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(54) **Postage metering system with indicia selectable to compensate for detected printer defects.**

(57) A postage metering system includes a printer for printing an indicia. Information is stored and adapted to generate signals for causing the printer to print a selected one of a plurality of postal indicia. A fault detection arrangement is coupled to the printer for detecting faults in the printer. The printer is caused to print a selected one of the plurality of indicia depending upon the fault sensed. The indicia may be a composite indicia formed from a plurality of portions of stored postal indicia. The size and position of the indicia and indicia elements, which may be printed or bar code information, may be altered in location and size, if desired, based on the detected fault in the printer.

EP 0 605 122 A2

The present invention relates to postage metering systems and, more particularly, to a printing postage metering system having plural indicia selectable to compensate for detected defects in the printing system.

Postage metering systems print and account for postage and other unit value printing such as parcel delivery service charges and tax stamps. Because these systems print indicia and information having monetary value, the systems must be secure to protect the funds for which they account and must insure that proper indicia printing occurs.

It has also been suggested in the thermal printing area that when thermal printing element failures are detected, it is possible not to utilize a detected defective thermal printing element during a normal printing operation. One such system is disclosed in U.S. Patent No. 4,595,935 for SYSTEM FOR DETECTING DEFECTIVE THERMAL PRINTHEAD ELEMENTS issued June 17, 1986.

Various electronic postage meter systems have been developed, as for example the systems disclosed in U.S. Patent No. 3,978,457 for MICROCOMPUTERIZED ELECTRONIC POSTAGE METER SYSTEM issued August 31, 1976 and U.S. Patent No. 4,301,507 for ELECTRONIC POSTAGE METER HAVING PLURAL COMPUTING SYSTEMS issued November 17, 1981. Electronic postage meter systems have been employed with various printing systems. Examples include the postal meter thermal printing control disclosed in U.S. Patent No. 4,605,937 for POSTAL METER THERMAL PRINTER CONTROL issued August 12, 1986 and the ink jet printing system disclosed in U.S. Patent No. 4,168,533 for MICROCOMPUTERIZED MINIATURE POSTAGE METER issued September 18, 1979.

The utilization of printing systems such as thermal printing, pin printing, ink jet printing or xerographic printing or laser printing, have allowed the provisions of added features and capabilities in metering systems. This includes the ability to print different fixed and variable information in the advertisement slogan and postage indicia such as date, city and town based on information stored in the meter read only memory or non-volatile memory, depending upon the design of the postage metering system. It has been proposed that graphic change information can be downloaded from a remote location over a communications path to the postage metering system and changed in the metering system when a different pattern is authorized as is disclosed in U.S. Patent No. 4,933,849 for SECURITY SYSTEM FOR USE WITH AN INDICIA PRINTING AUTHORIZATION DEVICE issued June 12, 1990.

It has been recognized that thermal printing metering systems and other types of printing systems can have a failure or fault occur at a user location. A thermal printing pin failure, for example, can be detected such that further printing cycles are allowed if a sufficient number of elements can be operated to effect printing, otherwise further printing is inhibited. Alternatively, the printing data may be printed in machine readable form. The data is read to produce a signal which is compared with data intended to be printed or printed in a visual inspectable form. One such system is disclosed in U.S. Patent No. 4,813,802 for DEVICE FOR VERIFYING IF THERMAL PRINTER IS OPERATING CORRECTLY issued March 21, 1989.

While the above systems provide features and functionality useful in postage metering systems, it is desirable to provide both increased security and also to further enhance the ability of such systems to be maintained in an operable mode in the field despite various failures in the meter printing system. This is particularly important because postage metering systems are mass produced business equipment which must be both low cost and have high reliability, while not being field serviceable because of postal regulations and the need to preclude entry into the interior of the postage metering system secure housing.

It has been discovered that in postage metering systems, high security can be retained enabling the printing of high quality indicia and other information, despite the failure of the printer subsystem.

The present invention provides for the ability to change the indicia or to construct new indicia based on the nature of the printer failure.

The present invention also provides the capability to maintain the security of the postage metering system by continuing to print high quality indicias, including any forensic or encrypted information embodied in such indicia or elsewhere, without the need to take the metering system out of service for repair.

It has been discovered that by storing a plurality of different indicias and other information if desired, in the metering system memory or in a remote location and activating the selection of the indicia and other information based on the nature of a detected printer failure, a continued operation of the metering system can be maintained, without the compromising of metering system security and with acceptable imprint quality.

It has also been discovered that portions of an indicia may be stored within the metering system memory or in a remote location and used to form a composite indicia. Based upon detected printer failure a composite indicia is formed which provides the high level of security required and the print quality desired in postage metering systems. This is accomplished by reconstructing new indicias from the available portions of the stored indicias reducing or eliminating the consequence of the printer failure.

In accordance with the present invention, postage metering system includes a printing means for printing an indicia. Means are coupled to the printing

means for storing information adapted to generate signals for causing the printing means to print a selected one of a plurality of postal indicias. Fault detection means are coupled to the printing means for detecting faults in the printing means. Means connected to the fault detection means are provided for causing the printing means to print a selected one of said plurality of indicias depending upon the fault sensed by the printing means fault detection means.

In accordance with a feature of the present invention the selected one of the plurality of indicias is a composite indicia formed from a plurality portion of stored postal indicias.

A complete understanding of the present invention may be obtained from the following detailed description of the preferred embodiment thereof, when taken in conjunction with the accompanying drawings, where in like reference numerals designate similar elements in the various figures, and in which:

FIGURE 1 is a block diagram of a postage metering system embodying the present invention and employing a thermal printer;

FIGURE 2A through 2K are a series of indicia and portions of the indicia helpful to an understanding of the present invention;

FIGURE 3A through 3C are a series of flow charts of software suitable for implementing the selection of various indicia and alternatively forming composite indicia from stored portions of indicia depending upon the nature of a matrix printer failure;

FIGURE 4 is a schematic circuit diagram, partly in block diagram form, of a thermal printhead control logic of a postage metering system embodying the present invention and not employing the analog to digital converter used in the system as shown in FIGURE 1; and,

FIGURE 5 is a schematic circuit diagram partly in block diagram form, of the postage metering system shown in FIGURE 1.

Reference is now made to FIGURE 1. A postage metering system 2 includes a microprocessor 4 having a memory system 6. An input means 8 is connected to the microprocessor 4.

The input means may be a keyboard or input port or other device for inputting information into the postage meter system 2. The postage meter system may be a self contained stand alone unit or a detachable meter adapted to be physically connected to a mailing system as is known in the postage meter field. The postage metering system may also be a system such as those involving personal computers and postal fund vaults as is disclosed in U.S. Patent No. 4,775,246 for SYSTEM FOR DETECTING UNACCOUNTED FOR PRINTING IN A VALUE PRINTING SYSTEM issued October 4, 1988.

A secure housing 10 encloses the microprocessor 4 and the memory system 6. Depending upon the postage metering system design, the input 8 and the thermal printhead 12 may or may not be enclosed within the secure housing 10.

The memory system 6 may include a plurality of different types of memories. There may be one or more read only memory or other suitable memory for storing the operating program for the metering system and the various postal indicias or portions and other information shown in FIGURES 2A through 2K. These operating programs and indicias, indicia portions and other information may, alternatively, in whole or in part, be stored in a non-volatile memory. Examples of some such memories include EEPROMs and battery backed CMOS devices. The division of portions of the indicia and operating programs between various types of memories depends upon the particular design involved and the applications for the postage metering system 2. Additionally, the memories can be organized so that some of the programs and/or data are at a user location and some of the programs and/or data are at a remote location.

As used herein indicia or postal indicia are intended to mean the graphic and other information, or portion of such graphic or other information, printed by the postage metering system 2. The graphics can be of any design such as an eagle or other emblems and the other information can be alpha numeric and/or coded or encrypted information. This information may be printed either in alpha numeric or other form such as bar codes. The information printed can include the meter serial number, the postage amount, the date, the city, state or country and a cryptocode. The cryptocode is often based on information printed by the metering system such as serial number, date, and postage amount and is employed to authenticate the postage imprint and enable detection of fraudulent or counterfeit indicia. Examples of such cryptoauthentication systems are disclosed in U.S. Patent No. 4,641,347 for SYSTEM FOR PRINTING ENCRYPTED MESSAGES WITH A CHARACTER GENERATE AND BAR-CODE REPRESENTATION issued February 3, 1987 and the above-noted U.S. Patent No. 4,775,246 for SYSTEM FOR DETECTING UNACCOUNTED FOR PRINTING IN A VALUE PRINTING SYSTEM issued October 4, 1988. The quality and clear printing of the cryptocode and the information on which it is based for authenticating the imprint is, thus, of importance in postal systems. This is particularly important since postage meter imprints may constitute very large amounts of revenue for the Postal Service.

The operation of the printhead 12 and the related circuitry is disclosed in greater detail in FIGURES 4 and 5. However, it should be noted that when the metering system 2 is not printing, the microprocessor causes the thermal print elements of the print element array shown generally at 14, such as print element 16, to be turned on one at a time. The current

flowing through the print element is measured. The value of the current flowing through the print element is processed by an analog to digital converter 18, and the digitized information provided to the microprocessor 4.

Based on a program stored in the memory system 6, the microprocessor will determine if the print element resistance is within an acceptable range. If it is not within an acceptable range, the microprocessor 4 under program control compensates for that element failure by using a different adjacent element during a printing operation instead. The substitution can be such that it minimizes the perception of the print element failure by the reader of the imprinted indicia. However, this is the case only when the quality of the imprinted indicia graphics and any encrypted or other information to be imprinted is not compromised by the nature of the detected printer failure.

When there is a compromise in the quality or security of the imprint, particularly, the indicia graphics, or the encrypted information, if any, the system, as is hereinafter described in greater detail, will cause the printer to print a different indicia or to relocate the indicia and/or the encrypted and other information to minimize the effect of the printer failure.

Referring again to FIGURE 1 when the meter is not printing, it will turn off transistor 19. Transistor 19 shorts out resistor 20 when the transistor is biased into conduction by the microprocessor 4. The microprocessor 4 will then under program control turn on one of the printhead elements by appropriately shifting information to the printhead shift register 22 which is then latched and thereafter gated or strobed to allow current to flow through the print element. The current drawn by the element flows through resistor 20. The microprocessor 4 assesses the voltage developed across resistor 20 via the operational amplifier 24 and the analog to digital convertor 18, by analyzing the digital value generated by the analog to digital convertor 18. Microprocessor 4 compares the value provided by the analog to digital convertor 18 with the limits stored in the memory system 6. If the value is outside these limits, the particular element being measured or its circuitry is determined to be defective. The microprocessor 4 will then store in a non-volatile memory of memory system 6 the identity of the defective print element. At all future power up and initializations of the postage metering system 2, microprocessor 4 will relocate the indicia and/or the encrypted and other information to be printed or will revise the indicia with one of the indicias stored in the memory system 6 or form a new composite indicia. The graphic image and information selected to be printed will eliminate the defective thermal print element or will minimize the effect of the utilization of the defective thermal print element or a series of elements. The system can, if desired, also substitute adjacent thermal print elements to further minimize the consequences of the printer failure.

The type of substitution depends both on the nature of the pattern to be printed and by the nature of the detected failure. In this manner, the failure of a print element or a series of print elements will have little effect on the quality of the indicia image or other information to be printed.

