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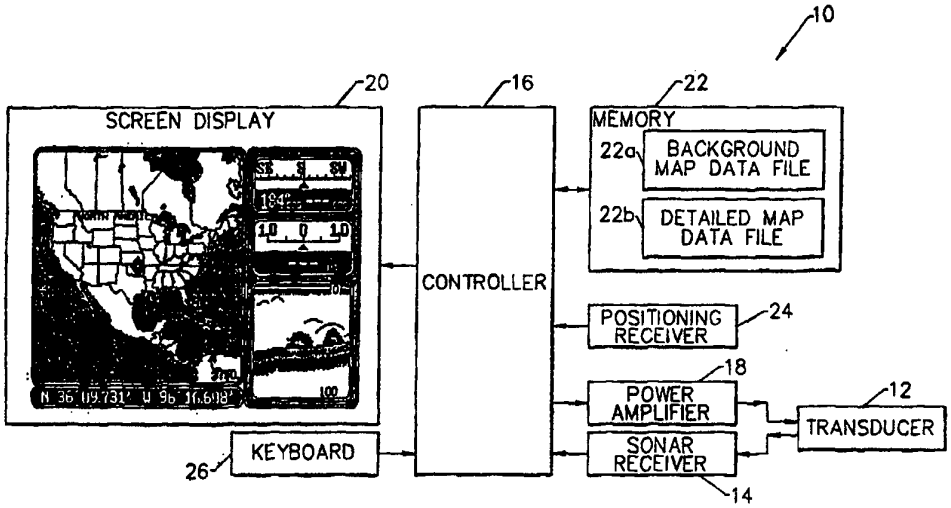

(57) Abstract

An integrated sonar and mapping system for providing both sonar and mapping features in a single integrated system includes a controller for processing the returning sonar signals emitted and received by a transducer to generate echo data representative of the objects within the body of the water which reflect the sonar signals. The integrated sonar and mapping system also includes a screen display for displaying a graphical representation of the echo data, such as a visual image of at least some of the objects within the body of water which reflect the sonar signals. The screen display can also display a graphical representation of cartographic data representative of a map such that a visual image of at least a portion of the map is also displayed. The integrated sonar and mapping system can also include a navigational and positioning system, such as a positioning receiver for receiving positioning signals from at least one reference transmitter. Thus, the controller can generate positioning data representative of the position of the integrated sonar and mapping system and, therefore, the boat on which the system is mounted, based upon the positioning signals. Accordingly, the integrated sonar and mapping system can provide a number of distinct features in a single unit, including sonar, mapping and navigational features.

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INTEGRATED SONAR AND MAPPING SYSTEM AND ASSOCIATED METHOD

Field of the Invention

The present invention relates generally to sonar systems and associated sonar display methods and, more particularly, integrated sonar and mapping systems and associated methods of displaying both cartographic and echo data.

Background of the Invention

Boaters and sport fisherman oftentimes refer to maps or charts in order to properly navigate a body of water. Conventionally, these maps have been paper maps which depict the shoreline as well as prominent features on both land and water. For example, the location of buoys or channel markers are typically identified on navigational maps. In addition, some of the more detailed maps can include contour lines or other topographic information indicative of the depth of the water and the slope of the bottom surface of the body of water. Accordingly, by referring to navigational maps, boaters and sport fisherman can determine their approximate location and can plot an appropriate route to their destination.

Although paper maps provide a significant amount of information, successful navigation based upon such maps depends on a boater's recognition of the various shoreline and other land and water based features identified on the map in order to determine the present position of the boat. Even for experienced navigators, therefore, the position of the boat as determined by the boater is an approximation which

depends upon the accuracy with which the boater identifies and locates the various features. In addition, paper navigational maps can often prove unwieldy as the boater must often leaf through a number of different maps in order to identify the appropriate map. Once the boater identifies the appropriate map, the boater must then attempt to read the map which may be blowing about in the wind. In addition, the boater must also attempt to keep the paper maps relatively dry so that they can be reused.

In order to provide additional navigational information, a number of mapping and navigation systems have been developed which provide video representations of navigational maps. For example, Lowrance Electronics, Inc. has developed the Global Map™ 1000 marine mapping and navigation system. The Global Map™ 1000 marine mapping and navigation system is described in detail in the installation and operation instructions published by Lowrance Electronics, Inc. and bearing document number 9880134-00, the contents of which are expressly incorporated by reference herein.

Marine mapping and navigation systems, such as the Global Map™ 1000 marine mapping and navigation system, include a screen display for providing a graphical representation of a map. Depending upon the database available, the map image displayed may cover a large area with little detail, such as a country, or it may cover a small area with a great amount of detail, such as a harbor channel and individual navigational buoys. In addition, marine mapping and navigation systems can also determine the position of the boat on which the marine mapping and navigation system is mounted and can display an icon designating the relative position of the boat on the screen display concurrently with the graphical representative of a map to identify the relative position of the boat on the map.

Marine mapping and navigation systems typically determine the relative position of the boat based upon positioning signals received from one or more land-based beacons, one or more orbiting satellites comprising the Global Positioning System ("GPS"), or other sources. Based upon these positioning signals, the marine mapping and navigation system can determine other navigational data, such as the present latitude and longitude position of the boat and the present compass heading, course over ground, bearing and speed over ground. In addition, marine mapping and navigation systems, such as the Global Map™ 1000 system, allow the operator to enter several event markers to identify specific positions and several waypoints to mark a course which the operator desires to follow. Accordingly, the marine mapping and navigation system can also determine the distance and bearing to the nearest event marker and/or to the nearest waypoint based upon the positioning signals.

In addition to referring to maps, such as paper maps or graphically displayed maps, in order to determine navigational information, boaters and sport fishermen commonly employ sonar systems, such as sonar depth finders and sonar fish finders, to provide detailed information regarding the contour of bottom surface of the body of water and objects submerged therein. Sonar systems are based upon sonar systems developed during the World War II era which generated a sonar signal that was transmitted through a body of water and reflected by the bottom surface of the body of water to the sonar system. Based upon the length of time between the generation of the sonar signal and the reception of the reflected signal by the sonar system, these sonar systems could determine the distance to the bottom surface of the body of water.

