiseless and will produce a printed readout on heat sensitive paper with a high degree of speed and clarity.

Another object of the present invention is to provide a thermal printing device for electronic calculators and the like that is relatively small, compact and particularly well adapted for ease and economy of manufacture.

Still another object of the present invention is to provide a thermal printing device for electronic calculators and the like that is highly compatible for use with electronic calculators utilizing integrated circuit semiconductor devices for its computing or arithmetic logic circuitry.

One problem that arose during previous efforts to develop thermal printing devices was in providing a system capable of producing printed alpha-numeric characters by electrically heating preselected segments of master characters and moreover to accomplish this by utilizing a minimum number of electrical interconnections. Accordingly, it is another object of my invention to solve this problem by means of a system wherein predetermined groups of heating elements forming the segmented parts of master characters on a print head are heated sequentially on a time-sharing basis during a print cycle.

Another object of my invention is to provide a thermal print head having resistance type segmented elements forming master characters which when selectively energized will heat up evenly and then dissipate their heat rapidly so that a minimum amount of time is required between print cycles and the printout copy will be clear and distinct.

Yet another object of my invention is to provide a print head constructed as a composite multi-layer ceramic and metal structure with internal connections that are reliable and durable.

The aforesaid objects are accomplished by a thermal printing system which provides a driving control data handling and multiplexing function to control electrical energy supplied to an integrally structured heater element assembly or print head. Essentially, the data handling and multiplexing or logic and control sub-system in the form of semiconductor integrated circuitry, includes logic circuitry that decodes data from a driving source such as a calculator output, stores the decoded data and then furnishes it to a power control subsystem. The latter operates to apply electrical energy to different groups of characters on the print head in a timed sequential order during each print cycle. In the embodiment of my invention described herein the print head is a laminated structure comprised of a top metallized layer formed on a ceramic plate as a series of segmented master characters arranged in a horizontal row, each character having seven segments or heater elements including a committed decimal point as an eight heater element. When the master character segments are energized in different combinations and pressed against heat sensitive paper they will form readable alpha-numeric characters. The print head structure includes internal and bottom metallized layers in the form of conductive paths which are connected with the character segments of the top metallized layers. Ceramic layers between the metallized layers afford complete environmental protection for the interconnections and a base for a series of bonding pads so that the print head can be readily connected directly to leads from the logic and control sub-system. The eight segments or heater elements for each master character are divided into two 4-element sections, and these sections are connected to form four segment groups which are energized on a time sequential basis by means of the logic and control sub-system. Thus, only four power drivers are required for each 7-segment character plus decimal point, thereby providing system compactness and operating efficiency. Further time sharing for energizing the master characters on the print head is accomplished by electrically paralleling the power drivers of a single character to other master characters causing the supply terminals of these characters to be energized in time sequence. This clustering of time shared character groups enables the number of required power drivers to be kept to a minimum and permits optimization of the time sharing sequence so that it can be made compatible with the print head structure. The time sharing and sequential energizing of character segment groups also controls the heat flow to and dissipation from the character segments so that clear, distinct thermal print copy is obtained.

Other objects, advantages and features of my invention will become apparent from the following detailed description taken in conjunction with the drawings, in which:

FIG. 1 is a view in perspective showing an electronic calculator with a thermal printer embodying the principles of the present invention;

FIG. 2 is a view in side elevation of the calculator of FIG. 1 with portions broken away;

FIG. 3 is an enlarged plan view of my multilayer thermal printer package with portions broken away to show the various layers;

FIG. 4 is an enlarged fragmentary and exploded view in perspective showing a portion of the thermal printer package of FIG. 3;

FIG. 5 is a further enlarged fragmentary view in section of the thermal printer package;

FIG. 6 is an enlarged fragmentary view showing a single character of my thermal printer with its electrical connections;

FIG. 7 is a diagrammatic electrical representation of the single character of FIG. 6 as seen from its underside; and

FIG. 8 is a block diagram showing the logic and control sub-system for my thermal printer according to the present invention.