If desired, the image (or a portion of the image) can be stored in a non-volatile memory which can be erased and rewritten with new information. The indicia to be printed by the thermal print head 12 may be a software generated, bit map graphic indicia or portions. This permits the entire indicia or any portion of it or the other information to be adjusted in the field. Moreover, the indicia can remain the same and only its size or shape changed. As an example, the user of the postage metering system 2 could be required to call a remote data center once a month or once a quarter to receive a new code number to be entered into the meter input 8. The new code word would be generated in a manner similar to that process used to load additional postage funds into the meter system, as disclosed for example in U.S. Patent No. 4,097,923 for REMOTE POSTAGE METER CHARGING SYSTEM USING AN ADVANCED MICROCOMPUTERIZED POSTAGE METER issued June 27, 1978. The new code word would be acted upon by the meter software to change the printed indicia graphics. At the same time, Post Offices would be given a new graphic template to compare against the incoming metered mail. This template could be used visually to inspect the incoming mail for compliance as part of the Postal Services incoming mail acceptance procedure. Alternatively, the template could be in the form of an electronic image to facilitate automatic imaging and/or verification by the Postal Service of the incoming metered mail.

Mail not having the correct image for that period of time would be rejected and the source of the imprint investigated. The new image could be initiated either nationally or regionally or even down to a unique customer as desired by the Postal Service. In this manner, mail can be tracked for a specific customer or for data collection purposes or for fraud trapping if the meter is illegally moved by means of specifying the particular indicia and/or indicia graphics required to be imprinted by the meter system 2 or meter systems in a given region or for a given time period.

A calendar clock contained in the meter can be employed to turn off the graphics if not updated for the required time period or the graphics could be auto altered to indicate visually, by machine readable indication or by encrypted information that an update is required. Manual meters, that is meters that do not employ remote recharging, could also be required to use the update system when the metering systems is physically taken to the Postal Service to be reset with additional funds.

If the meter system 2 is connected to a auto phone dialing system to connect to a data center, as for example for funds recharging, the updates could take place automatically. If desired, these updates can be implemented transparent to the user at an increased frequency. The frequency, depending upon the systems could be on a daily basis or other type system can be employed such as is disclosed in U.S. Patent No. 4,864,506 for POSTAGE METER RECHARGING SYSTEM issued September 5, 1989 and U.S. Patent No. 4,831,554 for POSTAGE METER MESSAGE PRINTING SYSTEM issued May 16, 1989. The Postal Service can also provide the images to users in encoded form on floppy disks or other means. The system when utilized in conjunction with a cryptographic code for verification of the indicia increases the difficulty of counterfeiting postal indicias and assists in tracking postage meters.

If desired, the indicia and graphic image to be printed by the meter system 2 can be derived from a cryptocode provided for security. This cryptocode can be encoded as a function of time and the match can be done visually or electronically using imaging techniques. It should be also noted that a meters indicia could be activated for a new installation only after the data center call is made as is disclosed in U.K. Patent Application No. 2 251 213 A for POSTAGE METER. Thus, all new meters arrive at the users facility inoperable and, if lost, stay inoperable until telephone contact is made with the data center.

The above described system capabilities are enhanced when coupled with the ability to revise the graphics and/or indicia or other information to be printed based on failures of the metering system printer. This allows both an enhanced security by providing a new level of security by means of changed indicias and other information as noted above while allowing the flexibility to revise these indicias based on failures of the printer.

Reference is now made to FIGURES 2A through 2K which show a series of various indicia and information which may be imprinted on a mailpiece or label. This information shown printed on a label adhered to a mailpiece or package is stored in the memory system 6 or at a remote location, except for the data entered at the meter 2, here, the postal value 23 and 7/10 cents. As can be seen by reference to FIGURE 2A an indicia shown generally at 202 is imprinted on a label 204 which is attached to a mailpiece or package 206. It should be recognized that the indicia can be directly imprinted on the mailpiece itself as opposed to being imprinted on a label which is then applied to the mailpiece or package. The indicia includes a graphic design, here, an eagle 208 with outstretched wings. The city and state where the postage metering system is located is printed at 210 and the meter serial number is printed at 212. The postage amount is printed at 214, here, 23 and 7/10 cents. Alpha numeric information is printed generally at 216 bar and half bar information is printed at 218. It should be specifically noted that the indicia just described is only one form of many forms of indicia that can be printed. The indicia can be all graphics with encrypted information embodied in the graphics the indicia can be all alpha numerics with encrypted information embodied in the alpha numerics or the indicia could be bar code or half bar code or any combination of these. The indicia 204 is imprinted by being passed under a thermal printhead 220 as can be seen in FIGURE's 2. Should a portion of the thermal elements of the printhead 220 become defective such as print elements 222 in FIGURE 2B, the indicia can be modified to accommodate the series of failed print elements 222. In FIGURE 2B the indicia is modified such that the eagle 207 is in a sitting position and further, the indicia and the other alpha numeric, 211, 213, bar code 217 and other information 215 have been shifted relative to the label 204.

Reference is now made to FIGURE 2C. As can be seen in this FIGURE a series of print elements of thermal printhead 220 are failed both at the top and the bottom of the thermal printhead. Thus, print elements 224 and 226 have failed. To accommodate this change, the indicia, alpha numeric, bar code and other information has been shifted to the middle of the label and again changed so that the defective print elements 224 and 226 are not needed to make the entire imprint. It should be noted that only that imprinted matter which would be normally printed by the failed print elements is shifted.

FIGURE 2D and 2E show two types of indicia not employing graphics where the printing of the information has been reorganized in FIGURE 2D to accommodate failed printing element 228 and in FIGURE 2E to accommodate failed print elements 229.

In FIGURES 2F, 2G, 2H, 21, 2J and 2K various portions of an indicia are shown which can be stored in either the metering memory system 6 or in a remote data center for downloading to the metering system 2 to be printed on a label or mailpiece. The various portions are shown printed alone on a label to facilitate an understanding of the invention; however, in normal operation these various indicia portions can be selectively combined to form various different indicia. For example, the eagle shown in FIGURE 2A is composed of indicia portions shown in FIGURES 2F, 2G, 2I and 2J. It should be recognized that all forms of indicia portions can be provided depending upon the particular designs desired and the level of protection against metering system printer failures. For example, the eagle portion shown in 2G can be broken into subportions including a beak portion, an upper head portion and a neck portion. In like manner any of the other portion can be broken up into multiple portions and additional other graphic, alpha numeric and bar code designs provided.

Reference is now made to FIGURES 3A through 3E. When the meter is idling at 302 with no specific task a determination is made if a key is depressed or letter inserted into the meter or other communication requested at 304. If a action is required the meter will go to service the pending request or action required by the key depression or inserted letter at 306. If there is no such action required, the program will change the thermal printhead operating mode from printing to a testing mode by making the printing/test bit equal to zero at 308. The number, stored in memory, of the previously tested thermal printhead element will be fetched and will be incremented by 1. The program will load the thermal printhead for printing a column with only the new element number NE turned on at 310. The element resistance will be read and a status bit provided at 312 which is the output of the comparators at junction 448 of FIGURE 4 as will hereinafter be described.

If the error bit is not equal to one at 314 the element is within bound and the element number NE will be stored at 316. The program will change the operating mode from the testing mode to printing by making the print/test bit equal to one and return to the meter idle at 318 for looping through the process.

If the error bit is equal to one at 314 it will store the element number and store in non-volatile memory the defective status of the element number at 320. The program will then fetch the code identifying the possible modes of compensating for the failure of each element flagged as defective in the non-volatile memory at 322.

The fetch code identifying the possible modes have been previously determined and stored either in the meter itself or at a remote location for utilization to compensate for the failure of each element flagged. This may be a bit mapped indicia or composite bit mapped indicia. The new indicia will minimize the impact of the element failures.

If there are no compensation modes common to all defective elements at 324, a write will be effectuated to the non-volatile memory of the meter that there is a fatal thermal printhead failure and the meter will be put into a fatal error state disabling the printing at 326.

If however there are compensation modes common to all defective elements, then the program will continue to determine if the compensation mode code equals zero at 326.

If the compensation mode equals zero a copy of indicia "B" (indicating a different indicia graphic) will be taken from the meter ROM to the meter RAM or alternatively from a remote location to the meter non-volatile memory for use by the RAM. The configuration data in the non-volatile memory of the meter will be changed to identify indicia "B" as current for initialization purposes and to reflect relocation of variable data fields in the indicia bit map for real time insertion of data at 328. The program thereafter continues to initialization of the meter.

If however the compensation mode is not equal to zero, a determination is made at 330 if there is a compensation mode code equal to one. If this exists, the meter will copy indicia "C" from ROM to RAM of the meter and change the configuration data in non-volatile memory to identify indicia "C" as current for initialization purposes and also to reflect relocation of variable data files in the indicia bit map for real time insertion of data at 332. The meter thereafter goes into the initialization.

As is clear from the flow chart this is a repetitive process and as many different composite indicias are stored as is necessary to provide the level of redundancy desired. This will be a compromise based on meter memory size and the number of print elements as well as the cost of bringing meters into and out of service. The process is again reiterated at 334 and as many times as is necessary where a determination is made if there is a compensation mode code equal to five. If this exists, indicia "D" will be copied from the ROM to the RAM and the configuration data in the non-volatile memory will be changed. This, as before, will identify the indicia "D" as current for initialization purposes and reflect relocation of variable data fields in the indicia bit map for real time insertion of data at 336.

At decision block 338, a determination is made if a compensation mode code six exists. If this exists, the variable data in field "A" will be relocated in the indicia bit map for real time insertion of data at 340. This relocates the variable data field "A" and the bit map stored in the meter RAM and changes the configuration data in non-volatile memory for initialization purposes. In this case, it is only the data which is relocated and not the graphics of the indicia. As before, this information can be stored locally in the meter memory system 6 or in a remote location. Again, many various reorganizations of the data are possible with the same previous type of considerations.

Through compensation mode code 11 decision at 342 and the relocation of variable data field "B" at 344. If none of the previous alternatives resolved the printhead failure, a decision is made at 346 if a compensation mode code twelve exists. If it exists, a determination is made at 348 if variable data fields can be located so as to avoid the use of defective elements. If this is impossible, at 348, or if no such mode existed at 346, in either case, a write is effected to the non-volatile memory that there is a fatal thermal printhead failure and the meter is put into a fatal error state disabling printing at 350.

If on the other hand, an alternative exists at 348 the indicia stored in the random access memory is cleared and variable data fields in the indicia are located in the bit map spaces in RAM. Other indicia elements are fetched such as the eagle body bit map

from the ROM and located in the RAM indicia space so as not to interfere with variable data fields. This could include for example, fetch of the left wing of the eagle and locate without interfering, fetch of the right wing of the eagle in similar location without interference and similar activity for various other portions of the indicia graphics such as the eagle feet, head, etc.

While an example of an eagle has been given, any other suitable graphics and printing can be utilized. The composite indicia and data are stored in memory system 6 and made the current indicia current and data required by the initialization routine which is also stored in the memory system. The meter thereafter goes to initialization.

Reference is now made to FIGURE 4 which is a schematic circuit diagram, partly in block form, of a thermal printhead control logic of an electronic postage meter system embodying the present invention and employing an alternative failure detection approach from that shown in FIGURE 1.

Meter control electronics 402, which may be the main electronic postage meter microprocessor or micro controller, is connected to control a thermal printhead 404. The meter control electronics 402 provides serial data on line 406 and clock data on line 408 to a series of serial shift registers 410a, 410b, and 410c. These serial shift registers are just a portion of the actual number of serial shift registers used in the system. For the particular embodiment shown, although other configurations are possible, there is a serial shift register and associated circuitry for each print element. The particular embodiment of the present invention employs a 240 pin thermal printing matrix having eight pins per millimeter. One suitable thermal print device is Kyocera Part No. KSL240A. Other suitable thermal printheads may be employed depending on the needs and application of the electronic postage metering system.