A number of sonar systems have been developed which display the reflected sonar signals in a variety

of manners. For example, some sonar systems include rotating disk lamps or "flashers" which produce a pulse of light upon the reception of a reflected sonar signal. However, flashers do not generally provide historical data representative of the contour of the bottom surface of the body of water. Instead, the pulse of light provides only a momentary indication of the distance to the bottom surface of the body of water. Accordingly, the operator must closely monitor the flasher in order to determine the contour of the bottom surface of the body of water. In addition, sonar signals reflected by submerged objects, such as fish, are typically difficult to identify by the pulses of light provided by flashers since the pulses of light provide only a momentary indication of the distance to the submerged object from which the sonar signals are reflected.

In order to provide historical data indicative of the contour of the bottom surface of the body of water as well as the relative location of submerged objects, such as fish, sonar systems were developed which included a chart recorder. These sonar systems generate a strip chart on which markings indicate the contour of the bottom surface of the body of water as determined from the reflected sonar signals. While sonar systems incorporating chart recorders provide a permanent record of the contour of the bottom surface of the body of water, the strip charts produced by these sonar systems can be relatively difficult to interpret.

For example, the strip charts typically include a wide area or band of markings to indicate the relative location of the bottom surface of the body of water. However, thermoclines within the body of water or multiple reflections of the sonar signals, such as due to spurious reflections of the sonar signals from the bottom surface of the boat, can create additional

reflections which, if received by the sonar system, will create additional lines or bands on the strip chart. In addition, the operator of a sonar system having a chart recorder may change the scale to which the strip chart is drawn in order to more clearly depict the bottom surface of a body of water. However, the strip chart generated prior to the change in scale will remain drawn to the previous, albeit different, scale. Thus, the operator of the sonar system may find it difficult to read and compare markings on the strip chart, particularly in the region in which the scale of the strip chart was changed.

Accordingly, sonar systems having associated display devices have been developed to provide a historical graphical display of the bottom surface of the body of water over which the boat is passing as well as to identify submerged objects from which the sonar signals reflect. The associated display devices typically include cathode ray tubes, electroluminescent panels, liquid crystal displays and LED displays. These sonar systems also generally include advanced electrical circuitry, including one or more microprocessors or microcontrollers, to provide a number of features which allow the operator to customize the resulting display.

Notwithstanding the variety of features offered by both sonar systems and marine mapping and navigation systems, operators must still purchase, install, operate and repeatedly refer to two or more separate systems in order to obtain sonar information and mapping or navigational data. In addition to the increased cost of purchasing and the increased space required to install these two different systems, operators must learn how to configure and operate each of the systems in order to appropriately utilize the various features provided. Thus, an otherwise enjoyable boating or fishing excursion can quickly

become a laborious task in which a large amount of the boater's time is consumed configuring, operating, monitoring and trying to coordinate and interpolate the sonar system and the separate mapping and navigational system.

Summary of the Invention

It is therefore an object of the present invention to provide an integrated sonar and mapping system and an associated method for providing both sonar and mapping operations.

It is another object of the present invention to provide an integrated sonar and mapping system which includes a screen display capable of displaying graphical representations of both a map and a sonar display such that an operator need only refer to the single screen display for both mapping and sonar information.

It is a further object of the present invention to provide an integrated sonar, mapping and navigational system and an associated method for providing not only sonar and mapping information, but also navigational information in a single system.

These and other objects are provided, according to the present invention, by an integrated sonar and mapping system which provides both sonar and mapping information to an operator in a single system. The integrated sonar and mapping system includes at least one transducer and a cartographic storage means, such as a memory device, for storing cartographic data representative of a map. The at least one transducer emits sonar signals through a body of water and receives returning sonar signals reflected by objects within the body of water. The integrated sonar and mapping system also includes a controller for processing the returning sonar signals to generate echo data representative of the objects within the body of

water which reflect the sonar signals. In addition, the integrated sonar and mapping system includes a screen display for displaying a graphical representation of the echo data such that the operator is provided with a visual image of at least some of the objects within the body of water which reflect the sonar signals. Further, the screen display of the integrated sonar and mapping system is capable of displaying a graphical representation of cartographic data which is representative of at least a portion of a map. Thus, by viewing the screen display, the operator can determine both sonar and mapping information.

In one embodiment, the screen display is capable of concurrently displaying graphical representations of the cartographic data and the echo data. Thus, the integrated sonar and mapping system can simultaneously provide visual images of both the map and objects within the body of water which reflect the sonar signals such that the operator need only refer to a single screen display.

In one embodiment, the cartographic storage means includes first storage means for storing cartographic data representative of a background map and second storage means for storing cartographic data representative of a detailed map. The detailed map typically has a greater resolution than the background map. Accordingly, graphical representations of maps having various degrees of resolution can be provided by the integrated sonar and mapping system to thereby provide the operator with different levels of detail.

According to one advantageous embodiment, the integrated sonar and mapping system also provides navigational or positioning information to thereby provide an integrated sonar, mapping and navigational system. The integrated sonar, mapping and navigational system of this embodiment includes a positioning receiver for receiving positioning signals from at

least one reference transmitter, such as one or more GPS satellites or land-based beacons or other navigational sources. According to this embodiment, the controller is operably connected to the positioning receiver for generating positioning data representative of a position, typically the position of the integrated sonar, mapping and navigational system, based upon the positioning signals.

The screen display of this embodiment can display a graphical representation of the positioning data to provide the operator with a visual image of the relative position of the integrated sonar, mapping and navigational system. In one advantageous embodiment, the screen display is capable of concurrently displaying graphical representations of the cartographic data and the positioning data such that the operator can determine the position of the integrated sonar, mapping and navigational system relative to the map.

According to the present invention, the integrated sonar and mapping system can provide both sonar and mapping information to the operator in a single system. Thus, the operator need refer only to a single screen display in order to obtain visual images of the terrain above the surface of the water from a map display and of the terrain below the surface of the water from a sonar display. Furthermore, the operator need only purchase and learn how to operate a single system in order to obtain both sonar and mapping information. According to one advantageous embodiment of the present invention, the integrated sonar, mapping and navigational system provides not only sonar and mapping information, but also navigational or positioning information. Thus, the versatility and flexibility of the integrated sonar, mapping and navigational system is significantly enhanced due to

the incorporation of the sonar, mapping and navigational features into a single system.

