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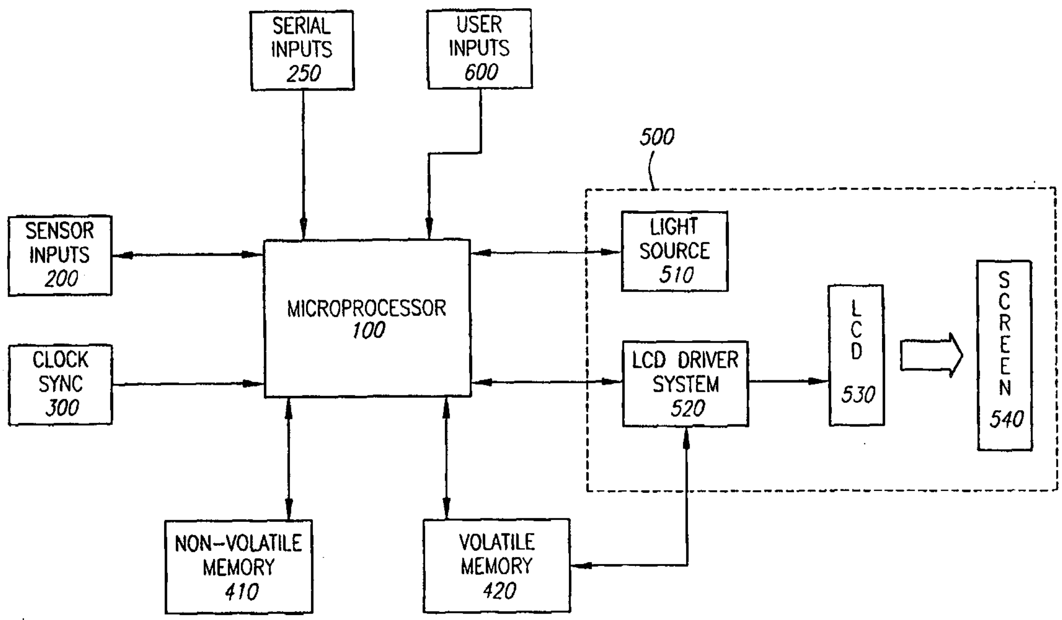

(57) Abstract

A display system for an airplane or other vehicle is disclosed. A rear projection LCD is used to allow for a maximum amount of screen area to be used in displaying operator pertinent data.

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DISPLAY SYSTEM FOR AIRPLANE COCKPIT OR OTHER VEHICLE

BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION

The present invention relates generally to display systems for airplane cockpits or other vehicles, and more particularly, to a rear projection digital display system which allows a high level of information to be selectively displayed regarding such data as travel path, travel conditions, vehicle condition, geographical conditions, and hazard or obstruction warnings.

2. DESCRIPTION OF THE RELATED ART

The layouts of cockpits for airplanes are regulated by the FAA in the United States. The SAE (Society of Automotive Engineers), which acts as a standards writing/recommending body to the FAA, has issued standards for aircraft instruments which are adhered to in aircraft construction. For example, the 3ATI slot standard, which is an ARINC (Aeronautical Radio, Inc.) standard, has been complied with in the vast majority of all aircraft in use today. This standard was developed when electro-mechanical display devices, such as HSI (Horizontal Situation Indicator), were the norm, and only allows a panel area of 3" x 3" in dimension.

With the advance of digital technology, there has been a need in the industry to replace these displays with digital versions, to provide increased reliability, accuracy and more functionality. However, these planes cannot be easily retrofitted with digital equipment that require a bigger screen, and the required 3 x 3 panel has conventionally proven to be too small for digital displays. The 3" x 3" display has been a major impediment to the development of such a digital display.

First, standard direct view LCDs are not mass produced in this size, and therefore a specially made LCD for 3" x 3" can cost as much as $10,000 each to produce. Furthermore, due to the construction of the direct view LCD, the outer perimeter of the device cannot be used to display information, as it is used by the drive electronics. As a result, the 3" x 3" LCD typically produces a display area of only 2.3" x 2.3". This reduced display area impedes the ability to put enough information on the display for it to be useable for many functions.

A second problem addressed by the invention is the growing demand in the avionics industry for more sophisticated "situational awareness for safety" (SAS) technology. This refers to technology which provides the pilot with more easily understandable and more comprehensive information about the immediate surroundings, and any hazards which may be present.

For example, in 1996, there were 246 general aviation airplane crashes in the United States. Of these crashes, 42 were controlled flight into terrain (CFIT). That is, situations in which the airplane was flown into an obstruction such as a mountain, an antenna or the ground under control of the pilot. Typically these instances occur when visibility is very low and the pilot is off course. As a result, the pilot is unaware of the natural obstructions in flight path because the display devices only provide information on the desired flight course.

It is believed that if the present invention had been available for these planes, a large number of these accidents would have been prevented, and hundreds of lives saved. Thus, there is a need in the industry for (1) technology to effectively collect data on surrounding structures even when the pilot is off path, and (2) hardware to display this information in a simple and direct manner to the pilot, preferably using digital instruments.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to overcome the above-noted deficiencies in the prior art.

In particular, in certain aspects of the invention, an avionics display device may include a rear projection LCD system which obtains maximum display area in a 3ATI display slot.

In addition, in the present invention the microprocessor may receive G.P.S. ("Global Positioning System") data as an input, and also has a memory which stores with the Defense Mapping Agency topographical information of North America or other geographical area in database form. The device correlates the G.P.S. and topographical data to determine the location of the aircraft, and any obstacles in the flight path or surrounding area. In addition, data from the flux gate and gyro, which indicate the current location of the airplane, are used to determine the flight path of the aircraft. Other navigational devices (e.g. VOR) may also be used to determine heading. From this information, upcoming obstacles are determined from the DOD topographical data, and are displayed to the pilot.

In certain embodiments of the invention, different types of information are selectively displayable on the system. To avoid clutter and ease of understanding, user inputs are provided to allow the pilot to selectively turn on or off the display of certain information. For example, as the pilot is approaching the runway for a landing, and is within visible range of the runway, the pilot may turn off the rearward view or navigational aids not associated with the approach to the runway.

In addition, it should be noted that while the present invention is a well-suited for use in the avionics cockpit display, it is equally applicable to other vehicles.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is block diagram of the components of one embodiment of the present invention.

Fig. 2 is a cross section of one embodiment of the invention.

Fig. 3A is a block diagram of one embodiment of the video display system of the invention.

Fig. 3B is a more detailed block diagram of the mirror and LCD system of the invention.

Fig. 4 is a block diagram of one embodiment of the sensor input system of the invention.

Fig. 5 is a program flow of the operation of one embodiment of the invention.

Fig. 6 is a subroutine for use in the program flow of Fig. 5

Figs. 7A and 7B are representative display screens of one embodiment of the invention.

Figs. 8A and 8B represent a 3ATI slot as used in the invention.

DETAILED DESCRIPTION

General Description

Fig. 1 is a block diagram of the overall system. The entire system is run by a microprocessor 100 which may be the MPC 821 manufactured by Motorola. As will be explained more fully below, microprocessor 100 receives a plurality of the sensor inputs 200 which may include, for example, G.P.S. information, flux gate data, gyro data, etc. The sensor inputs 200 are sampled and input to processor 100 in sync with clock sync signal 300. The microprocessor 100 receives clock sync signal 300 and regenerates and supplies it to the attached devices. Microprocessor 100 is also associated with a non-volatile memory 410, which may be a flash memory such as model 208F800 manufactured by Intel. This memory is used to store operational software, database information, and repetitive screen data as explained more fully below. Microprocessor 100 is also associated with volatile memory 420, such as DRAM , for storing information used during operation, and graphical information for driving the display system. Typically, memories 410 and 420 each will have at least 4M bytes of storage space.

Microprocessor 100 also controls rear projection system 500, which includes a light source 510, LCD driver system 520, and a rear projection LCD 530, which displays data on screen 540. The LCD driver 520 receives the graphical information from memory 420, which is programmed by the microprocessor 100. Microprocessor 100 programs the graphical data into memory 400 based on the data received from sensor inputs 200, and the user input conditions received from a user input device 600.