Each shift register stores a series of the 240 bits needed to activate (or not activate) the 240 pin print elements of the printhead. Thus, the number of shift registers 410a, 410b, and 410c will vary depending on the particular number of pins of the printhead and the particular number of data bits which can be held by the shift register. Each output of each shift register 410a, 410b and 410c is connected to a latch. For example, output pin 3 of shift register 410a is connected to latch 412a. Latch 412a latches the data to be printed by its associated print element 414a. The information stored in latch 412a is gated via an AND gate 416a controlled by a strobe signal on line 418 which controls the duration of the application of energy to the print element. This is achieved by the output of the AND gate 416a being coupled to the base electrode of a NPN transistor 420a. When the output from AND gate 416a is high, transistor 420a is biased into conduction causing a current to flow from the 24 volt power supply 422 through the collector emitter electrode current path of transistor 420a and through print element 414a. This causes the print element 414a to be energized to cause thermal printing to occur due to heating of the print element. Pin 13 of shift register 410a is connected to the latch 412b (the eighth in a series of latches for the eight outputs of shift register 410a) and through associated AND gate 416b and transistor 420b to energize the associated print element 414b. The shift register 410a is connected in series with the input to shift register 410b and the last output of shift register 410b is connected to any of a series of additional shift registers down through shift register 410c, depending on the number of printhead pins in the thermal printhead. Similar to the other shift registers, shift register 410c is connected to an associated latch 412c and through the AND gate 416c to cause its associated transistor 420c to actuate the print element 414c.

Line 409 connected between the meter control electronics 402 and the latches 412a through 412c, provides a latch signal which enables the transfer of data from the shift registers after all the data, the 240 bits of data, have been stored in the associated shift registers and to be latched into the associated 240 latches 412a through 412c.

For printing to occur, that is for current to flow, a transistor 424 must be biased for conduction. For example, current will flow from power supply 422 through the collector emitter or current path of transistor 420a, print element 414a and transistor 424 to ground. Transistor 424 is biased for conduction when line 425 is caused to be high by the meter control electronics indicating that the various data has been latched into the various latches and the print elements are ready to be selectively energized in accordance with the particular information to be printed.

Thermal print element test circuitry shown generally at 428 is provided to ensure that the thermal print elements are each operating properly and to provide the necessary information to enable remapping of the print element pins as has been previously explained if a pin is found to be defective.

The line 425 is put in a low voltage condition such that transistor 424 is biased out of conduction causing current from power supply 422 to flow through the various thermal elements (the particular thermal elements selected for tests) through resistor 426. This results in a voltage to be established at the junction 430 of resistor 426 and the energized print element which provides an indication of the condition of the print element or other element in the circuit which could have malfunction such as the transistor 420a or the power supply 422 or due to bad connections.

The voltage at the junction 430 is applied to two comparators 432 and 434. The incoming voltage from junction 430 is applied to the positive terminal of comparator 432 via a voltage divider including resistor 436 and resistor 438. Similarly, the voltage at junction

430 is applied to the negative input of comparator 434 via a voltage divider including resistors 440 and 442. A reference voltage is applied via a voltage dividing network including resistors 444 and 446 to the respective negative input terminal of comparator 432 and the positive input terminal of comparator 434. The positive input terminal of the comparators 432 and 434 are the non inverting input. The negative inputs are the inverting inputs.

As a result of this arrangement, the voltage which is established at junction 448 will remain high due to the voltage applied to junction 448 via the pull up resistor 450 so long as the resistance of the tested printed element remains within a predetermined range. If the resistance is above a predetermined range, voltage at junction 430 would be sufficiently low such that comparator 432 will generate a low output pulling junction 448 low and providing an indication to meter control electronics 442 that the thermal print element (and/or its associated circuitry) is malfunctioning due to the high resistance of the element and/or associated circuitry).

In contrast, should the voltage at junction 430 be high due to resistance below the desired range of resistances, then, the comparator 434 will cause a low voltage at its output to occur pulling junction 448 low providing information to the meter control electronics 442 that the print element of 414 being tested is not within the predetermined range.

In this manner, the meter control electronics 402 is provided with information that the print element being tested is not within the predetermined range required for proper operation of the printhead.

Reference is now made to FIGURE 5. In this particular embodiment which is a more detailed circuit of the system shown in FIGURE 1, digitized information is provided back to control electronics 502 as to the particular output voltage level of the print element so that the control electronics can determine if the print element or its associated circuitry is out of range high resistance or out of range low resistance. In this embodiment, an analog to digital converter 552 is provided. The analog to digital convertor 552 determines the voltage on junction 430 through a voltage dividing arrangement including resistors 554 and 556. The output from the analog to digital convertor 552 is applied via a data bus shown generally at 558. The analog to digital convertor 552 takes the analog voltage at VIN and converts it to a digital output which is provided to the control electronics 502. This digital output due to the voltage level at junction 430 provides information as to the proper operation of the system and enables remapping of the energized pins as has been previously described. The information is provided over the data bus 560 and operates in conjunction with the various bus control lines 562, 564, 566, 568, and 570. The analog to digital convertor 552 is for example a National Semiconductor device Part No. ADC0820.

While the invention has been disclosed and described with reference to the particular embodiment in the preceding detailed description of the preferred embodiment, it will be clearly apparent that variations and modifications may be made to the preferred embodiment. For example, as previously noted, any number of a different type of printing systems may be utilized. Or, as yet another example, various fault detection techniques may be employed for determining failures of the print element. It should be recognized that detection techniques suitable to the particular printing technology employed would be utilized in this regard.

Claims

1. A postage metering system, comprising:
   printing means for printing an indicia;
   storing means coupled to said printing means for storing information adapted to generate signals for causing said printing means to print a selected one of a plurality of postal indicia;
   fault detection means coupled to said printing means for detecting faults in said printing means; and,
   means for causing said printing means to print a selected one of said plurality of indicia stored in said storing means depending upon the particular failure sensed by said fault detection means.

2. A postage metering system, comprising:
   matrix printing means for printing an indicia,
   storing means coupled to said printing means for storing information adapted to generate signals for causing said printing means to print a selected one of a plurality of postal indicia;
   fault detection means coupled to said matrix printing means for detecting faults in said matrix printing means; and,
   means for causing different elements of said matrix printing means to print a selected one of said plurality of indicia stored in said storing means depending upon the failure sensed by said fault detection means.

3. A postage metering system as defined in Claim 1 or 2 wherein said information stored in said storage means are a series of portions of a postage meter indicia.

4. A postage metering system as defined in Claim 1 or 2 wherein the information stored in said storage means are a plurality of different indicia graphics.

5. A postage metering system as defined in Claim 1 or 2 wherein the information stored in said storage means are a plurality of different indicia alpha numeric characters.

6. A postage metering system as defined in Claim 1 or 2 wherein the information stored in said storage means are a plurality of different indicia machine readable markings.

7. A postage metering system as defined in Claim 1 or 2 wherein said machine readable markings are bar code markings.

8. An electronic postage metering system as defined in claim 1 or 2 further including an input means coupled to said storing means for entering indicia information through said input means.

9. A postage metering system as defined in Claim 2 wherein different series of matrix printing means elements are utilized to print each of said plurality of postal indicias.

10. A postage metering system as defined in Claim 9 wherein said fault detection means detects faults in the operation of each of said matrix printing means elements.

11. A postage metering system as defined in Claim 9 or 10 said matrix printing means is a thermal printer.

12. In a postage metering system having a printing means, a method comprising:

storing information adapted to generate signals for causing the said printing means to print a selected one of a plurality of postal indicia;

detecting faults in said printing means; and,

causing said printing means to print said selected one of said plurality of indicia graphics depending upon the particular detected printing means failure.

13. A method as defined in claim 12 wherein said encryption information is an encrypted bar code.

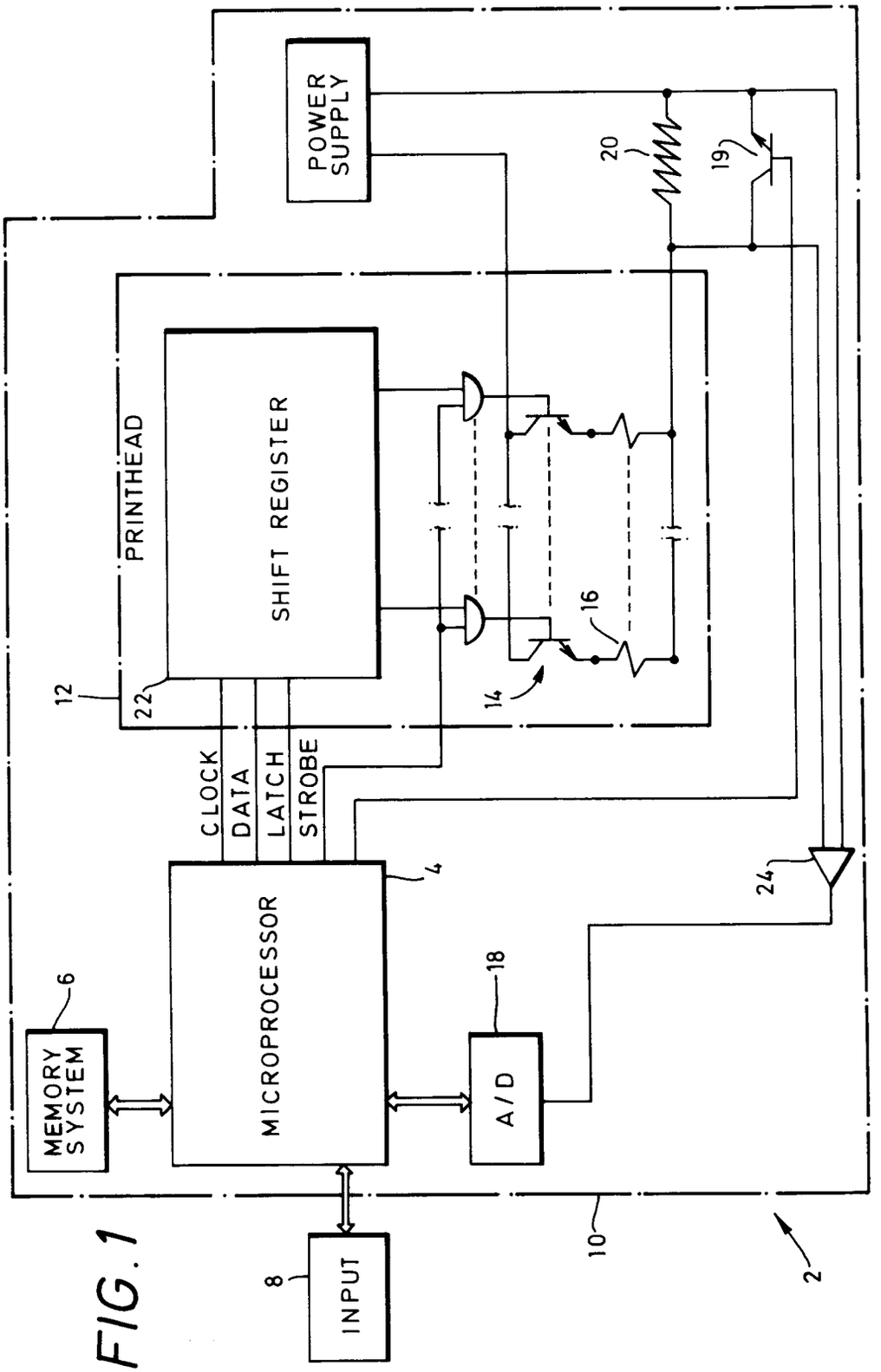

POWER SUPPLY
20
19
PRINTHEAD
SHIFT REGISTER
12
22
16
14
CLOCK
DATA
LATCH
STROBE
4
24
MEMORY SYSTEM
6
MICROPROCESSOR
18
A/D
INPUT
8
10
2