Brief Description of the Drawings

Figure 1 is a block diagram of the components of an integrated sonar and mapping system according to one embodiment of the present invention which illustrates an exemplary graphical representation provided by the screen display of the integrated sonar and mapping system.

Figure 2 is a perspective view of a screen display of an integrated sonar and mapping system according to one embodiment of the present invention.

Figure 3 is a flow chart illustrating the general operations performed by the integrated sonar and mapping system according to one embodiment of the present invention.

Figure 4 is a flow chart illustrating different processes performed by the integrated sonar and mapping system of one embodiment of the present invention, including a keyboard process, a display process, a positioning/navigation process, a mapping process and an sonar process.

Figures 5A-5I are flow charts illustrating the detailed operations performed by the integrated sonar and mapping system according to one embodiment of the present invention during the keyboard process.

Figures 6A-6F are flow charts illustrating the detailed operations performed by the integrated sonar and mapping system according to one embodiment of the present invention during the display process.

Figure 7 is a flow chart illustrating the detailed operations performed by the integrated sonar and mapping system according to one embodiment of the present invention during the positioning and navigation process.

Figure 8 is a flow chart illustrating the detailed operations performed by the integrated sonar and mapping system according to one embodiment of the present invention during the mapping process.

Figure 9 is a flow chart illustrating the detailed operations performed by the integrated sonar and mapping system according to one embodiment of the present invention during the sonar process.

Figures 10A-10M illustrate display screens which are presented to an operator during operation of an integrated sonar mapping system according to one embodiment of the present invention.

Detailed Description of the Preferred Embodiments

The present invention will now be described more fully hereinafter with reference to the accompanying drawings, in which a preferred embodiment of the invention is shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, this embodiment is provided so that this disclosure will be thorough and complete and will fully convey the scope of the invention to those skilled in the art. Like numbers refer to like elements throughout.

Referring now to Figure 1, a block diagram of the integrated sonar and mapping system **10** according to one embodiment of the present invention is shown. As illustrated in Figure 1 and block **32** of Figure 3, the integrated sonar and mapping system includes at least one transducer **12** for emitting sonar signals toward the bottom surface of a body of water. While the illustrated embodiment of the integrated sonar and mapping system includes only a single transducer, the integrated sonar and mapping system can include a plurality of transducers, each of which emits sonar signals, without departing from the spirit and scope of

the present invention. In addition, the integrated sonar and mapping system can include a variety of types and configurations of transducers, including a plurality of transducers which are alternately driven or a phased array of transducers. As known to those skilled in the art, two or more transducers of a phased array of transducers are simultaneously driven in order to appropriately map the contour of the bottom surface of the body of water and to identify objects submerged therein, such as fish and underwater structures. Other alternative embodiments include transducers operating at different frequencies or producing different beam patterns.

As also known to those skilled in the art, sonar transducers **12** not only emit sonar signals into a body of water, but also initially receive the returning sonar signals which have been reflected by objects in the body of water as shown in block **34** of Figure 3. The objects which reflect the sonar signals can include the bottom surface of the body of water and other submerged objects. Although the transducers initially receive the sonar signals, the integrated sonar and mapping system **10** can also include a receiver **14** to process the returning sonar signals initially received by the transducers. For example, the receiver can filter and amplify the signals and can convert the signals from analog to digital.

In addition, embodiments of the integrated sonar and mapping system **10** of the present invention which include the plurality of transducers **12** can include receiver means for receiving and processing the returning sonar signals which are initially received by the transducers. As described in co-pending U.S. Patent Application entitled "Sonar System Having An Interactive Sonar Viewing Apparatus And Method Of Configuring Same" filed July 14, 1995, the contents of which are expressly incorporated by reference herein,

the receiver means can include a receiver **14** as described above and multiplexing means, such as a multiplexer, operably connected between the plurality of transducers and the receiver. The multiplexing means selects the returning sonar signals which were initially received by at least one of the transducers for receipt by the receiver. Accordingly, the integrated sonar and mapping system can have a common or universal receiver for effectively receiving the returning sonar signals originally emitted by each of a plurality of transducers.

As illustrated in Figure 1, the integrated sonar and mapping system **10** also includes a controller **16**. For example, the controller can include one or more microprocessors or microcontrollers which are operably connected or networked for coordinated operation. The controller is also operably connected to the receiver **14** for further processing the returning sonar signals. In particular, the controller generates echo data representative of the objects within the body of water which reflect the sonar signals as shown generally in block **36** of Figure 3.

As shown in Figure 1, the controller **16** typically controls the operation of the transducer **12** by driving the transducer via an associated power amplifier **18**. Thus, the controller can provide an activation signal to the power amplifier associated with the selected transducer. The power amplifier, in turn, amplifies the signal provided by the controller and provides the amplified signal to the associated transducer, thereby driving the associated transducer to emit sonar signals into the body of water. However, the integrated sonar and mapping system **10** need not include a power amplifier, but can, instead, employ the controller to directly drive the transducer without departing from the spirit and scope of the present invention.

According to the present invention, the integrated sonar and mapping system **10** also includes a screen display **20**, responsive to the controller **16**, for providing a graphical representation of the echo data generated by the controller as shown in Figures 1 and 2. As described above, the echo data is representative of the objects within the body of water which reflect the sonar signals. Thus, the screen display can provide a visual image of the contour of the bottom surface of the body of water as well as the relative locations of submerged objects, such as fish, for example. While a two-dimensional graphical representation of the echo data is illustrated herein, the integrated sonar and mapping system and, more particularly, the screen display can provide the echo data in a variety of other formats, including a three-dimensional graphical representation, without departing from the spirit and scope of the present invention.