As is shown in Fig. 2, the entire device may be fitted into a 3ATI box. As shown, user input device 600 includes a plurality of knobs and switches which are selectively positioned so as not to obstruct screen 540. In addition, these devices are positioned within the instruments so as to avoid crossing the light path between lamp 510, LCD 530 and the image path between the LCD 530 and screen 540. The mechanical aspects of the present invention to achieve such a compact and unobstructed design will be explained more fully hereinafter.

Rear Projection LCD Display System

Fig. 3A is a more detailed block diagram of rear projection system 500 which includes light source 510, mirror system 532, LCD 530,LCD driver 522, serializer 524 and screen 540. A commercially available TFT (Thin Film Transistor)type LCD may be used for the image projection. Although any suitable projection LCD system may be used. LCD 530 and mirror system 532 make up a filterless microlens type rear projection LCD. An example of such device is the Sony model no. LCX019. The device may operate as follows: Light source 510 emanates white light, and mirror system 532 breaks up the light into three components, R, G, B, respectively along a first axis R, a second axis G, and a third axis B, all three of which are at an angle to one another. The light rays R, G, B impinge upon individual pixels of LCD 534 at discreet angles. In accordance with electrical signals received from driver 520, which are formulated in response to data from microprocessor 100 and the graphical data from memory 420, the individual pixels of 554 are adjusted so as to collectively form a color image which is projected along optical axis X and on to screen 540. The LCD 534 may be updated at any desired rate via driver 520, but preferably is updated at 30 frames per second. The operation of the LCD driver is described below.

A more detailed description of the light system of one embodiment of the invention is provided with reference to Fig. 3B. Lamp or other light source 510 generates white light which is reflected off a first mirror 5322 and passed through a condenser lens 5324 so as to form a colliminated light beam which is then presented to a dichroic lens system 5324. The system includes a wedge 5324A which has a top surface 5324A coated with a dichroic material which reflects red light and passes all other colors. The reflected red is direct to the LCD at 7° above the line normal to the LCD. The second surface 5324B of the wedge 5324 reflects blue at 0° to the normal and passes all other colors. Beneath the wedge 5324 is a mirror 5325, which reflects the remaining green light -7° with respect to the normal. For sake of simplicity, this is illustrated in Fig. 3B with respect to only one ray of light. Of course, in operation all light presented to the wedge 5324 and mirror 5325 will undergo similar separation. R, G and B light beams are then impinged upon LCD 530. Following the LCD 530, the formed image is passed through a projection lens system, including lenses 5326A and 5326B and projected on the screen.

It should be noted that instead of a wedge 3324, two separate mirror plates could be used. However, the wedge arrangement achieves the same results as a mirror system, while avoiding the necessity of light passing through up to four additional surfaces (*e.g.*, the green light would have to go through two extra surfaces on the way down and two extra surfaces on the way up). This allows for greater display intensity.

The LCD driver 520 includes a digital to analog converter. The analog data is then input to the serializer 524, which is then input to LCD 530. The LCD driver 520 is refreshed from a graphics buffer which is in memory 420. This is done in hardware. If processor 100 stops updating the screen memory, the LCD driver 520 will still continue to pull the screen data in bursts from the graphics buffer in memory 2, and keep the LCD image updated. This means that processor 100 does not have to update the screen graphics data at a constant speed in order to eliminate flicker.

The screen data is updated in "push-pull" graphics buffers. This means that while a first buffer is used for LCD refresh, the processor software updates a second buffer. When the processor is done with the new update, it sets a "ready" flag and changes the start address for the LCD driver 520. This is called a "handoff" of the new buffer. When the LCD driver 520 is at the end of the current screen refresh period, the LCD driver will automatically use the new buffer address, placing the newly updated graphics data on the screen. The LCD driver also generates an interrupt in processor 100 which indicates "handoff complete" by resetting the "ready" flag and setting the address of the next update buffer. This flag/address indicates the free buffer and will be used by the main program loop for the next update.

A three buffer system may be used to accomplish this result.

1. Buffer currently displayed (read-only until hand-off to next buffer).
2. Buffer being painted (will become next displayed).
3. Buffer being cleared (will become next painted).

The use of a three buffer scheme allows the buffer clear operation to be done by direct memory access (DMA) which improves processor efficiency by allowing processor software execution to occur simultaneously with screen buffer clearing.

In order to increase system speed, repetitively displayed graphics, e.g. background graphics such as a compass pattern, are written only once and stored as background scenes. Thus, instead of the buffer being cleared to black, the appropriate repetitive scene is copied via DMA into the buffer. This allows the paint procedures to add only the appropriate graphics on top of the repetitive scene.

Thus, the process of reading and writing three (buffers, buffer 0, buffer 1, and buffer 2) is as follows:

1. Refresh the LCD screen with data from buffer 0.
2. Processor 100 and memory 2 cooperate to store a new graphic into buffer 1.
3. Processor 100 and memory 2 cooperate to store repetitive scene data in buffer 2.
4. Refresh the LCD screen with data from buffer 1.
5. Write new scene data into buffer 2 to overlay repetitive scene data already in buffer 2.
6. Store repetitive scene data in buffer 0.
7. Refresh the LCD screen with data in buffer 2.

It will be recognized that the above description is merely one example of how the LCD reading and writing and driving functions may be performed. It will be clear to those of ordinary skill in the art that many other types of memory and program architecture are possible to achieve similar results.

Sensor Inputs

The present invention receives a plurality of sense signals, which are used by processor 100 to calculate various parameters such as current heading, height off ground, longitude and latitude positions, attitude of the aircraft, etc. As shown in Fig. 4, a plurality of signals 210 may be received from various sensors in the aircraft. The signals 210 may be fed into signal conditioning circuits 220 which in turn are fed into a 48 channel multiplexor 230. The multiplexor 230 also receives a clock control signal 240. In one embodiment, the clock control signal 240 is the A/C power supply of the aircraft which is 400 Hz. Use of the aircraft power supply of the clock signal is advantageous to sync multiplexor sampling to the A/C sensors, as sensors throughout the aircraft may be synched with processor 100 and the multiplexor 230 without the need for a separate clock signal to be run throughout the aircraft. The use of a single multiplexor 230 also allows use of a single A/D convertor 250 which inputs to microprocessor 100. Signal inputs 210 include signals from the flux gate, the directional gyro, the G.P.S. receiver, the ILS receiver (instructional landing system) which provides for precision approach guidance and landing. As shown in Fig.1, some inputs may be directly coupled to the microprocessor 100 by serial input 250. For example, GPS data may be serial input from a GPS receiver. Or, data from the radar altimeter, which indicates the height of aircraft above the ground may be input by serial input. Depending on the priority level of the data, some of the inputs may be sampled once per cycle while others may be sampled multiple times per cycle through the multiplexor 230.

In some embodiments a 1600Hz sync signal is generated by "synching" off the peak voltages and zero crossings of the 400Hz power supply signal. This allows faster sampling.

In addition to the above-described sensors, additional sensors such as a lightening sensor may be used. Indeed any navigational or other flight data sensor may be used.

In certain embodiments of the invention, nonvolatile memory 410 will store database corresponding to a topographical map illustrating different obstacles throughout a given sector of the world based on longitudinal and latitudinal locations. The sense data which provides the plane's location such as a G.P.S. receiver, or a similar type system will be reviewed by the microprocessor 100 and correlated via a look-up table with the topographical data. As a result, microprocessor 100 will be able to determine if any obstacles are within the flight path of the aircraft or within the vicinity of the aircraft. This data, as explained below, can then be displayed to the pilot in a succinct manner so as to alert him of the possibility of hitting the obstacle.

Memory 410 also stores other database information, such as airport location, runway data, magnetic north data, etc.

The present invention also provides a unique method of updating the database information stored in memory 410.