With reference to the drawing, FIGS. 1 and 2 show a typical electronic calculator 10 as it appears when utilizing a thermal printing system embodying the principles of the present invention. Generally, the system includes a print head **12** located within the calculator housing **14** which is attached thereto by a support member **16** having a high thermal conductivity, such as a rigid and fairly thick piece of metal. This support member may be generally U-shaped so that its ends **18** can be fixed to the sides of the calculator frame or housing, thereby enabling it to serve as a heat sink or heat dissipator for the print head. One surface of the print head **12** is located adjacent to a platen **20** that is movable as by a solenoid **22** to a position against the printer surface. A roll of heat sensitive paper **24** is also mounted rearwardly in the calculator housing and its free end **24***a* extends upwardly between one surface of the print head and the platen. Some suitable means (not shown) are provided for advancing the paper in increments after each printing cycle. Such mechanical features as the platen and its control, the paper advancing means and other standard calculator mechanisms are well known to those skilled in the calculator art and therefore are shown only schematically and will not be described in detail here. Within the calculator **10**, the print head **12** is connected, as by a multi-lead flat cable **26** to a logic and control subsystem **28** situated within the calculator housing. This printer sub-system is connected to the calculator logic circuitry **30** which receives inputs from the keyboard **32** or input control and produces output data in the conventional manner. This general arrangement is shown schematically in FIG. **2**.

The print head **12** as shown in the enlarged view of FIG. **3** is a multilayered package with a generally rectangular shape comprising a dielectric layer **34** or plate made from a material such as a suitable ceramic having a smooth planar surface on its upper side. Formed on this ceramic surface from a layer of electrically conductive material are a series of spaced apart multisegment master characters **36** arranged in horizontal alignment. Selective heating of different combinations of segments of these master characters will form different numerical figures. Thus, when the print head surface is adjacent the heat-sensitive paper **24** and pressed against it the heated character segments will print the proper figures.

As shown in greater detail in FIGS. **4** and **5**, a second dielectric plate **38** is located beneath the upper layer or plate **34** and these two plates are held together as a unitary laminated structure by some suitable means. On the upper surface of the upper dielectric layer **34** the master characters **36** are preferably portions of a metallized layer formed by masking and vapor deposition steps in the conventional manner. It should be apparent that any desired number of characters may be used although generally an eight character display or printout is preferred for calculators. Between the master characters including the ends of the character row are period or decimal point symbols **40** and at one end of the row is a minus sign **42**. Between the two dielectric plates or layers **34** and **38** of the printer is a buried metallization layer formed as a multiplicity of conductive bars or paths **44** and **46** which provide for interconnection of ground lines for all of the various segments of the master characters **36**. A series of transverse conductive members called "vias" **48** (also designated as +'s on the drawings) extend through the upper dielectric plate **34** and interconnect the ends of each of the character segments at various points with certain of the conductive bars **44** and **46**. On the bottom surface of the lower dielectric plate **38** is a third or lower metallized layer formed in a different predetermined pattern of spaced apart conductive bars or paths **52** and **54**. Another series of "vias" **48** extend transversely through the upper and lower plates to interconnect the master character segments with bars **52** forming driver lines. Other "vias" extend from the conductive bars **46** of the buried metallized layer to bars **54** forming the ground lines. As shown in FIG. **3**, the driver lines are **16** in number for the embodiment shown and they extend to bonding pads **56** located along one edge of the print head. Four other bonding pads **58** for the ground lines are preferably located elsewhere on the bottom surface of the lower plate **38**. The entire layout of the various bars and paths for the intermediate and lower metallized layers are not shown because it is apparent that such is a matter of design which is readily attainable by those skilled in the art.

In the present invention each master character **36** is formed from a portion of the upper metallized layer in a configuration resembling a figure eight. As shown best in FIG. **6**, each character has an enlarged free end portion **60** located on one side to which one contact or via **48** is connected at a point designated by the number **62**. This end portion continues upwardly to form a segment "*f*," then over along a segment "*a*" and then downwardly along a segment "*b*" to form the upper half of the character. The lower half of each master character is formed by four connected segments "*c, d, e* and *g*" arranged in generally a rectangular configuration. A series of six other contact points or "vias" are provided at the ends of the various connected vertical and horizontal segments forming the character. Thus, a via **64** occurs at the junction of segments *f* and *a;* via **66** is at the junction of segments *a* and *b;* via **68** at the junction of *b* and *c;* via **70** at the junction of *c* and *d;* via **72** at the junction of *d* and *e;* and via **74** at the junction of *e* and *g*. On one side of each master character is a period symbol **40** formed by a segment having two contact points **76** and **78** and on the opposite side is another period symbol with contact points **80** and **82** which may also be connected to the contact points **84** and **86** of the horizontal minus sign symbol **42** at one end of the row of characters. When current is applied to the various pairs of these contacts or vias, current will flow through the segment between them and the resistance of the segment will cause it to heat up. This heat, transferred to the heat sensitive paper will cause the printing action to take place.