As further illustrated in Figure 1 and block **30** of Figure 3, the integrated sonar and mapping system **10** preferably includes cartographic storage means for storing cartographic data representative of a map. The cartographic storage means can include a memory device **22**, such as read only memory (ROM) or random access memory (RAM), in which the cartographic data is stored, such as in a cartographic data file. The memory device in which the cartographic data is stored can be either external to the controller **16**, as shown in Figure 1, or internal to the controller without departing from the spirit and scope of the present invention. In addition, as will be apparent to those skilled in the art, the cartographic data can be stored in a variety of forms, including various vector representations of the cartographic data.

In one embodiment of the integrated sonar and mapping system **10** of the present invention, the cartographic storage means includes both a first

storage means for storing cartographic data representative of a background map, such as in a background map data file **22a**, and second storage means for storing cartographic data of a detailed map, such as in a detailed map data file **22b**. Typically, the cartographic data representative of the detailed map has greater resolution than the cartographic data representative of the background map.

While both the background map data file **22a** and the detailed map data file **22b** are illustratively shown as residing within the same memory device **22** in Figure 1, the background map data file and the detailed map data file can be stored in different memory devices without departing from the spirit and scope of the present invention. For example, the background map data file can be stored in a memory device, such as a mask ROM, within the integrated sonar and mapping system **10**. In contrast, the detailed map data file can be stored on one or more external memory cartridges, such as C-MAP™ or Inland Mapping System cartridges or modules, which are operably connected to the integrated sonar and mapping system either serially or in parallel. For example, the external memory cartridges can be connected to the integrated sonar and mapping system either directly or indirectly, such as via a universal asynchronous receiver and transmitter (UART) or a synchronous LAN connection. Accordingly, detailed map data files representative of different portions of the background map can be stored in one or more external memory cartridges and can be operably connected to the integrated sonar and mapping system in order to provide further detail of geographical regions of particular interest to the operator.

According to this embodiment, the controller **16** of the integrated sonar and mapping system **10** is operably connected to the cartographic storage means for accessing at least a portion of the cartographic

data stored therein. Further, the screen display **20** of this embodiment is capable of displaying a graphical representation of the cartographic data such that a visual image of at least a portion of the map is thereby displayed. In one advantageous embodiment, the screen display is capable of concurrently displaying graphical representations of the cartographic data and the echo data as shown in block **38** of Figure 3. Thus, visual images of both the map and the objects within the body of water which reflect the sonar signals can be simultaneously displayed for the operator by the integrated sonar and mapping system of the present invention.

In addition to providing visual images of a map and a sonar display, the integrated sonar and mapping system **10** of one advantageous embodiment also provides navigational or positioning information, such as geographical coordinates of a present position, thereby creating an integrated sonar, mapping and navigational system. In this embodiment, the integrated sonar and mapping system includes a positioning receiver **24** for receiving positioning signals from at least one reference transmitter. As known to those skilled in the art, the type of positioning receiver depends upon the type of reference transmitter emitting the positioning signals which are to be received. For example, in one embodiment, the reference transmitters are a plurality of land-based beacon transmitters. Accordingly, the positioning receiver of this embodiment typically includes a Loran-C or Decca receiver. Alternatively, the reference transmitters can include the GPS satellites which provide extremely accurate positioning signals. Thus, in this embodiment, the positioning receiver generally includes a GPS-type receiver or antenna for receiving the positioning signals from the GPS satellites.

Regardless of the origin of the positioning signals, the controller **16** of this embodiment is operably connected to the positioning receiver **24** for generating positioning data representative of a reference position based upon the positioning signals. Typically, the reference position is the position of the integrated sonar, mapping and navigational system **10** and, since the integrated sonar, mapping and navigational system is typically mounted in a boat or other vessel, the reference position is generally the position of the boat on which the system is mounted.

According to this embodiment, the screen display **20** of the integrated sonar, mapping and navigational system **10** is capable of displaying a visual representation of the positioning data generated by the controller **16**. The graphical representation of the positioning data can include textual or numerical information relating to the position of the system, such as the latitude and longitude of the boat, compass heading, bearing, course over ground and speed over ground. In addition, if a route has been entered or one or more waypoints have been set by the operator, the integrated sonar, mapping and navigational system can provide additional navigational data, such as a bearing, time and distance to go to the next waypoint.

In addition to the textual and numerical information, the screen display **20** can provide a graphical representation of the position of the integrated sonar, mapping and navigational system **10**. For example, a cursor or other reference icon can be displayed to indicate the relative position of the boat. In particular, the screen display of this embodiment is preferably capable of concurrently displaying graphical representations of the cartographic data and the positioning data. For example, the cursor or other reference icon which identifies the position of the boat can be displayed at

the same time as the map, and properly positioned so as to indicate the position of the boat relative to the map. In one embodiment, the cartographic data is associated with geographical coordinates, such as the respective latitude and longitudinal position of the map, such that the cursor or other reference icon indicative of the position of the boat can be properly positioned relative to the geographical coordinates of the map which is concurrently displayed. Still further, as shown in Figures 1 and 2, the screen display is preferably capable of concurrently displaying graphical representations of the echo data, the cartographic data and the positioning data such that the operator can quickly analyze the output of each of the sonar, mapping and navigational features provided by the single system of the present invention.

In operation, the integrated sonar and mapping system **10** performs a number of different processes in order to provide each of the features or functions described above. Accordingly, the integrated sonar and mapping system can be multi-tasking so as to simultaneously perform several of the different processes. Alternatively, the integrated sonar and mapping system and, more particularly, the controller **16** can include a scheduler **40** or a scheduling routine which cyclically allots time to each of the processes as shown in Figure 4.

For example, in the embodiment illustrated in Figure 4, the scheduler **40** can initially determine if a key is depressed as shown in block **42**. If a key is not depressed or following completion of the keyboard process **44**, if a key has been depressed, the scheduler can determine if there is an active display request as shown in block **46**. If there is not an active display request or following completion the display process **48**, if there has been an active display request, the scheduler can determine if the position of the system

10 needs to be updated as shown in block 50. If the position need not be updated or following completion of the positioning/navigation process 52, if the position does need to be updated, the scheduler can determine if a map request is pending as shown in block 54. If a map request is not pending or following completion of the mapping process 56, if a map request was pending, the scheduler can determine if a sonar request is pending as shown in block 58. If a sonar request is not pending or following completion of the sonar process 60, if a sonar request was pending, the scheduler can repeat the above-described sequence of operations by again determining if a key has been depressed as shown in block 42. While a particular sequence of operations has been illustrated and described herein with regards to the cyclic allocation of time to each of the processes, it should be apparent that the order in which the processes are performed can be arranged in a number of different sequences without departing from the spirit and scope of the present invention.