As is well known in the art, database information such airport location, magnetic data, etc., is updated on a regular basis. However, when these databases are updated, they have an effective date in which they will become applicable.

Databases are updated by a regular maintenance procedure on the airplane. In particular, a maintenance computer is attached to the onboard microprocessor by, for example, a serial port. The maintenance computer updates the database to include the effective data. However, the problem is where the maintenance on the airplane is performed prior to the effective date of the new data. In such situations, the airplane has conventionally been forced to store both the "old" database information as well as the soon to be effective database information, thereby doubling the amount of memory required. However, according to the present invention, the database is updated such that only the changed information of database is written into the memory. These changed information points are written into a portion of the memory referred to as continuation data. Using the database, microprocessor 100 will first read the anticipated data from the regular portion of the database, and then it will check the conditional memory section to see if any changes have been made in data currently being polled. If a change has been made, microprocessor 1000 determines whether the new effective date has taken place, and if it has, it uses the new data in the conditional memory; otherwise, it uses the old data. That is, the maintenance computer determines the contents of the database of the onboard computer and determines what data has changed. It only uploads the changed data. For example, in one embodiment the onboard memory contains data indicating the date of the last update. The maintenance computer checks this date and from this can determine what data to add. It should be noted that multiple changes may be made to a particular datapoint, with each change stored in the continuation memory. Of course, if desired the extra main memory may be reupdated and the continuation memory cleared.

This system has two main benefits. First,it reduces the amount of onboard memory that is required, thereby reducing the cost of the device, and second, it speeds up the maintenance process of uploading the new data to the airplane as necessary to upload the changed data only.

Mechanical Improvements

As explained above, one of the aspects of the invention concerns maximizing the displayable area of the LCD screen. In one embodiment of the invention directed to a 3ATI avionics slot, any blockage of the 3" x 3" screen can result in a useable display area which is too small for practical purposes. Accordingly, one aspect of the invention is directed to the optimization of the placement of the user input devices, i.e., the user buttons and knobs which allow the pilot to control the symbolage displayed on the device. According to Fig.2, a plurality of push buttons 900 are arranged along the outer perimeter of the display device. In addition, at least one turn knob 910 is set in the bottom corner of the display device, to avoid conflict with the viewing area. Knob 910 is then connected via a universal joint 920 to a rotary encoder 930. Alternatively, a flexible shaft could be used instead of a joint arrangement. The use of the universal joints solves two problems. First, it allows the placement of the knobs to be substantially parallel and proximate to the outer casing of the device. Second, it allows the shafts of the knobs to be placed out of the optical path of the LCD.

The system of the present invention allows 8.4 square inches of a 3ATI panel, which has 9.56 square inches of possible space, to be used for video display. Thus, about 88% of the screen is utilized. According to the invention, preferably at least 70% of the screen is used. More preferably, 75-88% is used, or at least 75%. Even greater advantages are achieved by using at least 80% of the screen, or at least 85%. Accordingly, one embodiment utilizes in the range of about 80% of the screen.

Operation

Referring to Fig. 5, the program flow of the present invention will be described. In step 700, the processor 100 receives the sent signals from sensor inputs 200. This is done as the multiplexor steps through each of the inputs. In step 710, the microprocessor 100 polls the user input buttons, to determine the symbolage and various data to be displayed on the screen. In step 720, processor 100 calculates the required display parameters, e.g., attitude of the plane, compass direction, and other such data based upon the sensed signals and the particular graphical modes selected by the user controls. In steps 730 to 750, processor 100 calculates any "emergency" parameters, even if they were not selected by the user in step 720.

An example of such a subroutine is illustrated in Fig. 6. For example, assuming the user had the terrain data and G.P.S. and topographical data functions of the device turned off, in step 810, the processor would review the sensed G.P.S. data. In step 820, it would receive the flux gate and gyro data. In step 830 it would use the data from step 810 and 820 to calculate the current location and attitude of the plane and its present flight path. In step 840 it would look up the topographical data in memory 400 associated with the location and flight path calculated in step 830 and determine the location of any obstacles. In step 850 the processor would determine if any obstacles are in the current flight path. If yes, it would write emergency graphical data to the next buffer to be displayed by the LCD. If not, it would proceed to step 860 and determine if any obstacles are located within a predetermined distance of the plane's current location or flight path. If yes, warning data would be written into the graphical buffer to next be painted on to the LCD. For example, if in step 850 an obstacle is found to be within the flight path, it may be written to the buffer so as to show up in bright red and flashing on the next screen. If in step 860 an obstacle is found within the predetermined location of the aircraft, but not directly within the flight path, a yellow or amber symbol may be displayed on the screen so as to advise the pilot to closely monitor the location of that obstacle.

In determining whether an obstacle is within the flight path, the system considers the altitude of the obstacle and the plane, as well as the current flight path. For example, if an obstacle is located at 1200 feet elevation, and the plane is currently flying at 6000 feet, a warning would not be issued, unless the plane was in a descending course that would put it on course with the obstacle.

Referring again to the main program flow, in step 760 the processor will write the graphical data to the next buffer in memory 420 and in step 770 repetitive data is written in the next plus 1 buffer. In step 780, the next plus 2 buffer is cleared and in step 790 the process is looped back to the beginning and repeated.

DISPLAY SCREENS

Figs. 7A and 7B illustrate representative screens which may displayed using the present system. Fig. 7A illustrates a 360 degree view with graphical representations of man made obstacles, as well as natural terrain obstacles. The current location of the plane is illustrated by a plane icon 1000. The current heading is illustrated as 240 degrees by icon 1100 and the current flight course is illustrated by line 1200. A natural terrain obstacle is illustrated as icon 1300. Natural obstacle 1300 has an elevation of 1670 feet, which may be considered dangerously close to the plane's current elevation of 1220 feet.

Furthermore, the current flight course may be considered dangerously close to the natural terrain object 1300, therefore an alert would be generated. For example, alert icon 1400 may flash amber or red, as well as icon 1300 itself flash in red or amber. In addition, an audible alarm may be sounded. Referring to the same figure, man made obstacle 1500 are represented by inverted "V's" on the screen.

Fig. 7B is similar to Fig. 7A described above, except it is in "arc" or 90 degree view, thereby only providing the pilot with a forward looking perspective. In addition, other graphical images may be presented on the display. For example, in Fig. 7B a nondirectional beacon 1600 is illustrated on the display.

As may be well appreciated by those of ordinary skill in the art any type of navigational display may be presented on the display of the present invention. Accordingly, the above described examples are to be recognized merely as illustrative and not exhaustive of the scope of the invention.

CONSTRUCTION

Fig. 8A illustrates an example of the 3ATI slot as used in the invention. Fig. 8B is a partial breakaway of the 3ATI slot with the rear projection system of the invention disposed therein. For simplicity, other components are not shown in the figure.

While the invention has been described above with particular reference to an avionics display system, it will be appreciated that it may be used in any vehicle display system. In particular, it is extremely well-suited for freight and commercial trains as well as high-speed bullet train systems. Moreover, while the Avionics display has been disclosed with reference to the 3ATI system, it is clearly understood that it may be used in other slot sizes and its applicability is clearly pertinent thereto.

CLAIMS

What is claimed is:

1. An avionics display device comprising:

a plurality of sensor inputs for receiving sensor data regarding the condition, location and attitude of the plane and generating sensor signals in response thereto;

a microprocessor for receiving the sensor signals;

a memory device;

a rear projection image system comprising a screen and an image producing unit;

a user input for selectively controlling items that will be displayed on the screen;

wherein the rear projection system and user input systems are selectively associated with the microprocessor; and

at least 80% of the screen is used in projecting the image.

2. An aviation cockpit display unit, comprising:

a display screen having a predetermined area; and

an image display circuit for displaying information on at least 80% of said display screen.

3. An aviation cockpit display unit, comprising:

a display screen for displaying aviation information; and

a rear projection imager for projecting the aviation information on the screen.

4. An avionics display device having a projection screen comprising:

an interface for receiving sensed signals;

a processor for converting the sense data to graphical data; and

a rear projector, receiving the graphical data, for converting the graphical data to an image and projecting the image on the screen.