An electrical equivalent of the character and its various segments is shown in FIG. **7** with the conductive metallized bar portions between contact points specified as separate resistances and similarly designated including separate resistances for the decimal points **40** on opposite sides of the character. As shown, each decimal point has essentially an H-shaped configuration which provides the necessary conductive paths between its connections **76** and **78**. When printed the H-shape becomes essentially a solid dot.

One end of each of the segments or resistances *a* – *g* are connected to either one of two ground leads **88** and **90**. The opposite end of each segment or resistance is connected by appropriate leads to one of four drive line lower leads designated **92, 94, 96** and **98**. A separate drive line **100** is provided for the minus sign **42** and the ninth decimal **40**. The interconnecting lead **46** of the intermediate metallized layer connects the ground contact points **64** and **72** on each character and the lead **44** interconnects contacts **68** and **82**. Still another portion of the lead **44** interconnects the ground lead **90** with contacts **78, 82** and **86.**

With respect to the configuration of my master character, it will be noted that since the segments *e, g, c* and *d* in the lower portion of each character are all joined together, a potential placed across the ends of segment *e* will also cause current to flow in the other connected segments *c, d* and *g*. The question might arise as to why these segments do not also print when segment is energized. The following will explain this. The combined resistance of the three segments *c, d* and *g* is approximately three times as much as segment *e* and therefore one third as much current will flow in them when a potential is applied between the end connections of segment *e*. The temperature which all segments will attain as a result of electrical conduction is proportional to the square of the current through each. Therefore, in this example the temperature reaction in the directly connected segment *e* is approximately nine times that in the other segments *c, d* and *g* and although these latter segments will conduct some current it will not be enough to cause their temperature to increase above the threshold level (e.g. 250°C) that is required to produce a printout on heat sensitive paper. Thus, the configuration and electrical hookup for my master characters takes advantage of this temperature-current relationship to further enhance the efficiency of the system.

It is necessary that the metallic character segments on the print head **12** be sized in width and thickness so as to heat rapidly to the temperature level required for printing on sensitive paper. Yet, it is desirable to accomplish the heating with a minimum of power. I have found that forming the master characters from nichrome (80% Cr, 20% Ni) having a thickness of around 0.0002 inches provides satisfactory results. During the brief time period of a print cycle these metallic characters on the upper dielectric plate of ceramic material lose relatively little heat by conduction and therefore the printed symbols produced on heat sensitive paper are clear and distinct. Yet, when the cycle is complete, the heat in the metal characters dissipates with sufficient rapidity so that only a short cooling period is required between print cycles. The heat dissipation may be further enhanced by the heat sink mounting bar **16** which conducts excess heat from the print head to the chassis or housing of the supporting structure.

Another important feature of my printing system **10** which contributes to its performance and efficiency is the logic and control sub-system **28** which multiplexes the data to be represented by the printout so that during each print cycle four separate groups of character segments are heated in a time-sharing sequential manner instead of all characters being heated simultaneously. In a block diagram of this sub-system, as shown in FIG. **8**, the block **30** represents a typical driving or computing system such as a calculator, minicomputer, counter or electronic measuring system. The outputs of this block are provided in some coded format such as binary coded decimal (BCD) and they are transmitted through a plurality of lines (e.g. 4) represented by the lead **102** in a bit parallel, character serial format. It should be understood that the particular code or format is not limiting to the design and operation of the thermal printer logic which may utilize data in synchronous form or, as in an electric typewriter, asynchronous form. However, in the description of the logic sub-system **28** that follows, the example of a four line binary-coded-decimal bit parallel, character serial asynchronous model will be used.