FIG. 1

FIG. 2A

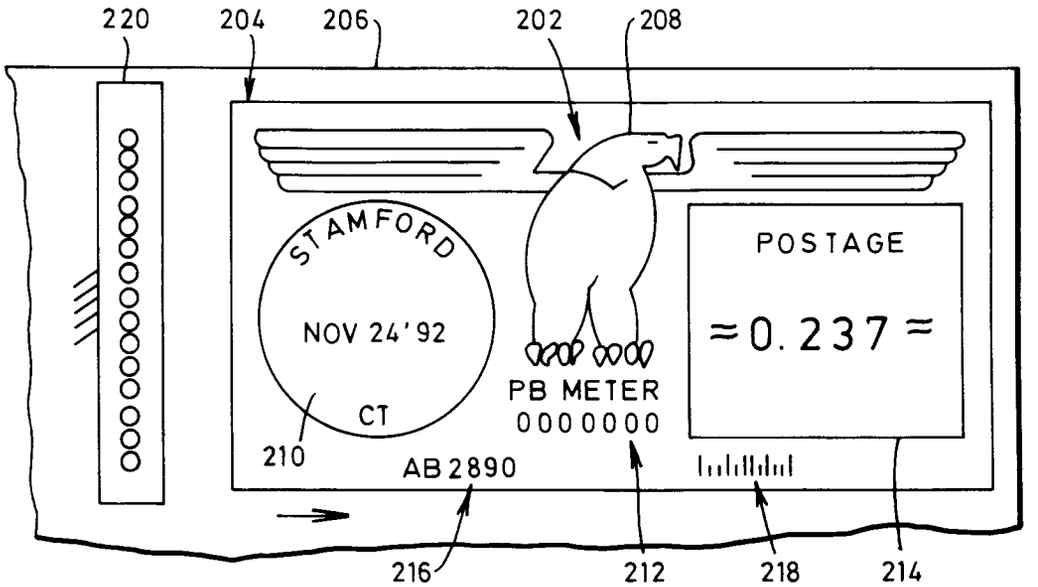

220
204
206
202
208
STAMFORD
NOV 24'92
CT
210
PB METER
0000000
AB 2890
POSTAGE
≈0.237≈
216
212
218
214

FIG. 2B

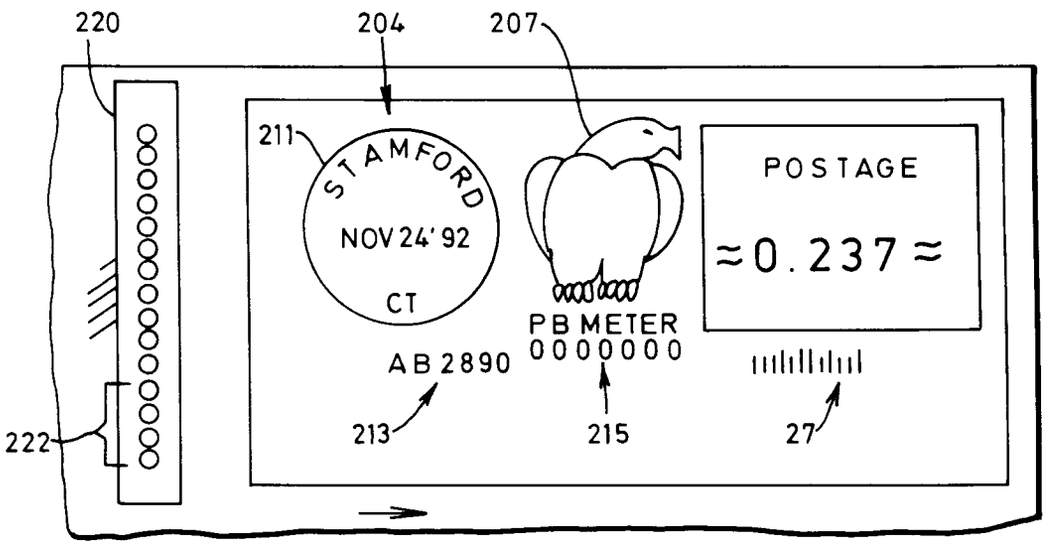

220
204
207
211
STAMFORD
NOV 24'92
CT
AB 2890
PB METER
0000000
POSTAGE
≈0.237≈
222
213
215
27

FIG.2C

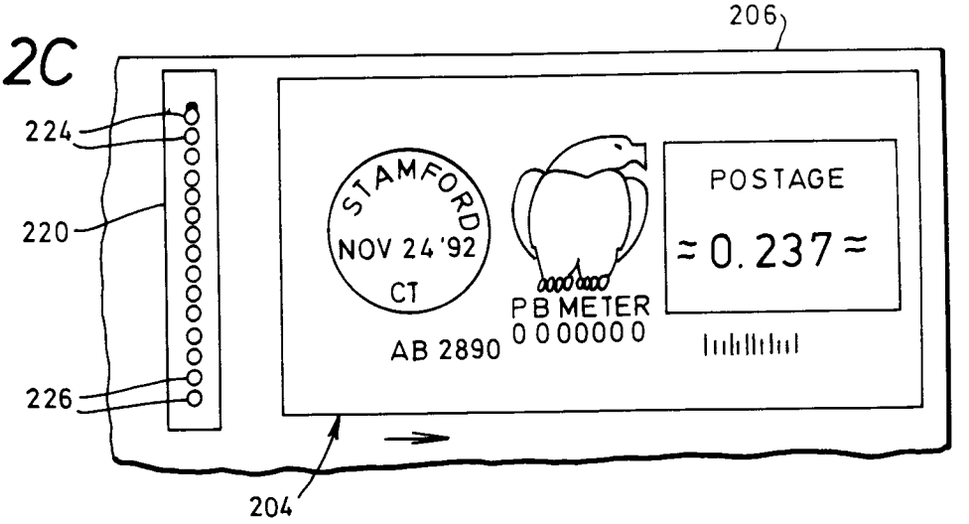


FIG.2D

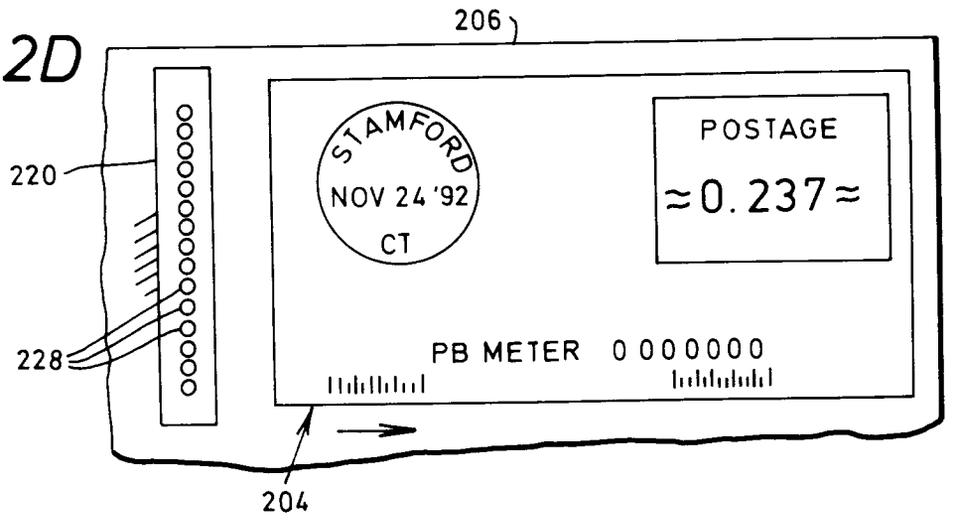


FIG.2E

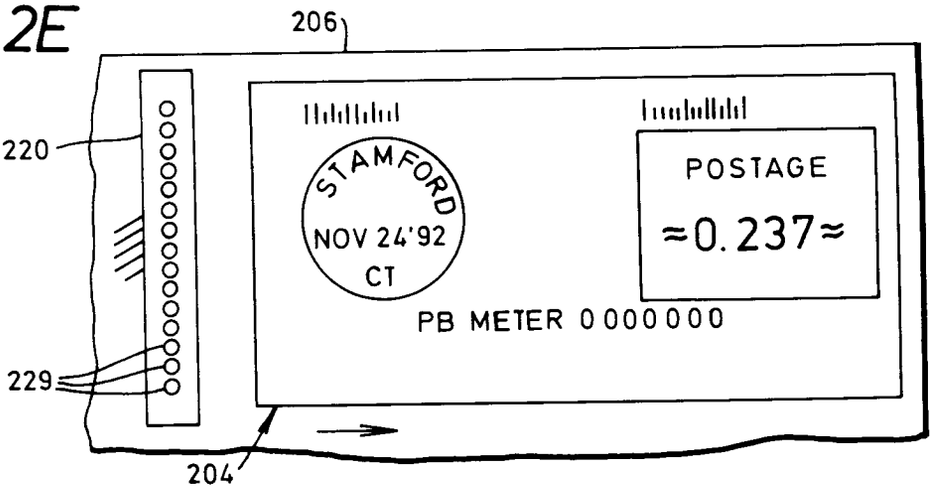


FIG. 2F

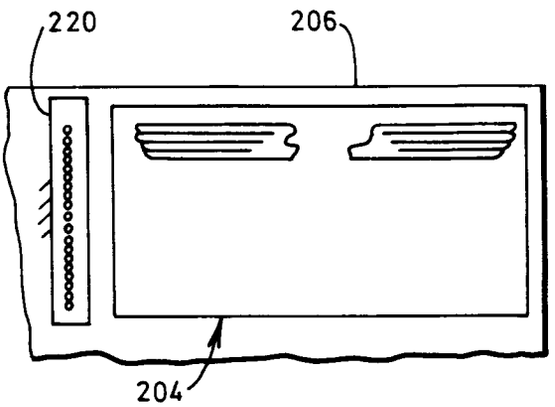


FIG. 2G

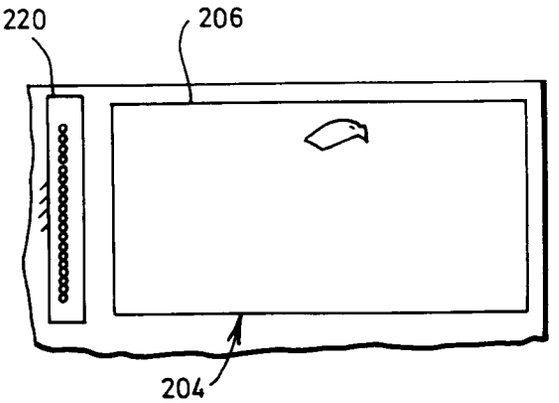


FIG. 2H

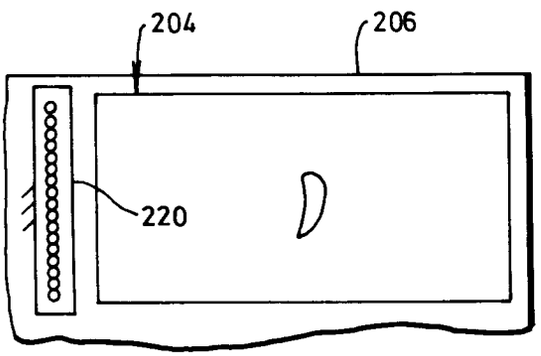


FIG. 2I

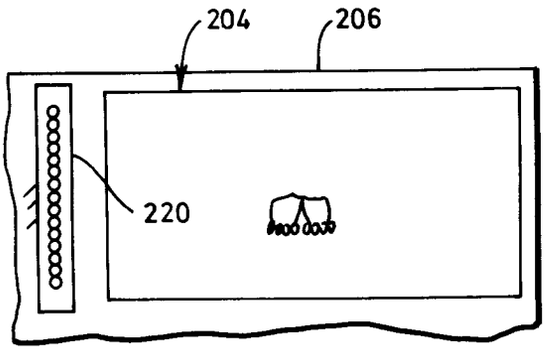


FIG. 2J

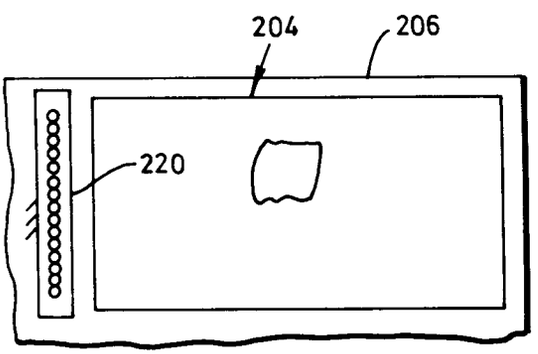
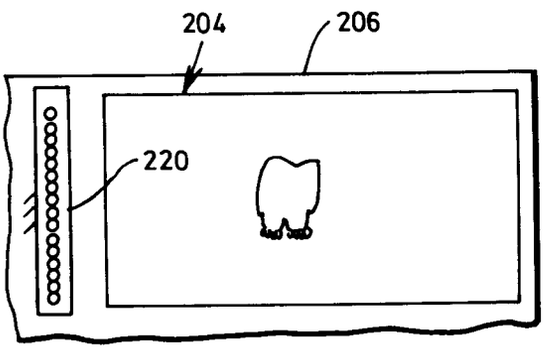