5. A method of increasing the display area of a digital avionics display in a 3" x 3" airplane panel, comprising:

(a) providing a rear projection screen;

(b) providing a rear projector;

(c) providing a controller for controlling the projector in accordance with a prestored program and user inputs;

(d) projecting desired images from the projector onto the screen;

(e) providing user control mechanisms at the periphery of the screen, and operatively associating the user control mechanisms with the controller to provide the user inputs,

whereby at least 80% of the screen is used to display the desired images.

6. A method of warning an airplane pilot of dangerous proximity to the ground, comprising:

(a) receive G.P.S. data providing the planes current geographical location;

(b) comparing the received G.P.S. data with topographical data stored in a computer memory and determining whether the plane is within a predetermined threshold range of the ground; and

(c) if the plane is withing the predetermined threshold, issuing a visual warning to the pilot.

7. A method of warning an airplane pilot of dangerous proximity to the ground using a rear projecting display device, comprising:

(a) receive G.P.S. data providing the planes current geographical location;

(b) comparing the received G.P.S. data with topographical data stored in a computer memory and determining whether the plane is within a predetermined threshold range of the ground; and

(c) if the plane is withing the predetermined threshold, projecting a visual warning on a screen using a rear projection system.

8. A display device for displaying vehicle information to a vehicle operator,

comprising:

a display screen;

a rear projection display unit for displaying an image on the screen, wherein an optical path is defined between the display unit and the screen;

user input mechanism having a proximate end disposed along an outer periphery of the screen and a distal end connected to the rear projection unit and having a universal joint disposed between said proximate and distal ends to prevent interference of the user input mechanism with the optical path.

9. A method of updating an avionics display system database with data having a predetermined effective date, comprising:

(a) providing an onboard computer having a storage media for storing the database;

(b) dividing the storage media into at least two sections including a main data portion and a continuation portion;

(c) storing initial database data in the main area;

(d) during updates, interfacing a maintenance computer with the storage media;

(e) using the maintenance computer to compare the new data to be updated with previously stored data in the storage media and determine the differences;

(f) only writing the difference into the continuation portion of the storage media, with its associated effective date wherein the on board computer in operation searches both the main and continuation data and uses the continuation data in lieu of the main data if the effective date has passed.

10. An avionics display device comprising:

a plurality of sensor inputs for receiving sensor data regarding the condition, location and attitude of the plane and generating sensor signals in response thereto;

a microprocessor for receiving the sensor signals;

a memory device;

a rear projection image system comprising a screen and an image producing unit;

a user input for selectively controlling items that will be displayed on the screen;

wherein the rear projection system and user input systems are selectively associated with the microprocessor; and

at least in the range of 80% of the screen is used in projecting the image.

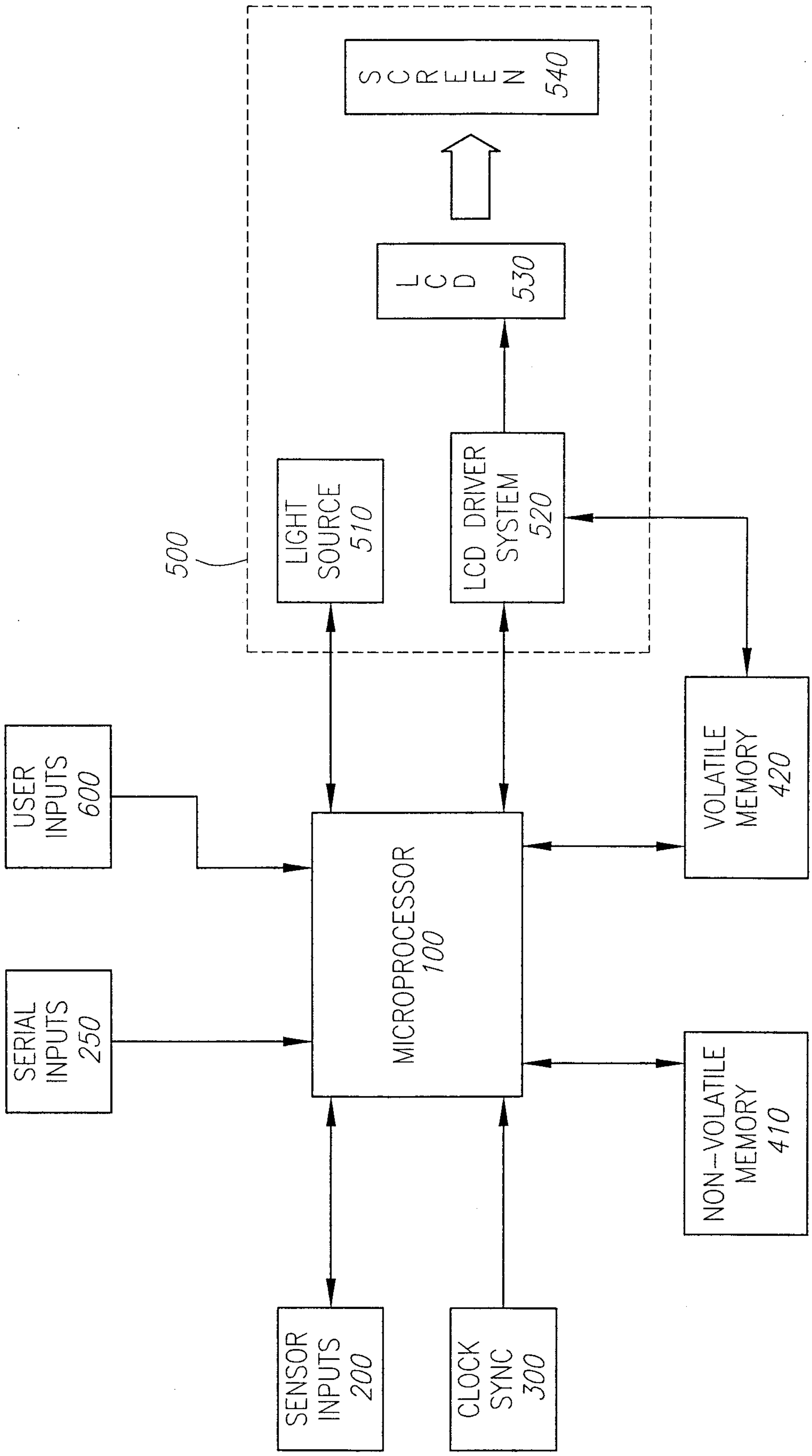
SCREEN 540
LCD 530
LIGHT SOURCE 510
LCD DRIVER SYSTEM 520
500
USER INPUTS 600
SERIAL INPUTS 250
MICROPROCESSOR 100
VOLATILE MEMORY 420
NON-VOLATILE MEMORY 410
SENSOR INPUTS 200
CLOCK SYNC 300