In order to further explain the present invention, the operations performed by each of the processes illustrated in Figure 4 will be described hereinafter in detail. As will be apparent, the operations illustrated generally in Figure 4 and described hereinafter are directed to an integrated sonar, mapping and navigational system 10 and typically continue so long as power is supplied to the system. In the embodiments of the present invention which do not include a navigational or positioning system, the positioning/navigation process is inactive and unnecessary. In addition, each process can be performed in a variety of different manners without departing from the spirit and scope of the present inventions since the specific steps and the order in which the steps are arranged are solely for purposes of

illustration. In addition, although the steps are oftentimes illustratively described in different blocks, it will be apparent to those skilled in the art that the steps may be performed in another order or simultaneously without departing from the spirit and scope of the present invention.

As shown in block **62** of Figure 5A, the keyboard process **44** initially determines if the man overboard key has been depressed. If the man overboard key has been depressed, the display is appropriately configured and the boat is automatically navigated toward the position that the boat was in at the time the man overboard key was initially depressed as shown in block **64**. If the man overboard key has not been depressed, the integrated sonar and mapping system **10** determines if a screen key has been depressed as shown in block **66**.

As illustrated in Figures 1 and 2, the integrated sonar and mapping system **10** can also include a keyboard or keypad **26**. As shown in Figure 2, the keypad of one embodiment of the present invention includes a number of feature keys **26a** illustratively positioned along the left-hand side of the screen display **20** and a number of screen keys **26b** positioned below the screen display. As shown in Figure 2, an appropriate legend or designation is typically provided adjacent each respective key to indicate the function or feature provided by the associated key. For example, the screen keys are designated the map key, the nav key, the steer key or the sonar key. In addition, a numeric keypad **26c** and arrow keys **26d** are generally provided on the right-hand side of the screen display as also shown in Figure 2.

Accordingly, if a screen key **26b** has not been depressed, the integrated sonar and mapping system **10** determines which screen is presently displayed since the functions of the remaining keys, i.e., the function

keys **26a**, the numeric keypad **26c** and the arrow keys **26d**, are dependent upon the type of screen presently displayed. In particular, the integrated sonar and mapping system determines if a menu screen, a mapping screen, a navigation screen, a steering screen or a sonar screen is currently displayed, as shown in blocks **68-76**.

If a menu screen, such as that illustrated in Figure 10F, is currently displayed, the integrated sonar and mapping system **10** determines if a function key **26a** has been depressed as shown in block **86** of Figure 5B. If a function key has been depressed, the integrated sonar and mapping system performs the requested function as shown in block **88**. For example, each function key can be associated with a respective menu selection such that by depressing a function key, the associated menu item is selected.

In particular, the operator can selectively configure the mapping screen, the navigation screen or the steering screen which is to be displayed as described in detail and illustrated hereinafter. For example, the operator can select the specific types of navigational or steering information which will be provided by the mapping, navigational or steering screens. In addition, the operator can elect to graphically provide a sonar display in conjunction with the navigational or steering information depicted by the mapping, navigational or steering screens.

However, if a numeric key **26c** or a arrow key **26d** is depressed instead of a function key while a menu screen is displayed, the integrated sonar and mapping system determines if the depression of the numeric or arrow key was appropriate as shown in blocks **90-96**. If the depression of the numeric key or the arrow key is appropriate, the numeric entry is processed as shown in block **98** or the function requested by depressing the arrow key is performed as shown in block **100**. If the

depression of a numeric key or an arrow key is inappropriate based upon the currently displayed screen, however, an error has occurred. The operator can be provided with an error indication, such as an audible tone or a textual message. Alternatively, the operator can be prompted to make an additional selection or the integrated sonar and mapping system can merely continue to display the same display screen, notwithstanding the error.

If the currently displayed screen is a mapping screen, such as illustrated in Figure 10A, the integrated sonar and mapping system **10** determines if a function key **26a** has been depressed as shown in block **102**. If a function key has been depressed, the appropriate function is performed as shown in block **104**. For example, the functions can include zoom, center and cursor selection. These functions control the detail or resolution with which the map is displayed, the position about which the map is centered and whether the cursor is displayed, respectively. Additional function keys allow the operator to select waypoints, routes and menus so as to customize the operation of the integrated sonar and mapping system.

Alternatively, if an arrow key **26d** is depressed, instead of a function key **26a**, the integrated sonar and mapping system **10** pans the graphical representation of the map in the direction indicated by the depressed arrow as shown in blocks **106** and **108**. As also shown in blocks **110** and **112** of Figure 5C, the operator has committed an error if a numeric key **26c** has been depressed while a mapping screen is currently displayed.

As illustrated in block **114** of Figure 5D, if the currently displayed screen is a navigation screen, such as Figure 10G, or a steering screen, such as Figures 10L and 10M, the integrated sonar, mapping and navigation system **10** initially determines if a function

key **26a** has been depressed. If a function key has been depressed, the integrated sonar, mapping and navigational system determines if the waypoint, route or menu keys have been depressed and, if so, performs the function requested by the depressed waypoint, route or menu key as shown in blocks **116** and **118**. If another type of function key has been depressed, however, an appropriate error indication can be provided as shown in block **120**. Likewise, if an arrow key or a numeric key has been depressed, an appropriate error indication can be provided as shown in blocks **120**, **122** and **124**.

Finally, if a sonar display is currently provided, such as shown in Figure 10B, the integrated sonar and mapping system **10** initially determines if a function key **26a** has been depressed. If a function key has been depressed, the requested function is performed as described above and as shown in blocks **126** and **128**. If a function key has not been depressed, the integrated sonar and mapping system determines if either the up or down arrow keys have been depressed and, if so, adjusts the sonar range accordingly as shown in blocks **130** and **132**. Alternatively, if the left or right arrow keys have been depressed, the sonar sensitivity is appropriately adjusted as shown in blocks **134** and **136**. Further, if a numeric key **26c** is depressed while a sonar screen is displayed, an appropriate error indication can be provided as shown in blocks **138** and **140**.