FIG. 2K



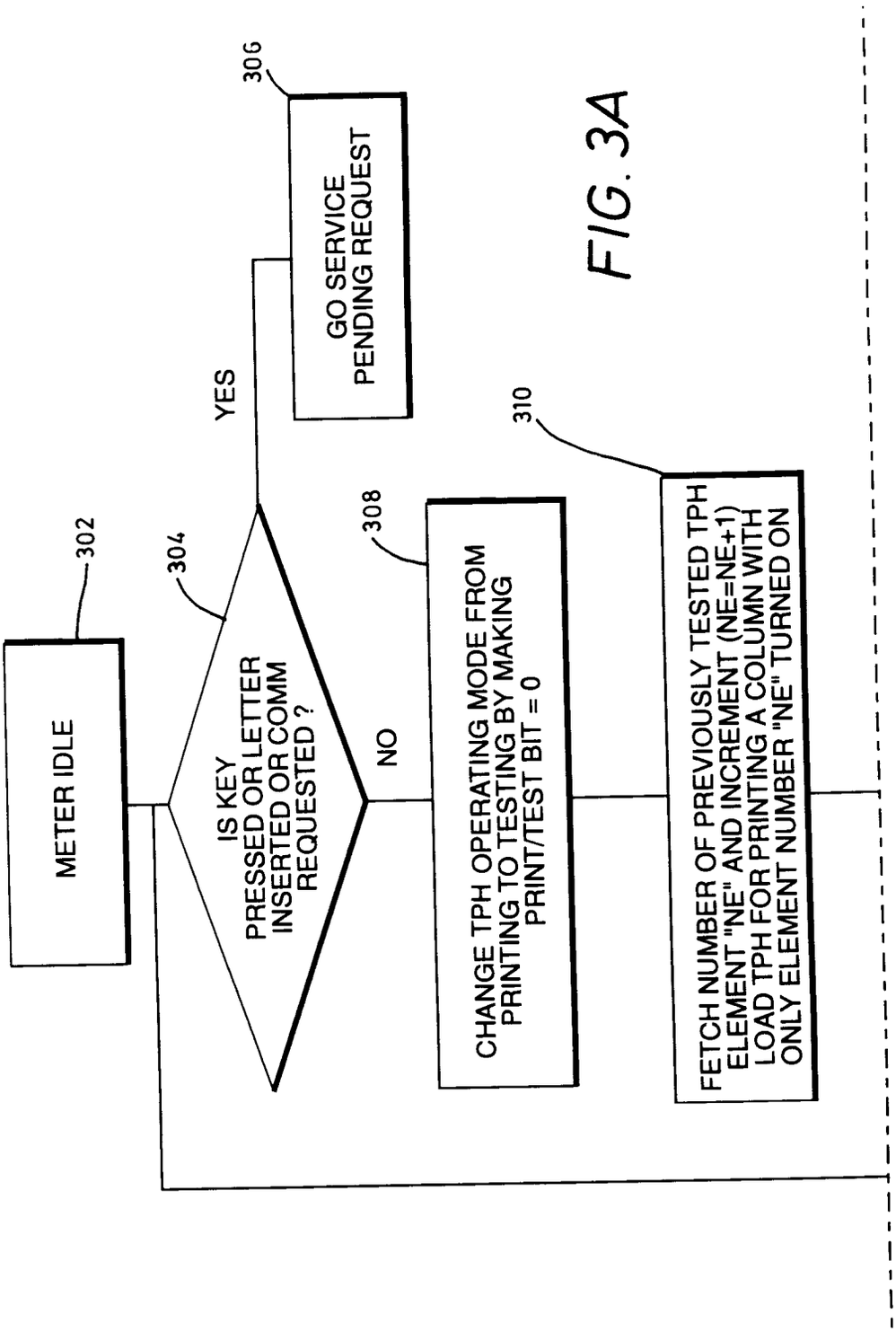

METER IDLE
302
IS KEY PRESSED OR LETTER INSERTED OR COMM REQUESTED ?
304
YES
NO
GO SERVICE PENDING REQUEST
306
CHANGE TPH OPERATING MODE FROM PRINTING TO TESTING BY MAKING PRINT/TEST BIT = 0
308
FETCH NUMBER OF PREVIOUSLY TESTED TPH ELEMENT "NE" AND INCREMENT (NE=NE+1) LOAD TPH FOR PRINTING A COLUMN WITH ONLY ELEMENT NUMBER "NE" TURNED ON
310

FIG. 3A

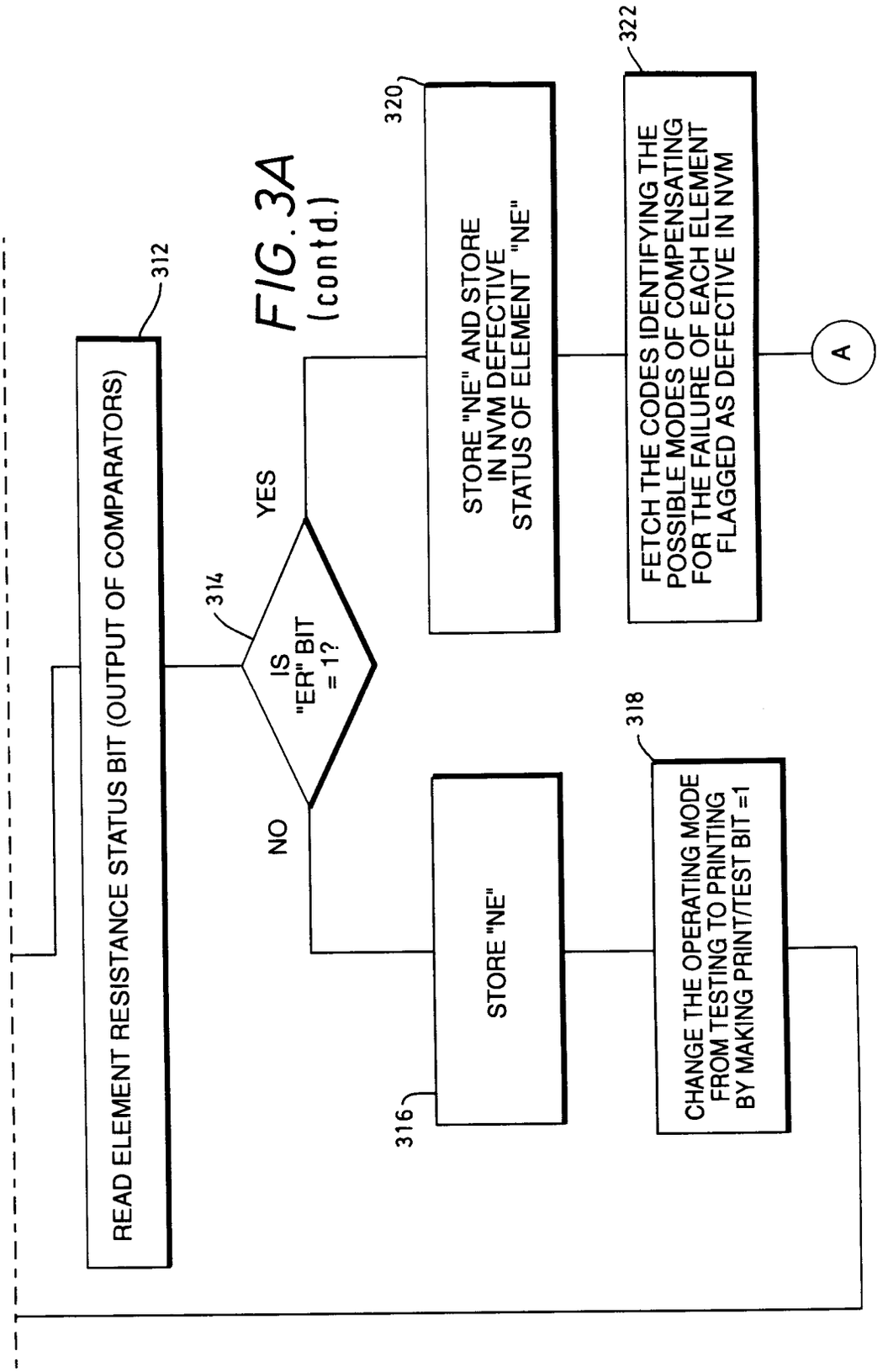

READ ELEMENT RESISTANCE STATUS BIT (OUTPUT OF COMPARATORS)
312
IS "ER" BIT = 1?
314
YES
NO
STORE "NE" AND STORE IN NVM DEFECTIVE STATUS OF ELEMENT "NE"
320
FETCH THE CODES IDENTIFYING THE POSSIBLE MODES OF COMPENSATING FOR THE FAILURE OF EACH ELEMENT FLAGGED AS DEFECTIVE IN NVM
322
A
STORE "NE"
316
CHANGE THE OPERATING MODE FROM TESTING TO PRINTING BY MAKING PRINT/TEST BIT =1
318

FIG. 3A (contd.)