FIG. 1

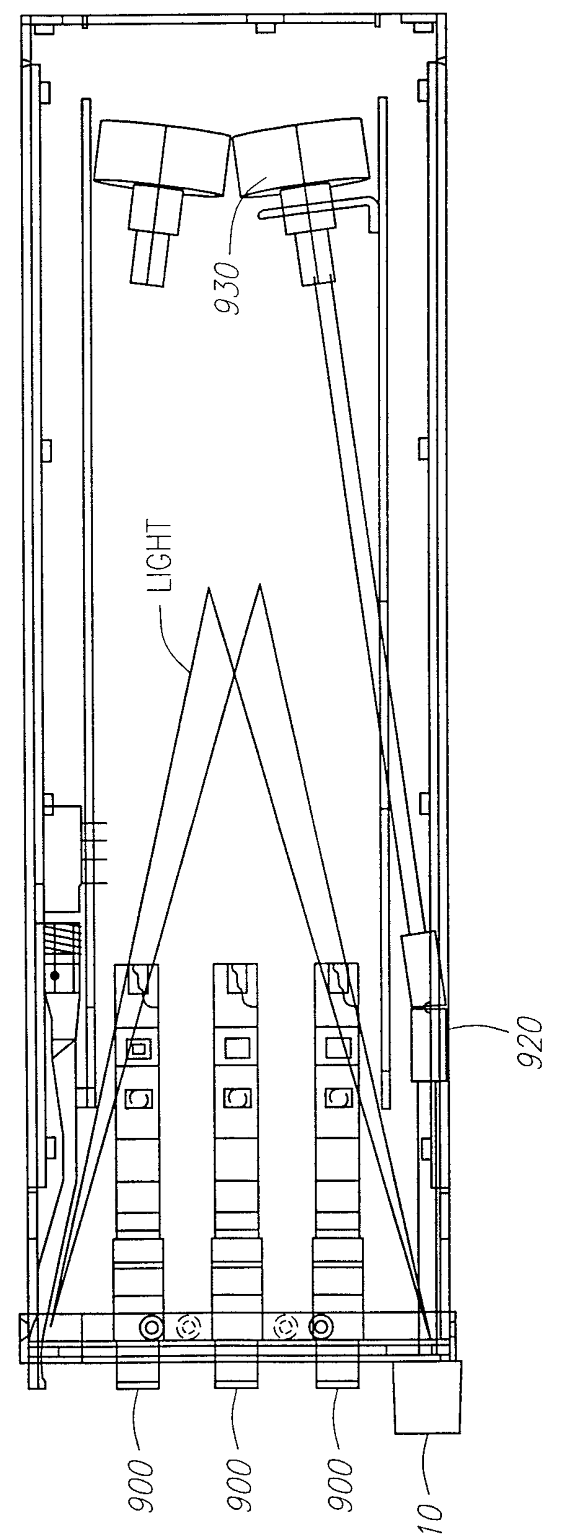

FIG. 2

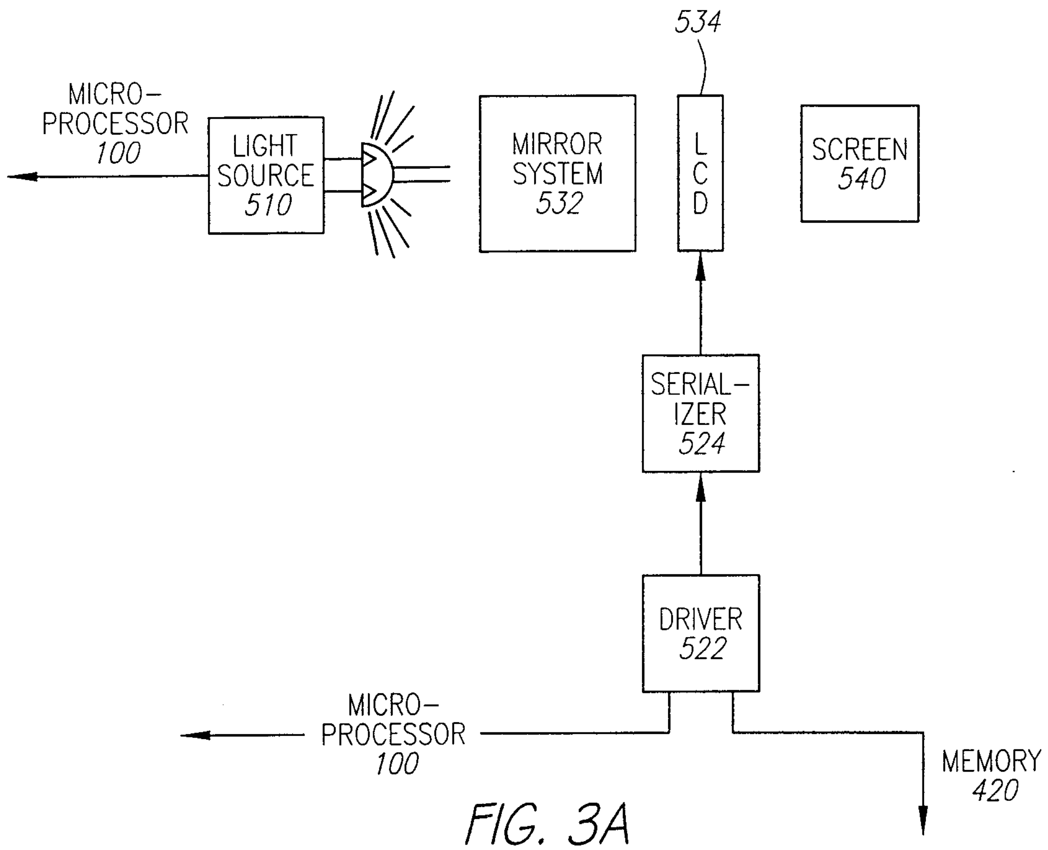
534
MICRO-
PROCESSOR
100
LIGHT
SOURCE
510
MIRROR
SYSTEM
532
L
C
D
SCREEN
540
SERIAL-
IZER
524
DRIVER
522
MICRO-
PROCESSOR
100
MEMORY
420

FIG. 3A

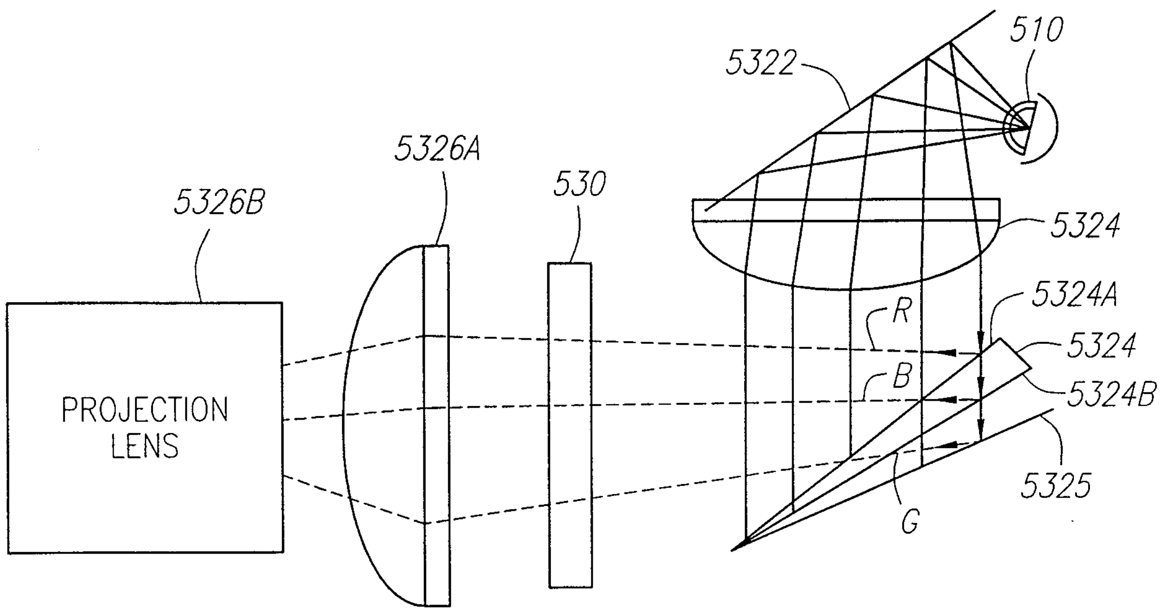
510
5322
5326A
530
5326B
5324
5324A
R
5324
B
5324B
PROJECTION
LENS
5325
G