If a screen key **26b** is depressed during the keyboard process **44**, however, the integrated sonar and mapping system **10** initially determines which screen key has been depressed. In other words, the integrated sonar and mapping system determines if the map key, the navigation key, the steering key or the sonar key has been depressed as shown in blocks **78-84** of Figure 5A.

If the map key has been depressed, the controller **16** initially determines if a mapping screen

is currently displayed as shown in block **142** of Figure 5F. If a mapping screen is not currently displayed, the most recently displayed type of mapping screen is selected for display as shown in block **144**. As explained hereinafter in conjunction with the display process **48**, the selected type of mapping screen can thereafter be displayed by the screen display **20** of the integrated sonar and mapping system **10**. However, if a mapping screen is currently displayed, the controller determines which type of mapping screen is currently displayed, that is, the controller determines whether a full mapping screen as shown in Figure 10A, a split mapping and navigation screen as shown in Figures 10C and 10E or a split mapping and sonar screen as shown in Figure 10D is currently displayed, as shown in blocks **146**, **150** and **154**, respectively. Depending upon the type of map currently being displayed, another predefined type of map can be selected for display as shown in blocks **148**, **152** and **156**. Accordingly, the operator can step through each of the different types of mapping screens in order to select the desired type of mapping screen for subsequent display.

In addition, Figures 10C and 10E depict two different types of split mapping/navigation screens which can be selected for display. As described above, the operator can customize the resulting display such that different types or combinations of information can be provided. Thus, in the display screen of Figure 10C, the operator has elected to provide a number of different types of navigational or positioning information on the right side of the screen display **20**, while the operator has elected to provide a combination of navigational or positioning information and a sonar display on the right side of the display screen of Figure 10E. The specific type of split mapping/navigation screen which is selected for display is therefore based upon the type of split

mapping/navigation screen which has been developed by the operator. If the operator does not elect to customize the display screens, including the split mapping/navigation screen, the integrated sonar and mapping system **10** is preferably provided with a standard set of display screens which will be provided in the absence of operator customization. In addition, although specific types of navigational or positioning information is depicted in the display screens of Figures 10C and 10E, different types of navigational or positioning information can be provided without departing from the spirit and scope of the present invention.

Likewise, if the navigation key is depressed, the controller **16** determines if a navigation screen is currently displayed as shown in block **158**. If a navigation screen is not currently displayed, the controller selects the most recently displayed type of navigation screen for display as shown in block **160**. However, as shown in blocks **162** and **166**, if a navigation screen is currently displayed, the controller determines if the type of navigation screen currently displayed is either the first or second type of navigation screen. As illustrated in blocks **164** and **168** of Figure 5G, the controller then selects the type of navigation screen which is not currently displayed for subsequent display. Accordingly, the operator can toggle between the first and second types of navigation screens.

One configuration of the first and second types of navigation screens is shown in Figures 10G and 10H, respectively. However, as described above in conjunction with the mapping screens, the operator can customize each of the navigation screens so as display the different types of navigational and sonar information. For example, the first type of navigation screen can include a number of navigational parameters

which are textually and numerically depicted as shown in Figure 10G, while the second type of navigation screen can include a number of navigational parameters which are textually and graphically illustrated as well as a sonar display as shown in Figure 10H. However, the first and second types of navigational screens can be customized in other manners so as to include other types of navigational and/or sonar information without departing from the spirit and scope of the present invention.

In a similar fashion to that described above in conjunction with the selection of the navigation key, if the steering key is depressed, the controller **16** initially determines if a screening screen is currently displayed as shown in block **170**. If a steering screen is not currently displayed, the controller selects the most recently displayed type of steering screen for subsequent display or shown in block **172** of Figure 5H. However, as shown in blocks **174** and **178**, if a steering screen is currently displayed, the controller determines if the type of steering screen currently displayed is either the first or second type of steering screen. As illustrated in blocks **176** and **180** of Figure 5H, the controller then selects the type of steering screen which is not currently displayed for subsequent display. Accordingly, the operator can toggle between the first and second types of steering screens.

One configuration of the first and second types of steering screens is shown in Figures 10L and 10M, respectively. However, as described above in conjunction with the mapping and navigational screens, the operator can customize each of the steering screens so as display the different types of steering and sonar information. For example, the first type of steering screen can include a number of steering parameters which are graphically and numerically depicted as shown

in Figure 10L, while the second type of steering screen can include a number of steering parameters which are graphically and numerically illustrated as well as a sonar display as shown in Figure 10M. However, the first and second types of steering screens can be customized in other manners so as to include other types of steering and/or sonar information without departing from the spirit and scope of the present invention.

Finally, if the sonar key is depressed, the controller **16** determines if the currently displayed screen is a sonar screen as shown in block **182** of Figure 5I. If the currently displayed screen is not a sonar screen, the controller selects the most recently displayed type of sonar screen for subsequent display as shown in block **184**. However, if the current screen is a sonar screen, the controller determines the type of sonar screen currently displayed. As depicted in blocks **186** and **188**, if the currently displayed sonar screen is a full sonar display screen as shown in Figure 10B, a split zoom sonar display screen as shown in Figure 10J is selected for subsequent display. Alternatively, as depicted in blocks **190** and **192**, if the currently displayed sonar screen is a split zoom sonar display screen as shown in Figure 10J, a split sonar and navigational display screen as shown in Figure 10K is selected for future display. Finally, as depicted in blocks **194** and **196**, if the currently displayed sonar screen is a split sonar and navigational display screen as shown in Figure 10K, a full sonar display screen as shown in Figure 10B is selected for future display. Thus, the operator can toggle between the various types of sonar displays available for display. Accordingly, the operator can select the appropriate type of sonar display to provide the desired sonar information in the preferred format.