As indicated in FIG. **8**, input signals are received from the driving system **30** through leads **102** and are entered into a decoder **104** of the logic sub-system. These input BCD signals appear on the output terminals of the decoder as decoded seven segment signals. In other words, the outputs from the driving system represent a series of numerals that are to be printed out. The decoder takes this data in BCD form and produces seven outputs designated by letters *e, d, c, f, a, b* and *g* that represent the numerals to be printed as combinations of the various character segments that will form these numerals. An additional output lead DP from the decoder provides decimal point information. Now, for each of the decoder outputs there are two shift registers. Thus, the sub-system includes **16** shift registers, designated **SR1** to **SR16** and these are arranged in four banks designated A, B, C and D. All of the decoder outputs are connected to these shift registers. For example, the output *e* from the decoder is connected in parallel to the shift registers SR1 and SR5 of banks A and B; the output *d* is connected to the shift registers SR2 and **SR6**, and so forth, as shown. Each of the shift registers has storage capacity for four bits of information, and therefore the pair of registers SR1 and **SR5** will hold the information relating to the segment *e* for a total of eight characters. As the printing system described herein is intended for printing eight characters requiring 64 bits of information, it follows that the shift registers (**SR1** to **SR16**) combined will hold the character and decimal point information for an entire eight character word.

The logic sub-system further includes a clock generator **106** of the conventional type that produces clock pulses for operating the shift registers and other elements. The clock generator output is supplied to the following components connected in parallel: a divide by four (÷ 4) counter **108**; a clock inhibit **110**; a divide by eight (÷ 8) counter **112**; and an adjustable exposure timer **114.** The ÷ 8 counter is also connected to an input lead **116** that provides an asynchronous start pulse from the driving system. The output from the ÷ 8 counter **112** is supplied by a lead **118** to both the clock inhibit **110** and the exposure timer **114,** and an output lead **120** from the clock inhibit **110** is connected to the ÷ 4 counter **108.** The latter has two output leads **122** and **124** that supply input enables to the system, the former being connected to the shift registers of banks A and C in parallel and the latter being connected to the shift registers of banks B and D in parallel. The exposure timer **114** supplies output enables to the system through four leads **126, 128, 130** and **132** which are connected to the shift registers of each of the four banks A, B, C and D. The four outputs of each of the four shift registers in each of the banks are thus enabled by one of the pulses from the exposure timer. This shift register outputs designated as leads **134, 136, 138** and **140** from all of the four banks A, B, C and D respectively, thus total **64** outputs for an eight character word and thus are connected to a junction **142.** Extending from this junction are **16** leads, designated by the numeral **144,** each lead being supplied to one triac in a bank of **16** triacs designated by the block **146.** The triac bank is connected to an electrical power source **148** (e.g. 110 volt AC) which is connected to all of the triacs in parallel, so that when each triac is energized it furnishes power to the print head. The **16** leads from the triacs of the bank **146** are connected to the **16** bonding pads **56** for the drivers of the print head **12.** Thus, as power is supplied to each bonding pad it is conducted through the conductive portions **52** of the lower metallized layer, through the dielectric plates **38** and **34** and ultimately to the various segments of the characters **36** on the top face of the print head.

The operation of the logic control sub-system for the thermal printer may be readily understood by the following description of a typical printing cycle with reference to clocking. Coded output signals (e.g. four line BCD) received from the driving system are decoded in the decoder and decoded seven segment signals in serial form for all the master characters **36** and the decimal point now appear on the decoder output leads *e, d, c, f, a, b* and *g* and DP. With each clock pulse this output data from the decoder is placed in storage in the shift registers SR1 to SR16. For example, the SR1 receives the data for the segment *e*, SR2 for the segment *d*, SR3 for segment *c*, SR4 for segment *f*, SR9 for segment *a*, SR10 for segment *b*, SR11 for segment *g* and SR12 for the segment DP. On clock pulse No. **1** SR's **1, 2, 3, 4, 9, 10, 11** and **12** receive data for the first SR store position and the received data represents one character of the printout. On the second clock pulse another set of pulses are provided from the decoder **104** to the shift registers which receive it and also shift the data of the first clock pulse to the second position. The same action takes place in the third and fourth clock pulses at the end of which the SR's **1, 2, 3, 4, 9, 10, 11** and **12** are loaded with all the data for four of the eight characters to be printed. The clock pulses from the generator **106** are supplied through the ÷ 4 counter **108** to the aforesaid SR's. However, after the fourth clock pulse this counter enables the SR's **5, 6, 7, 8, 13, 14, 15** and **16** so that on the next four clock pulses **5** through **8,** these latter SR become loaded with data representing the remaining four characters of the word to be printed including the decimal point at its proper location. During the data storage process the clock inhibit component **110** functions to assure that the shift register input enable signals from the ÷ 4 counter **108** are only activated coincident with the availability of the input data. As shown in the block diagram of FIG. **8,** the appearance of the asynchronous input pulse in lead **116** "ands" with a clock pulse to advance the divide by eight counter **112.** This removes the clock inhibit command **110** from the input enable ÷ 4 counter **108** and starts the loading of the first of eight characters in the appropriate shift registers. The next asynchronous pulse will load the shift registers for character **2** and the eighth asynchronous pulse will load character eight as described. After character eight has been loaded the "clock inhibit" disables the shift register inputs, holding the information for printout.