FIG. 3B

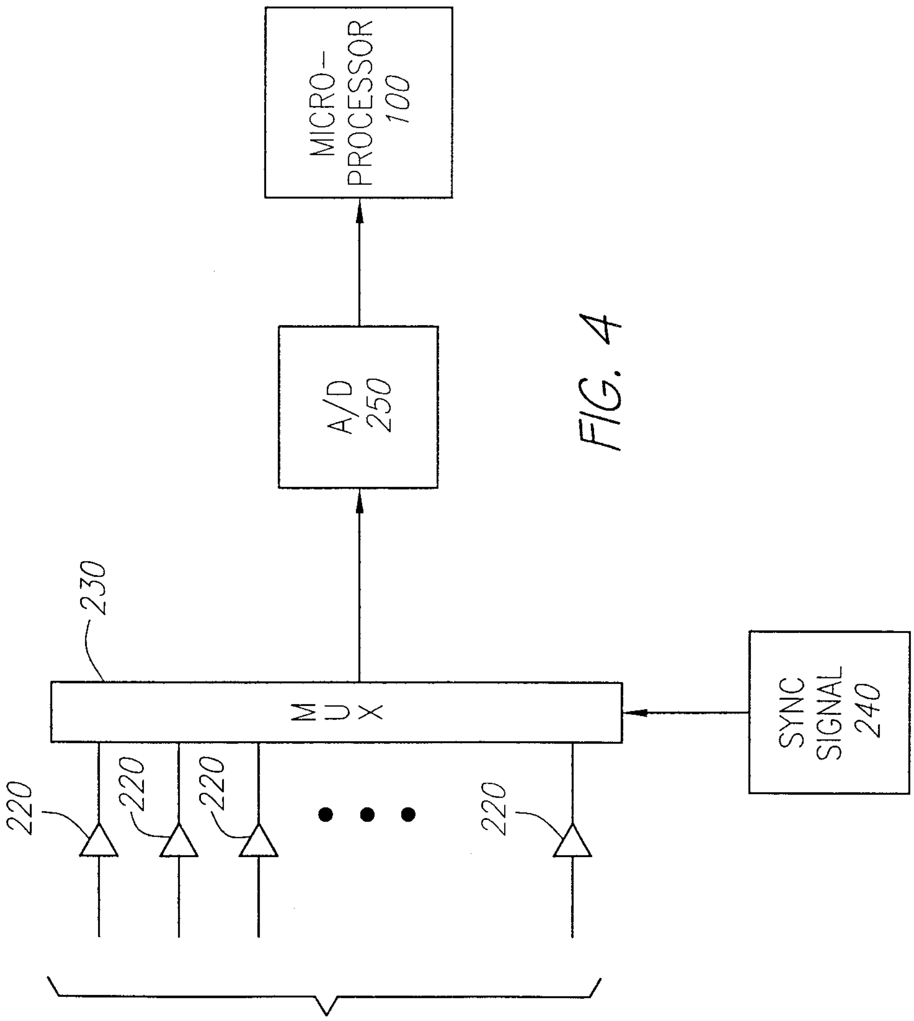
MICRO-
PROCESSOR
100
A/D
250
230
MUX
SYNC
SIGNAL
240
220
220
220
220

FIG. 4

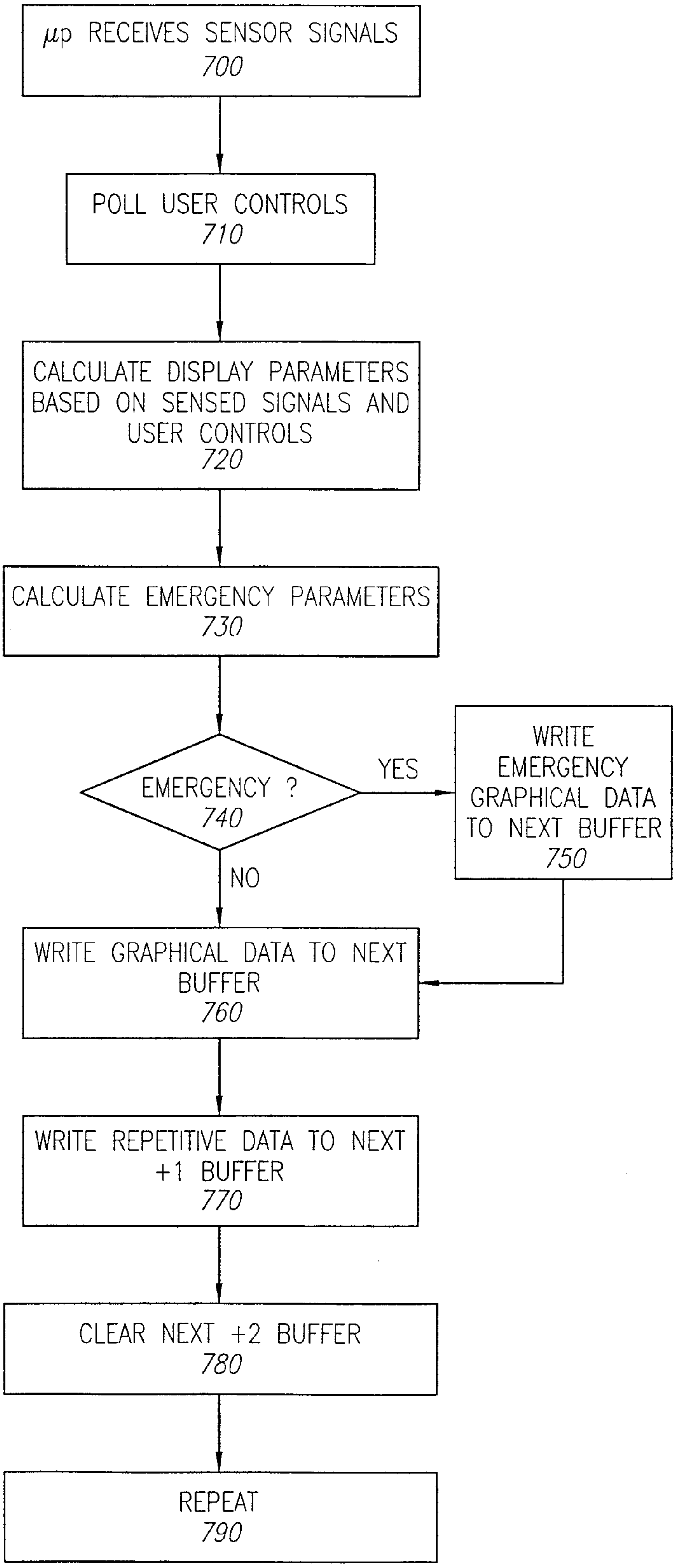
μp RECEIVES SENSOR SIGNALS
700
POLL USER CONTROLS
710
CALCULATE DISPLAY PARAMETERS BASED ON SENSED SIGNALS AND USER CONTROLS
720
CALCULATE EMERGENCY PARAMETERS
730
EMERGENCY ?
740
YES
WRITE EMERGENCY GRAPHICAL DATA TO NEXT BUFFER
750
NO
WRITE GRAPHICAL DATA TO NEXT BUFFER
760
WRITE REPETITIVE DATA TO NEXT +1 BUFFER
770
CLEAR NEXT +2 BUFFER
780
REPEAT
790