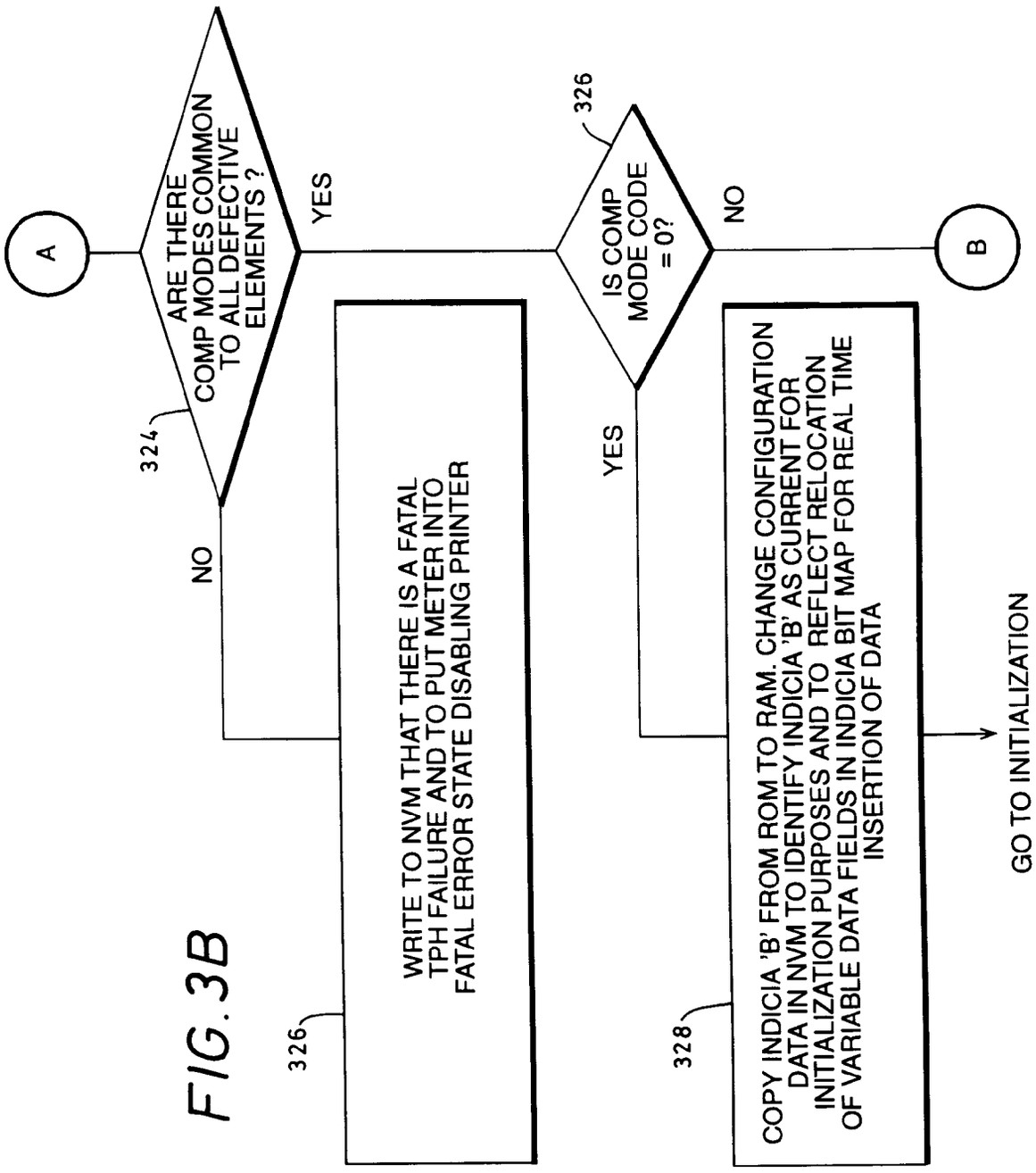
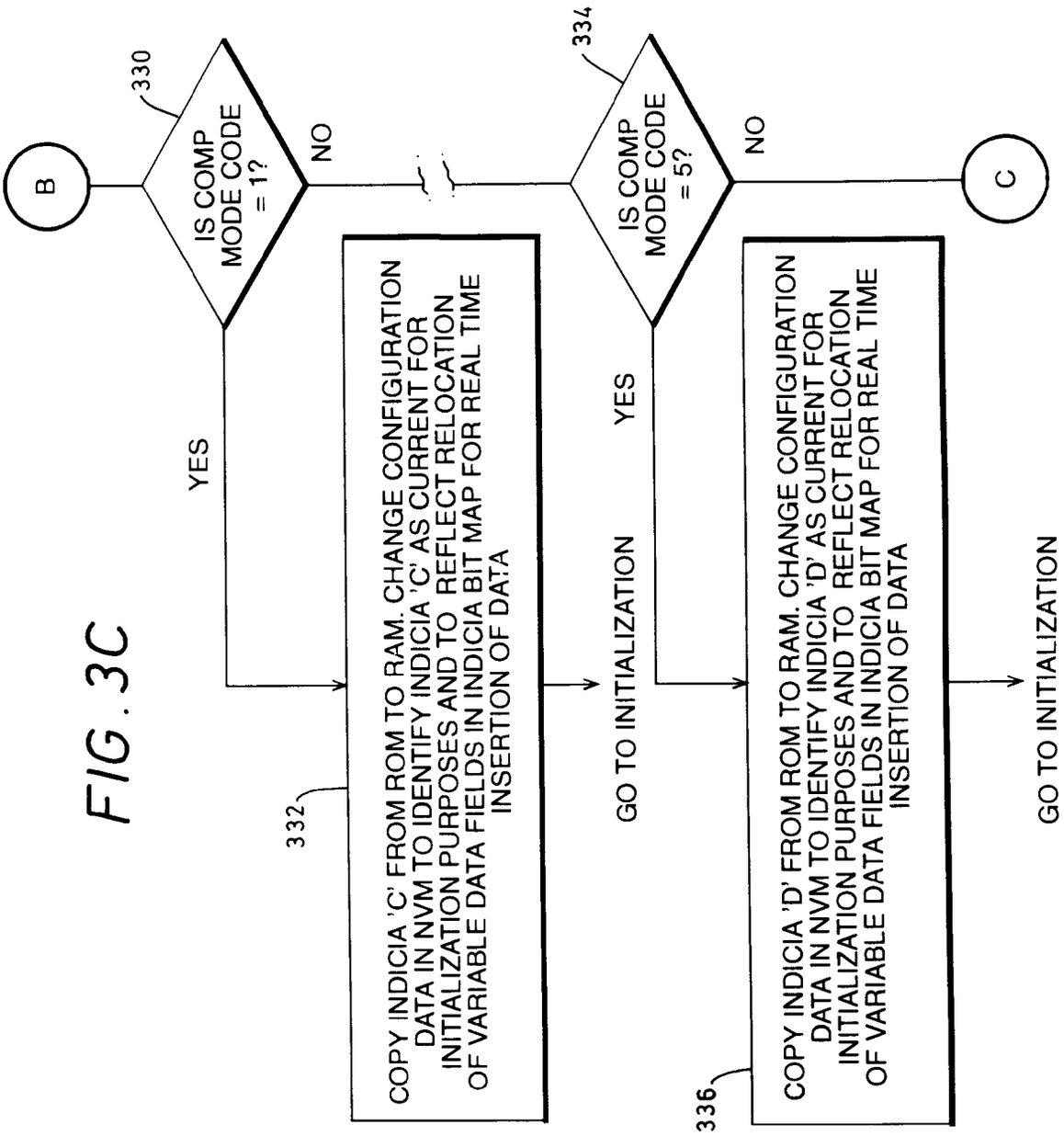

A
ARE THERE COMP MODES COMMON TO ALL DEFECTIVE ELEMENTS ?
324
YES
NO
326
IS COMP MODE CODE = 0?
YES
NO
B
WRITE TO NVM THAT THERE IS A FATAL TPH FAILURE AND TO PUT METER INTO FATAL ERROR STATE DISABLING PRINTER
326
COPY INDICIA 'B' FROM ROM TO RAM. CHANGE CONFIGURATION DATA IN NVM TO IDENTIFY INDICIA 'B' AS CURRENT FOR INITIALIZATION PURPOSES AND TO REFLECT RELOCATION OF VARIABLE DATA FIELDS IN INDICIA BIT MAP FOR REAL TIME INSERTION OF DATA
328
GO TO INITIALIZATION

FIG. 3B

FIG. 3C


B
330
IS COMP MODE CODE = 1?
YES
NO
332
COPY INDICIA 'C' FROM ROM TO RAM. CHANGE CONFIGURATION DATA IN NVM TO IDENTIFY INDICIA 'C' AS CURRENT FOR INITIALIZATION PURPOSES AND TO REFLECT RELOCATION OF VARIABLE DATA FIELDS IN INDICIA BIT MAP FOR REAL TIME INSERTION OF DATA
GO TO INITIALIZATION
334
IS COMP MODE CODE = 5?
YES
NO
336
COPY INDICIA 'D' FROM ROM TO RAM. CHANGE CONFIGURATION DATA IN NVM TO IDENTIFY INDICIA 'D' AS CURRENT FOR INITIALIZATION PURPOSES AND TO REFLECT RELOCATION OF VARIABLE DATA FIELDS IN INDICIA BIT MAP FOR REAL TIME INSERTION OF DATA
GO TO INITIALIZATION
C

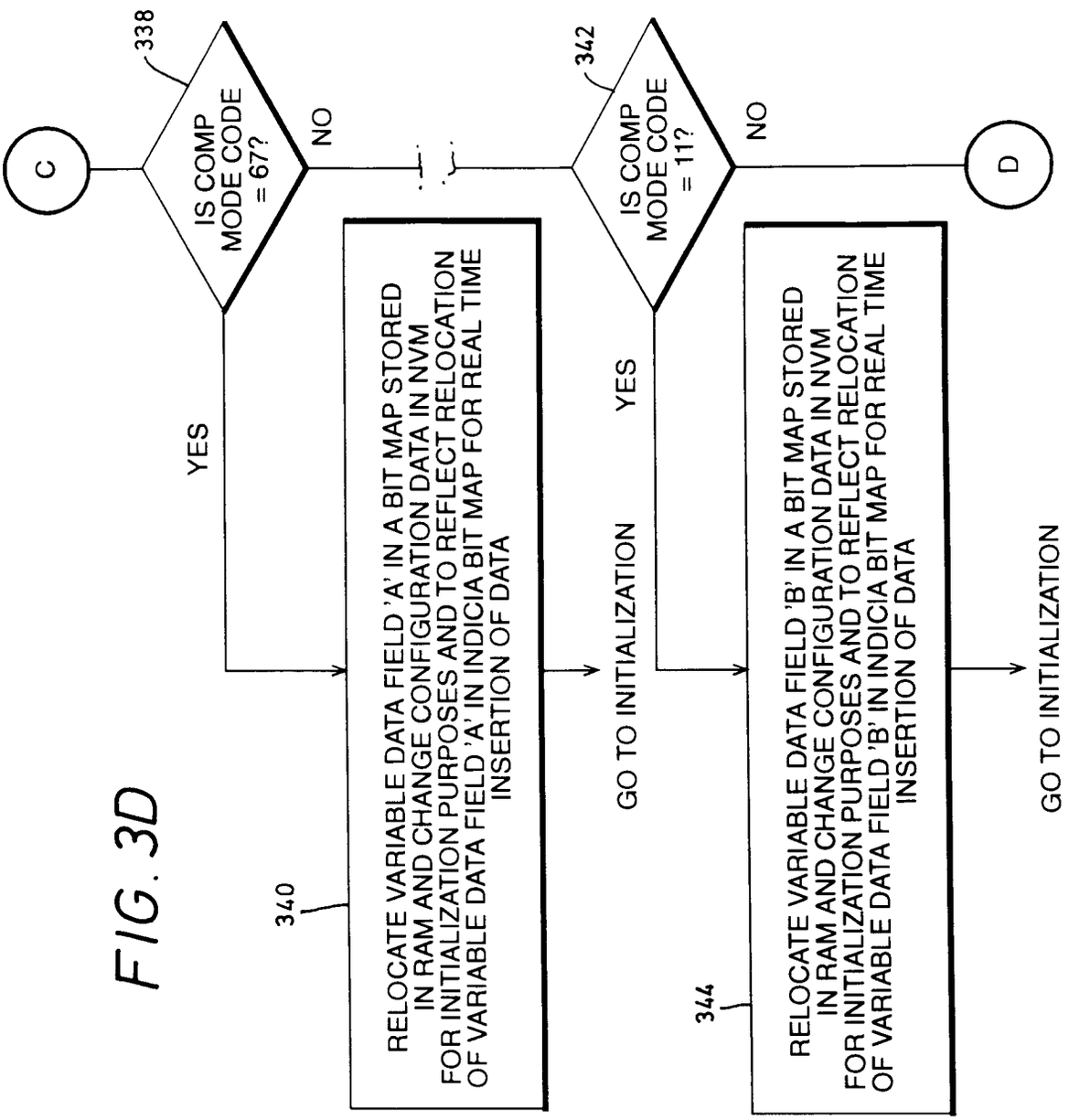

C
338
IS COMP MODE CODE = 67?
NO
YES
340
RELOCATE VARIABLE DATA FIELD 'A' IN A BIT MAP STORED IN RAM AND CHANGE CONFIGURATION DATA IN NVM FOR INITIALIZATION PURPOSES AND TO REFLECT RELOCATION OF VARIABLE DATA FIELD 'A' IN INDICIA BIT MAP FOR REAL TIME INSERTION OF DATA
GO TO INITIALIZATION
342
IS COMP MODE CODE = 11?
NO
YES
344
RELOCATE VARIABLE DATA FIELD 'B' IN A BIT MAP STORED IN RAM AND CHANGE CONFIGURATION DATA IN NVM FOR INITIALIZATION PURPOSES AND TO REFLECT RELOCATION OF VARIABLE DATA FIELD 'B' IN INDICIA BIT MAP FOR REAL TIME INSERTION OF DATA
GO TO INITIALIZATION
D