The operation of the thermal print head requires electrical driving in four successive time intervals for the eight characters of printout. In each of these time intervals sixteen electrical signals are utilized to heat the particular segments of the characters being printed. These sixteen signals are obtained by sampling the outputs of all four registers of the SR's **1, 2, 3** and **4** during the first time interval of the print cycle. The length of each time interval generally comprises a large multiplicity of clock pulses so that its duration may be of the order of 0.05 seconds. The exposure timer **114** is used to control the "on initiate" or print start and the "on duration." The latter which is essentially a simple counter means has an adjustable setting so as to provide control of the printing time and hence the printing contrast or density, which may vary for different types of thermal print paper. The exposure timer may also be made operative in response to a thermal sensor (not shown) that measures the overall temperature of the print head. Thus, if the duty cycle for the system increases so that a rapid influx of data has elevated the residual temperature of the print head, the sensor will signal the exposure timer and cause it to reduce the length of exposure time during the print cycle.

The sixteen print control signals obtained from the logic sub-system **28** are used to turn on the sixteen triacs in the bank **146** and thereby deliver power to the print head in the following manner. During the second thermal print interval the exposure timer enables the outputs of SR's **5, 6, 7** and **8.** The **16** signals from these SR's are then used to drive the same set of **16** triacs to activate the segments *e, d, c* and *f* on the characters **5, 6, 7** and **8.** In a similar manner, during the third and fourth print intervals SR's **9, 10, 11** and **12** and **13, 14, 15** and **16** are enabled successively to activate the triacs and heat the segments *a, b, g* and DP in one half of the eight characters in the third interval and the other four characters in the fourth time interval. The total print time for the eight characters printed in the four successive intervals may be of the order of 1/5 of a second. Upon completion of the print cycle, the SR's are cleared and system is ready to accept the next data from the driving system for the next eight character word. The entire circuitry for controlling the triacs which is designated by the numeral **120** in FIG. **8** can be formed as a single integrated circuit semiconductor device, such as an MOS (metal-oxide-silicon) device. Thus, the circuit for the logic and control system can be extremely compact and highly compatible with the circuitry of the driving apparatus.

From the foregoing it is seen that the logic accomplishes a multiplexing or time sharing of power applied to the print head which has several advantages. For one thing the number of driving leads required on the print head is limited to **16** rather than **64** if time sharing of the triacs was not used. This greatly simplifies the construction and operation of the print head, thereby decreasing its ultimate cost while increasing its reliability and life. Another advantageous result derived from my time sharing arrangement is that a more even surge of heat is applied to the characters of the print head and more distinct and well defined print copy is obtained on the heat sensitive paper. Moreover, the problem of dissipating residual heat is reduced because the heat applied is distributed both with respect to time and area.

To those skilled in the art to which this invention relates, many changes in construction and widely differing embodiments and applications of the invention will suggest themselves without departing from the spirit and scope of the invention. The disclosures and the description herein are purely illustrative and are not intended to be in any sense limiting.

I claim:

1. A thermal printing system for producing a printed record of a data output from an electronic measuring or computing apparatus, said system comprising:

a print head including a planar member of electrically non-conductive material, a series of master characters formed from a layer of electrically conductive material on the upper surface of said planar member, each said master character being comprised of a plurality of segments capable of forming human readable characters when viewed in preselected segment combinations, contact terminals at the ends of said segments for each of said master characters, interconnect means on and within said print head for conducting electrical current to each of said character segments; and

a logic and control sub-system connected to said print head and including means for receiving and storing data from said measuring or computing apparatus and providing means responsive to the receipt of said data for utilizing the stored data to supply electronic current to predetermined groups of said character segments on a sequential time-sharing basis during a print cycle.