FIG. 5

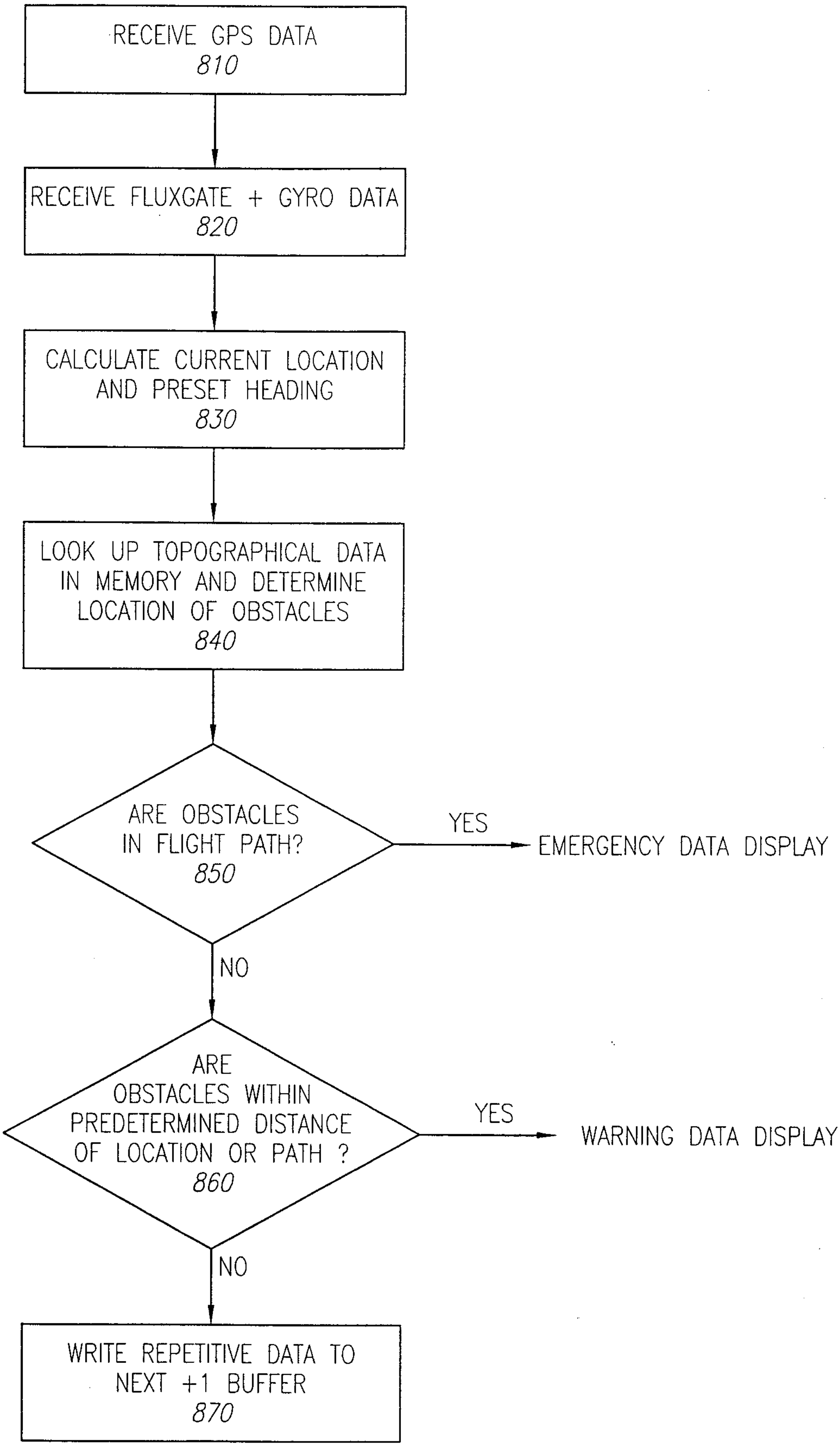
RECEIVE GPS DATA
810
RECEIVE FLUXGATE + GYRO DATA
820
CALCULATE CURRENT LOCATION AND PRESET HEADING
830
LOOK UP TOPOGRAPHICAL DATA IN MEMORY AND DETERMINE LOCATION OF OBSTACLES
840
ARE OBSTACLES IN FLIGHT PATH?
850
YES
EMERGENCY DATA DISPLAY
NO
ARE OBSTACLES WITHIN PREDETERMINED DISTANCE OF LOCATION OR PATH ?
860
YES
WARNING DATA DISPLAY
NO
WRITE REPETITIVE DATA TO NEXT +1 BUFFER
870

FIG. 6

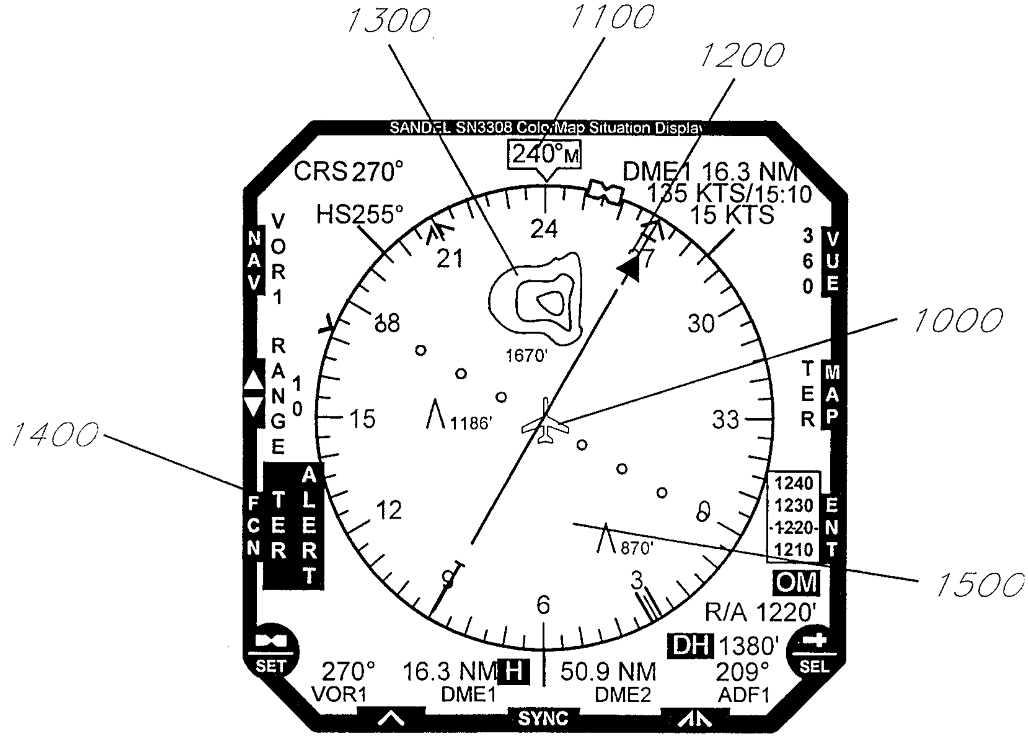
1300
1100
1200
1000
1400
1500
SANDEL SN3308 ColorMap Situation Display
240°M
CRS 270°
HS255°
DME1 16.3 NM
135 KTS/15:10
15 KTS
1670'
1186'
870'
OM
R/A 1220'
DH 1380'
270° VOR1
16.3 NM DME1
50.9 NM DME2
209° ADF1
SYNC
SET
SEL

FIG. 7A

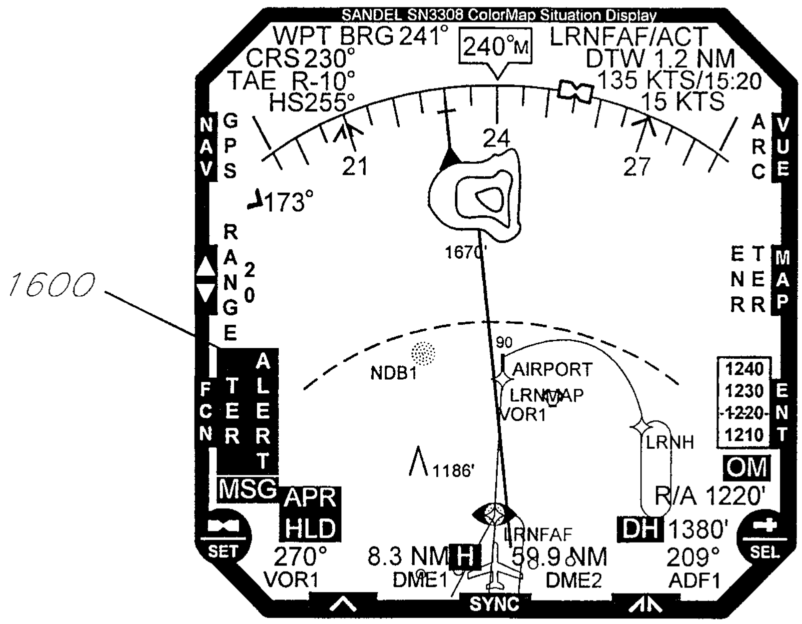
1600
SANDEL SN3308 ColorMap Situation Display
WPT BRG 241°
CRS 230°
TAE R-10°
HS255°
240°M
LRNFAF/ACT
DTW 1.2 NM
135 KTS/15:20
15 KTS
173°
1670'
NDB1
AIRPORT
LRNMAP
VOR1
LRNH
1186'
LRNFAF
MSG
APR
HLD
OM
R/A 1220'
DH 1380'
270° VOR1
8.3 NM DME1
58.9 NM DME2
209° ADF1
SYNC
SET
SEL