FIG. 3D

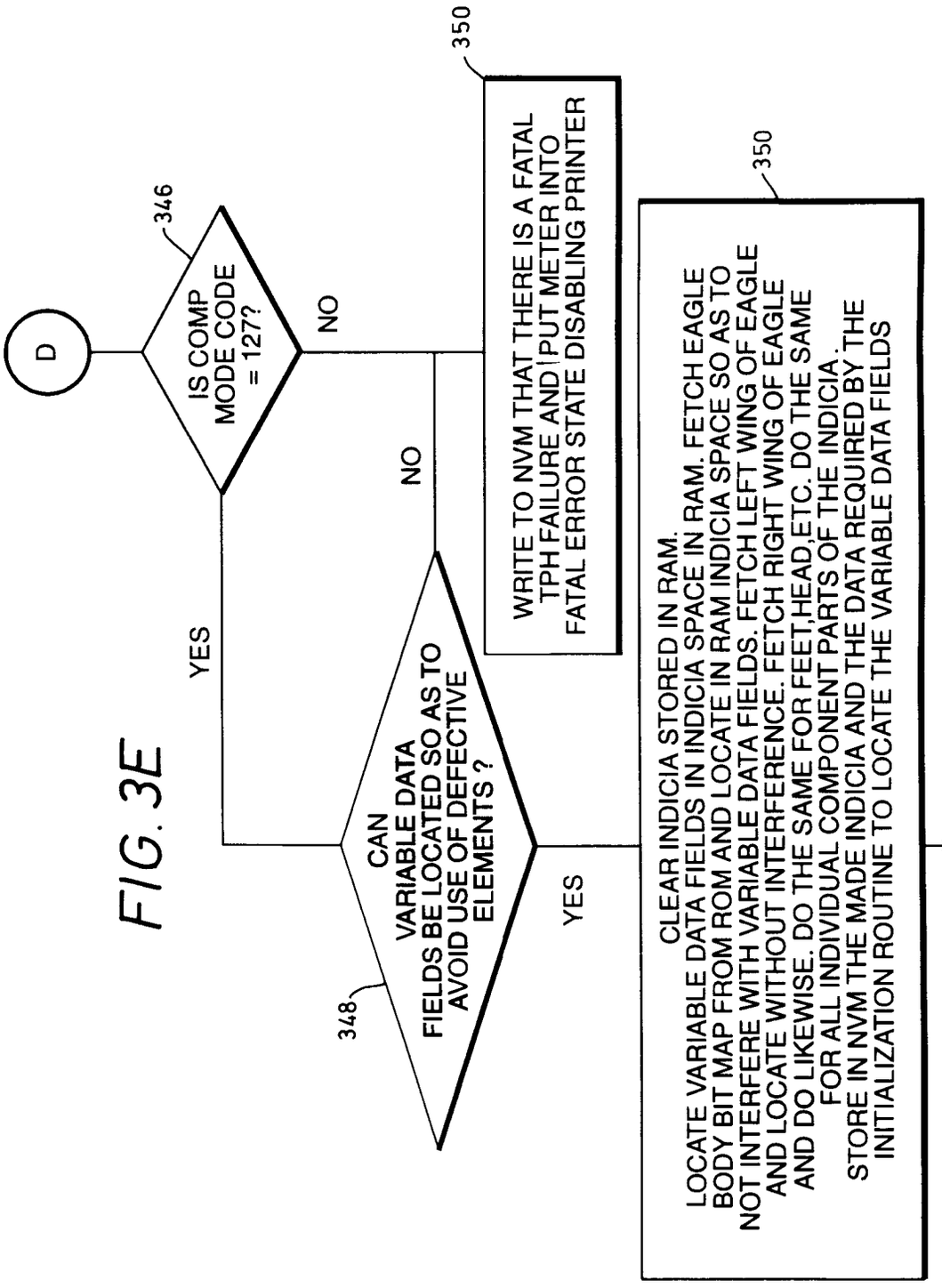

D
346
IS COMP MODE CODE = 127?
NO
350
WRITE TO NVM THAT THERE IS A FATAL TPH FAILURE AND PUT METER INTO FATAL ERROR STATE DISABLING PRINTER
YES
NO
348
CAN VARIABLE DATA FIELDS BE LOCATED SO AS TO AVOID USE OF DEFECTIVE ELEMENTS ?
YES
350
CLEAR INDICIA STORED IN RAM.
LOCATE VARIABLE DATA FIELDS IN INDICIA SPACE IN RAM. FETCH EAGLE BODY BIT MAP FROM ROM AND LOCATE IN RAM INDICIA SPACE SO AS TO NOT INTERFERE WITH VARIABLE DATA FIELDS. FETCH LEFT WING OF EAGLE AND LOCATE WITHOUT INTERFERENCE. FETCH RIGHT WING OF EAGLE AND DO LIKEWISE. DO THE SAME FOR FEET,HEAD,ETC. DO THE SAME FOR ALL INDIVIDUAL COMPONENT PARTS OF THE INDICIA.
STORE IN NVM THE MADE INDICIA AND THE DATA REQUIRED BY THE INITIALIZATION ROUTINE TO LOCATE THE VARIABLE DATA FIELDS
GO TO INITIALIZATION

FIG. 3E

FIG. 4

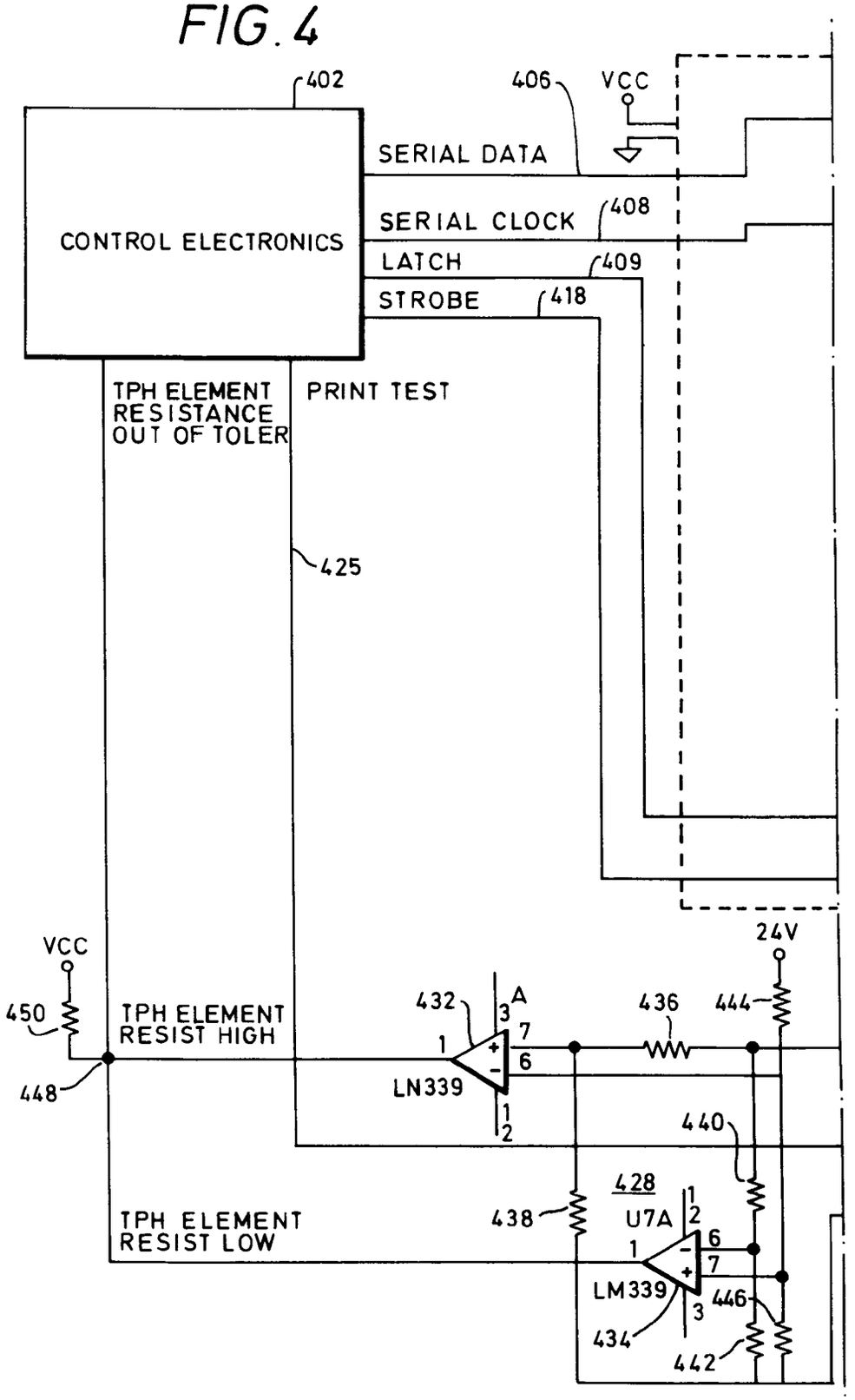

402
406
VCC
SERIAL DATA
CONTROL ELECTRONICS
SERIAL CLOCK
408
LATCH
409
STROBE
418
TPH ELEMENT RESISTANCE OUT OF TOLER
PRINT TEST
425
VCC
24V
450
TPH ELEMENT RESIST HIGH
432
A
436
444
LN339
448
440
428
438
U7A
TPH ELEMENT RESIST LOW
LM339
446
434
442

FIG. 4 (contd.)