2. The thermal printing system as described in claim 1 wherein said planar member comprises an upper ceramic plate and a lower ceramic plate; said master characters are formed from a top metallized layer on the surface of said upper ceramic plate; and said interconnect means includes an intermediate metallized layer between said ceramic plates forming conductive paths arranged in a predetermined manner, a lower metallized layer on the bottom surface of said lower ceramic plate forming a plurality of conductive paths terminating in bonding pads, and a multiplicity of connector means extending through said upper and lower ceramic plates for interconnecting the contact terminals of the segments of said master characters.

3. The thermal printing system as described in claim 2 wherein said intermediate metallized layer is formed to provide conductive paths that interconnect one terminal of each segment for all of the master characters with four separate ground paths, said lower metallized layer including four bonding pads connected to said ground paths of said intermediate metallized layer and sixteen bonding pads for driven inputs connected through both said ceramic plates to the ungrounded ends of master characters on said top metallized layer.

4. The thermal printing system as described in claim 2 wherein each said master character has generally a figure eight configuration comprised of seven connected segments of substantially equal width and thickness including two pairs of substantially vertical segments and three spaced apart top, bottom and middle horizontal segments, one of said vertical segments including an enlarged end portion spaced from the junction of said middle horizontal segment and an adjacent vertical segment.

5. The thermal printing system as described in claim 4 wherein the three upper segments and four lower segments are connected together at their ends to form a continuous metal path and means forming ground connections at one end of both the top and bottom horizontal segments and the opposite end of the middle horizontal segments.

6. The thermal printing system as described in claim 3 wherein said bonding pads for the driving leads are spaced apart along one side of the bottom surface of said lower plate.

7. The thermal printing system as described in claim 1 wherein said logic and control means comprises: means for receiving and decoding data from said apparatus;

a plurality of storage means for storing decoded data;

means for enabling the output of said storage means in a time sequential order to provide groups of output control signals;

electrical power means;

and switch means responsive to said output control signals for supplying power from said power means to said print head.

8. The thermal printing system as described in claim 7 wherein said storage means comprises a pair of shift registers for each character segment and capable of storing data for that segment for each of the master characters on the print head.

9. The thermal printing system as described in claim 7 wherein said output enabling means comprises an exposure timer including means for increasing and decreasing the length of time during which said switch means are operative to cause heating current to flow from said power means.

10. The thermal printing system as described in claim 7 including clock means for enabling said shift registers to shift and store data from said decoding means and counter means for shifting the data received from one group of shift registers to another group so that a plurality of data storage means can be loaded and thereafter sampled sequentially.

11. The thermal printing system as described in claim 7 wherein said electrical power means is a 110 volt AC source and said switch means comprises a bank of triacs connected to said power source.

12. A thermal printing system for producing a printed record of a data output from an electronic measuring or computing apparatus, said system comprising:

a print head including an upper planar member of electrically non-conductive material, a series of master characters formed from a top metallized layer on said upper planar member, each said master character being comprised of a plurality of seven segments capable of forming human readable characters when viewed in preselected segment combinations, contact means at the ends of said segments for each of said master characters, means on said print head for conducting electrical current to each of said character segments;

a logic and control sub-system including decoder means for receiving and decoding data from said electrical apparatus representing a group of characters to be printed out, said decoder means having at least seven output leads for producing encoded data representing the use of each segment for each of the characters to be printed, storage means for receiving and storing the encoded segment data for each character to be printed, means for extracting the stored segment data from said storage means in groups of segments for a plurality of characters and means for energizing said print head to print said groups of segments in a time sequential manner until all of the characters have been printed in one cycle.

13. The thermal printing system as described in claim 12 including an eighth lead from said decoder means representing a decimal point.

14. The thermal printing system as described in claim 13 wherein said storage means comprises a pair of shift registers for each of the characters to be printed, clock means for controlling the shifting of segment data into said shift registers, and exposure timer means controlled by said clock means for extracting stored data from groups of said shift registers on a time sequential basis, and switch means responsive to signals from said shift registers for supplying electrical heating power to said print head.

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