In addition to accepting input from the keyboard **26**, the integrated sonar and mapping system **10** drives the screen display **20** with the display process **48** to thereby display the appropriate graphical representations. As shown in the display process illustrated in Figure 6A, the controller **16** initially determines the type of display screen currently displayed. In other words, the controller initially determines whether a menu screen, a mapping screen, a navigational screen, a steering screen or a sonar screen is currently selected as shown in blocks **200-208**, respectively. A new type of screen can then be selected by the operator as described hereinabove or, if no selection has been made since the most recent screen has been displayed, the same type of screen is again selected and the information provided thereby can be updated based on the current positioning and sonar information.

If a menu screen is currently selected for display, the controller **16** determines is a sonar menu is currently selected, as shown in block **210** of Figure 6B. As illustrated in block **212**, if a sonar menu screen is currently selected, a half-width sonar display is provided on the right-hand portion of the screen display **20** while predetermined graphical and/or textual information relating to various parameters of the integrated sonar and mapping system **10** is provided on the left-hand portion of the screen display as shown in Figure 10I. Alternatively, as shown in block **214**, if a sonar menu screen is not selected, a graphical and/or textual message illustrating the various system parameters is preferably displayed as shown in Figure 10F.

If a mapping screen, instead of a menu screen, is currently selected, however, the controller **16** initially determines the type of mapping screen currently selected as shown in blocks **216**, **220** and **224**

of Figure 6C. If a split mapping/navigational screen is currently selected, the controller displays navigational data on the right side of the screen display **20** and a graphical representation of a map on the left side of the screen display as shown in blocks **218** and **228**. As described above and as shown in Figures 10C and 10E, the operator can customize or select the types and arrangment of the navigational data to be displayed in the split mapping/navigational screen and can include a sonar display if desired. If, however, a split mapping and sonar screen is currently selected, a sonar chart is displayed on the right side of the screen display while a graphical representation of a map is displayed on the left side of the screen display as shown in blocks **222** and **228** and in Figure 10D. Finally, if a full mapping display screen is currently selected, a graphical representation of a map is displayed on the full width of the screen display as shown in block **226** and in Figure 10A.

If a navigational screen is currently selected, navigational data relating to the present position of the boat is displayed in the upper half of the screen display **20** as shown in block **228** of Figure 6D. Additional textual and graphical information is also provided in the lower half of the screen display based upon the type of navigational screen currently selected and the specific configuration of the navigational screens provided by the operator, as shown in blocks **230**, **232** and **234**. In particular, additional textual and graphical information relating to the position of the boat is displayed in the lower half of the screen display of the exemplary first type of navigational screen shown in Figure 10G. In addition, a sonar chart, in addition to the textual and graphical information relating to the position of the boat, is displayed in the lower half of the screen display of the exemplary second type of navigational screen shown

in Figure 10H. However, the configuration of the navigational screens, including the types and arrangement of the information provided, can vary based upon operator customization of the navigational screens as described above.

Similarly, if a steering screen is currently selected, graphical data indicative of the position of the boat relative to the route and to the waypoints is displayed in lower half of the screen display as shown in block **236** of Figure 6E. Additional textual and graphical information is also provided in the upper half of the screen display based upon the type of steering screen currently selected, as shown in blocks **238**, **240**, and **242**. In particular, additional textual and graphical steering information is displayed in the upper half of the screen display of the exemplary first type of steering chart shown in Figure 10L. In addition, a sonar chart, as well as the textual and graphical steering information, is displayed on the upper half of the screen display of the exemplary second type of steering chart shown in Figure 10M. However, the configuration of the steering screens, including the types and arrangement of the information provided, can vary based upon operator customization of the steering screens as described above.

Alternatively, if a sonar display screen is currently selected, the controller **16** determines which type of sonar display screen is currently selected, as shown in blocks **244**, **246** and **248**. If a full sonar screen display is currently selected, a full width sonar chart is displayed on the screen display **20** as shown in block **250** and in Figure 10B. Alternatively, if a split zoomed sonar display screen is currently selected, a half width non-zoomed sonar chart is displayed on the right side of the screen display and a half width zoomed sonar display is provided on the left side of the screen display as shown in blocks **252** and

254 and in Figure 10J. Similarly, if a split sonar and navigational screen is currently selected, a half width sonar display screen is displayed on the left side of the screen display while appropriate textual and graphical navigational data is displayed on the right side of the display screen as shown in blocks 256 and 258.

As will be apparent to those skilled in the art, if a type of display different from that currently displayed has not been selected, the integrated sonar and mapping system 10 continues to provide the same type of display as that currently displayed, although the navigational and positioning information, the map and the sonar display can be updated or revised as necessary. In addition, although specific types of displays are described and illustrated herein, the types of displays are only for purposes of illustration and can be varied in order to provide additional detail or further information without departing from the spirit and scope of the present invention. Further, although specific key sequences are described herein to configure and operate the integrated sonar and mapping system, other predetermined key sequences can be defined or other selection devices, such as track balls or light pens, can be employed without departing from the spirit and scope of the present invention.

During the positioning and navigational process 52, the integrated sonar, mapping and navigational system 10 obtains the positioning signals, as shown in block 260 of Figure 7, with a positioning receiver 24 which is operably connected to the controller 16. The positioning signals are then converted to predetermined types of navigational data, such as latitude and longitude and speed and course over ground as described above and as shown in block 262. In addition, the integrated sonar, mapping and navigational system determines if the operator is

navigating to a predefined waypoint. If the operator is navigating to a predefined waypoint, the navigational data relating to the waypoint, such as bearing to waypoint and the distance and time to go to the waypoint, is updated based upon the current position of the boat as shown in blocks **264** and **266**.