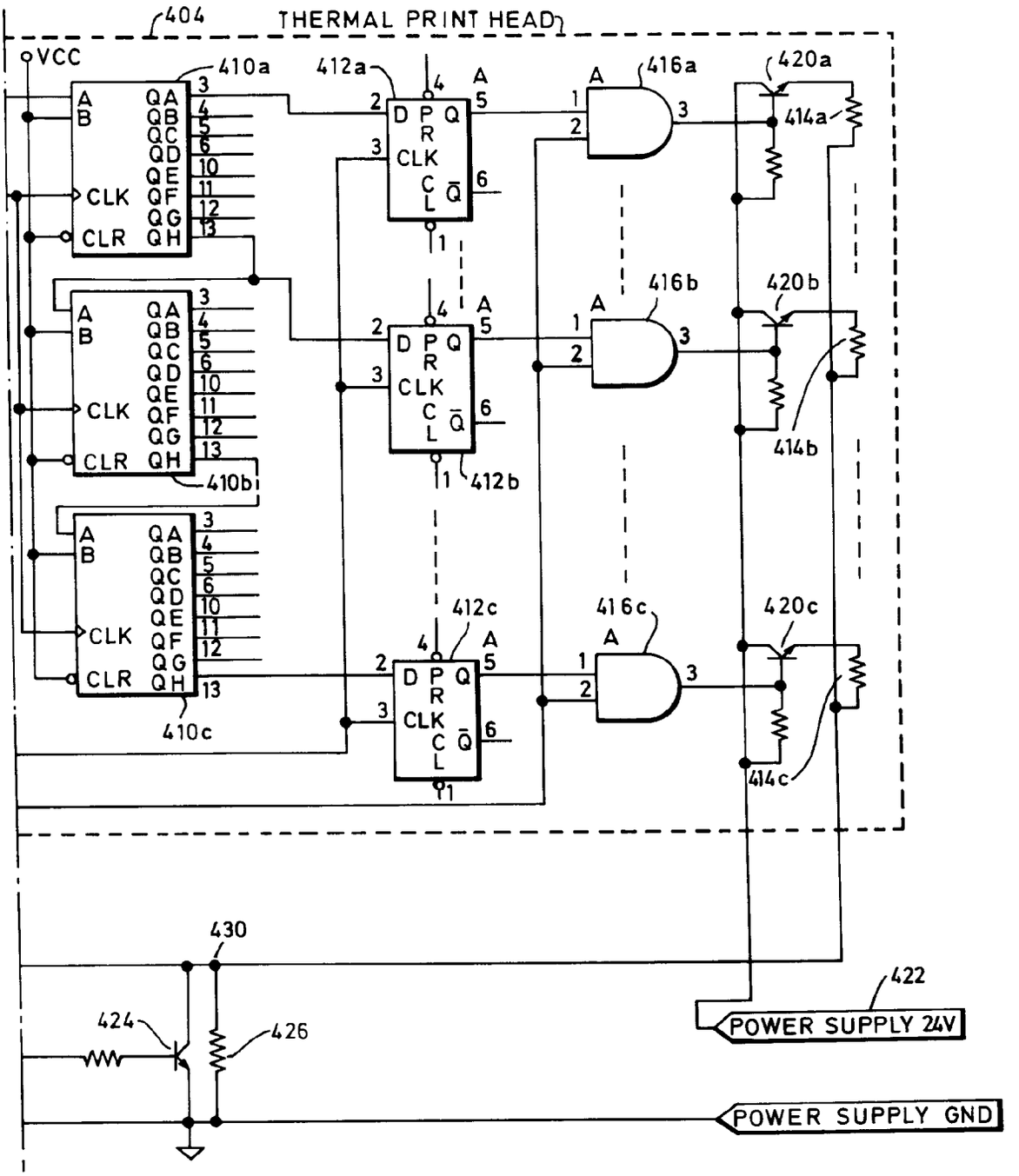

404
THERMAL PRINT HEAD
VCC
410a
412a
416a
420a
414a
416b
420b
414b
412b
410b
412c
416c
420c
414c
410c
430
424
426
422
POWER SUPPLY 24V
POWER SUPPLY GND

FIG. 5

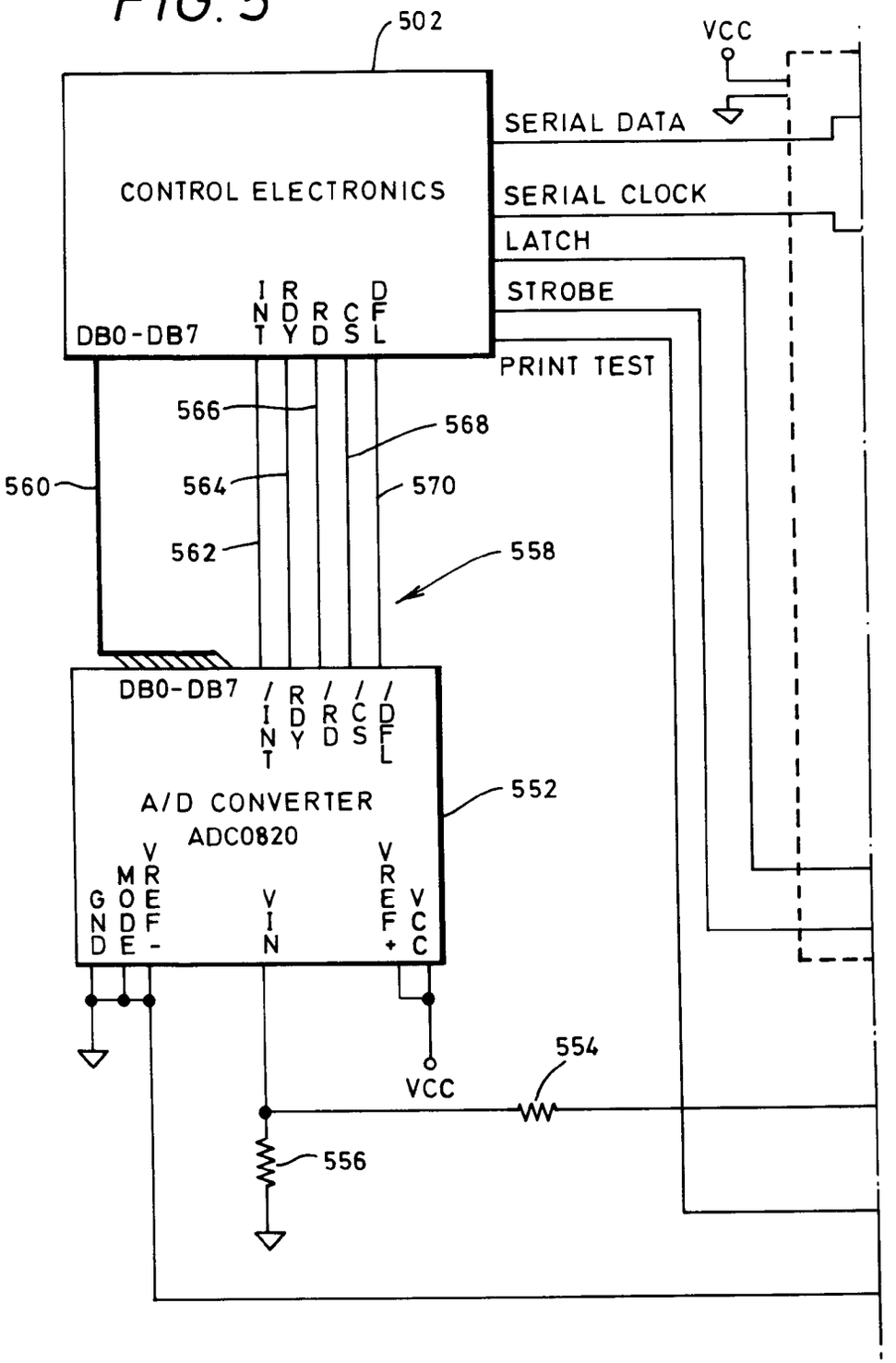
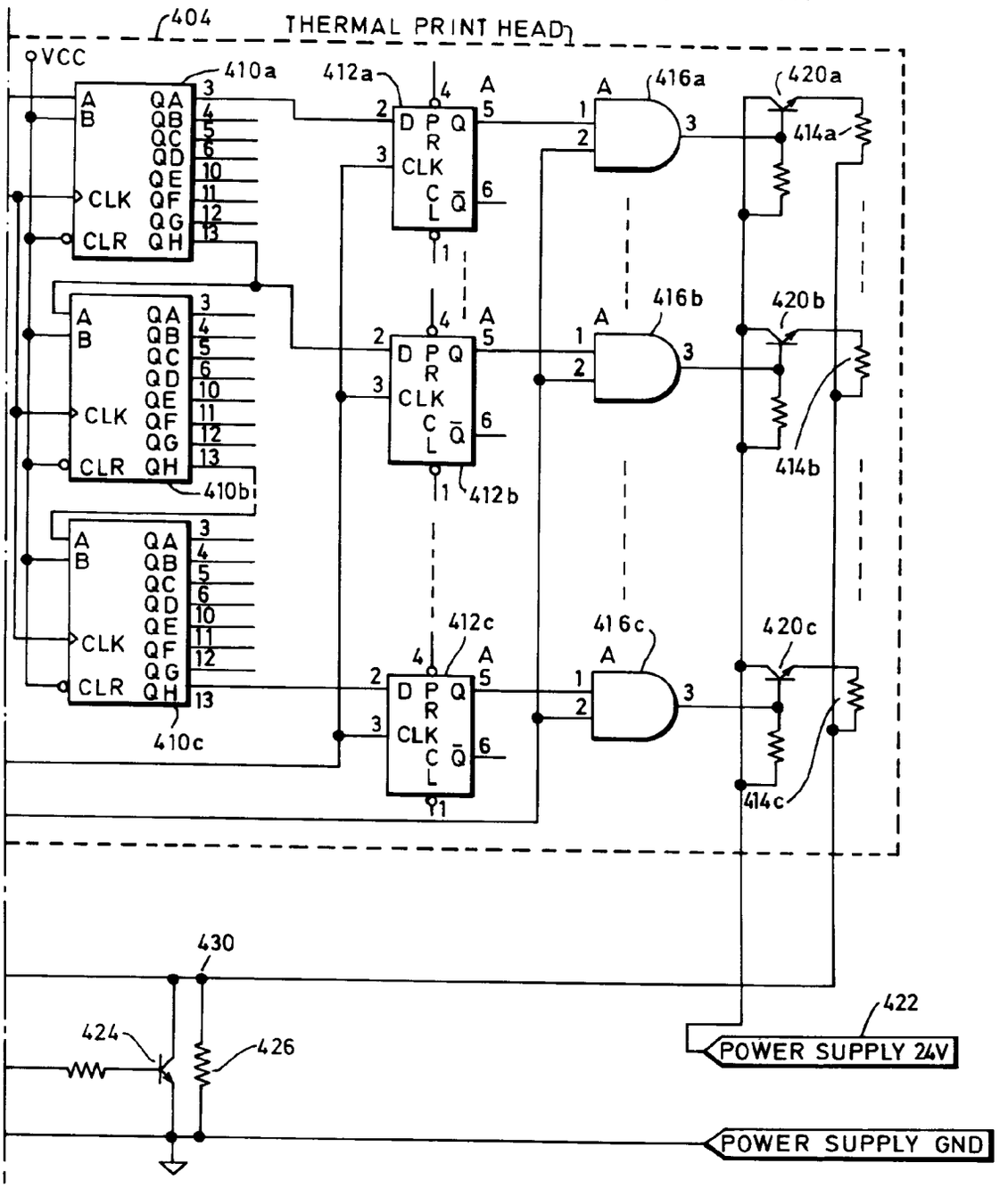

502
VCC
SERIAL DATA
CONTROL ELECTRONICS
SERIAL CLOCK
LATCH
STROBE
PRINT TEST
DB0-DB7
INT
RDY
RD
CS
DFL
566
568
560
564
570
562
558
DB0-DB7
/INT
RDY
/RD
/CS
/DFL
A/D CONVERTER
ADC0820
552
GND
MODE
VREF-
VIN
VREF+
VCC
554
VCC
556

FIG. 5 (contd.)


404
THERMAL PRINT HEAD
VCC
410a
412a
416a
420a
414a
416b
420b
414b
412b
412c
416c
420c
414c
410b
410c
430
424
426
422
POWER SUPPLY 24V
POWER SUPPLY GND