FIG. 7B

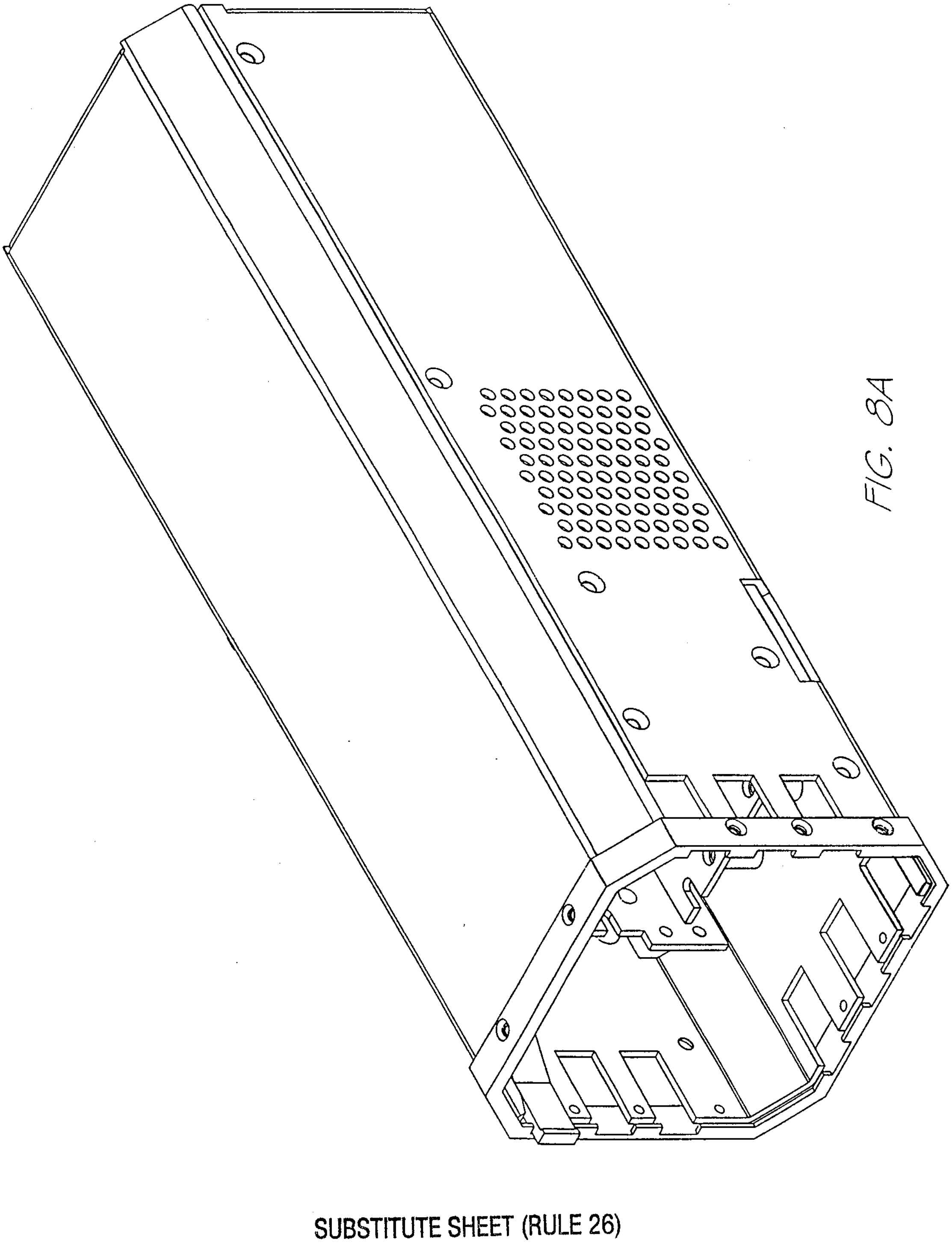

FIG. 8A

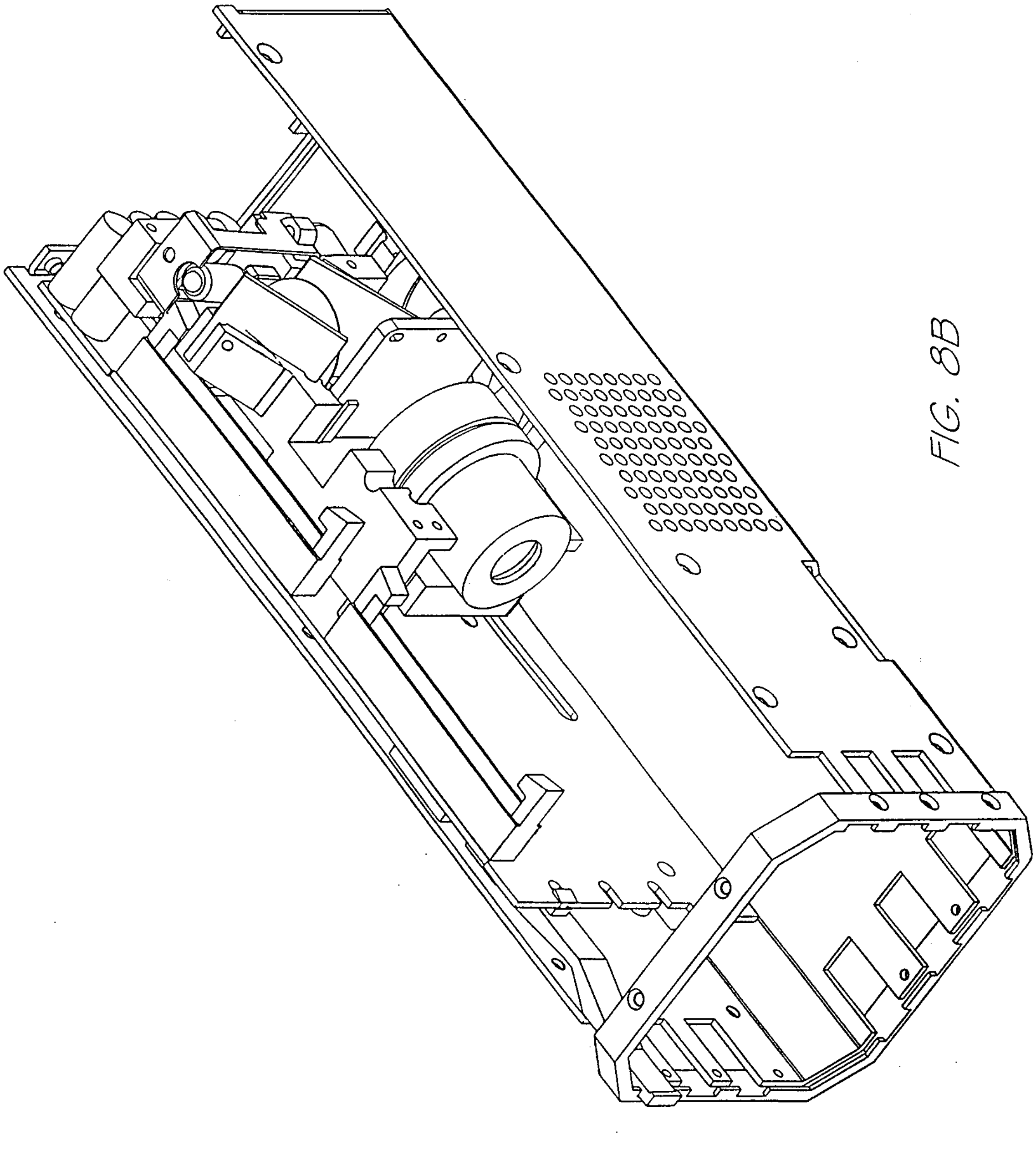

FIG. 8B