As shown in block **270** of Figure 8, the mapping process **56** initially determines the current position of the boat as determined by the above-described navigational process and the currently selected zoom scale. Based upon the current position of the boat and the currently selected zoom scale and as illustrated in block **272**, the controller **16** determines the appropriate cartographic data required to fill the portion or window of the screen display **20** allocated to a graphical representation of a map at the currently selected zoom scale or resolution level. Thereafter, the controller accesses the appropriate portions of the cartographic data as shown in block **274**. As described above, the controller can access cartographic data in either an internal or an external memory device. For example, cartographic data from the background map data file **22a** may be appropriate to provide a graphical representation which has a relatively low zoom scale, while cartographic data from the detailed map data file **22b** may be appropriate to provide a graphical representation which has a relatively high zoom scale. Based upon the cartographic data, the controller creates a graphical representation of the map for subsequent display as shown in block **276**. The graphical representation is typically stored in a buffer for subsequent display on the screen display **20** during the above-described display process **48**. By creating the graphical representation of the map prior to the actual display of the map, the integrated sonar, mapping and navigational system can responsively provide graphical

representations of the desired maps in a timely fashion.

Finally, the sonar process **60** which was described above in conjunction with the various components of the integrated sonar and mapping system **10** is illustrated in Figure 9. In particular, the controller **16** initially signals the power amplifier **18** to drive the associated transducer **12** to emit sonar signals into the body of water as shown in block **280**. Thereafter, the returning sonar signals are received and processed into a sonar chart for subsequent display as shown in blocks **282** and **284**.

According to the present invention, the integrated sonar and mapping system **10** can provide both sonar and mapping features to the operator within a single unit. Thus, the operator need refer only to a single screen display **20** in order to obtain visual images of at least a portion of a map and of a sonar display. In addition, the operator need only purchase and learn to operate a single system in order to obtain both sonar and mapping features. According to a further embodiment, the integrated sonar, mapping and navigational system provides not only sonar and mapping features, but also navigational features, including a determination of the position of the system. Thus, the operator can determine information regarding features not only above the water, via the mapping and navigational features of the system, but also below the water, via the sonar features. Thus, the versatility and flexibility of the integrated sonar and mapping system of the present invention is significantly enhanced. In addition, the incorporation of the sonar, mapping and navigational features into a single system eliminates the portions of the separate systems which are duplicative or redundant, such as multiple key pads **26** and multiple screen displays.

In the drawings and the specification, there has been set forth preferred embodiments of the invention and, although specific terms are employed, the terms are used in a generic and descriptive sense only and not for purpose of limitation, the scope of the invention being set forth in the following claims.

THAT WHICH IS CLAIMED IS:

1. An integrated sonar and mapping system comprising:

at least one transducer for emitting sonar signals through a body of water and for receiving returning sonar signals reflected by objects within the body of water;

cartographic storage means for storing cartographic data representative of a map;

a controller, operably connected to said at least one transducer, for processing the returning sonar signals to generate echo data representative of the objects within the body of water which reflect the sonar signals, said controller also being operably connected to said cartographic storage means for accessing at least a portion of the cartographic data stored therein; and

a screen display, responsive to said controller, for displaying a graphical representation of the cartographic data such that a visual image of at least a portion of the map is thereby displayed, said screen display being further capable of displaying a graphical representation of the echo data such that a visual image of at least some of the objects within the body of water which reflect the sonar signals is displayed by the integrated sonar and mapping system.

2. An integrated sonar and mapping system according to Claim 1 further comprising a positioning receiver for receiving positioning signals from at least one reference transmitter, and wherein said controller is operably connected to said positioning receiver for generating positioning data based upon the positioning signals.

3. An integrated sonar and mapping system according to Claim 2 wherein said screen display is capable of displaying a visual representation of the positioning data generated by the controller and indicative of the position of the integrated sonar and mapping system.

4. An integrated sonar and mapping system according to Claim 3 wherein said screen display is further capable of concurrently displaying graphical representations of the cartographic data and the positioning data such that the operator can determine the relative position of the integrated sonar and mapping system to the map.

5. An integrated sonar and mapping system according to Claim 1 wherein said screen display is capable of concurrently displaying graphical representations of the cartographic data and the echo data such that visual images of at least a portion of the map and at least some of the objects within the body of water which reflect the sonar signals are simultaneously displayed for the operator.

6. An integrated sonar and mapping system according to Claim 1 wherein said cartographic storage means comprises:

first storage means for storing cartographic data representative of a background map; and

second storage means for storing cartographic data representative of a detailed map having a greater resolution than the background map.

7. An integrated sonar, mapping and navigational system comprising:

at least one transducer for emitting sonar signals through a body of water and for receiving

returning sonar signals reflected by objects within the body of water;

cartographic storage means for storing cartographic data representative of a map;

a positioning receiver for receiving positioning signals from at least one reference transmitter;

a controller, operably connected to said at least one transducer, for processing the returning sonar signals to generate echo data representative of the objects within the body of water which reflect the sonar signals, said controller also being operably connected to said positioning receiver for generating positioning data representative of the position of the integrated sonar, mapping and navigational system based upon the positioning signals; and

a screen display, responsive to said controller, for displaying graphical representations of the cartographic data, the echo data and the positioning data to thereby provide the operator with respective visual images of at least a portion of the map, at least some of the objects within the body of water which reflect the sonar signals and the position of the integrated sonar, mapping and navigational system.

8. An integrated sonar, mapping and navigational system according to Claim 7 wherein said screen display is further capable of concurrently displaying graphical representations of the cartographic data and the positioning data such that the operator can determine the relative position of the integrated sonar, mapping and navigational system to the map.

9. An integrated sonar, mapping and navigational system according to Claim 7 wherein said

screen display is capable of concurrently displaying graphical representations of the cartographic data and the echo data such that visual images of at least a portion of the map and at least some of the objects within the body of water which reflect the sonar signals are simultaneously displayed for the operator.

10. An integrated sonar, mapping and navigational system according to Claim 7 wherein said cartographic storage means comprises:

first storage means for storing cartographic data representative of a background map; and

second storage means for storing cartographic data representative of a detailed map having a greater resolution than the background map.

11. A method of providing visual images of both sonar and mapping data, the method comprising the steps of:

providing cartographic data representative of a map;

emitting sonar signals through a body of water;

receiving returning sonar signals reflected by objects within the body of water;

processing the returning sonar signals to generate echo data representative of the objects within the body of water which reflect the sonar signals; and

displaying graphical representations of the cartographic data and the echo data to thereby provide visual images of at least a portion of the map and at least some of objects within the body of water which reflect the sonar signals, respectively.

12. A method according to Claim 11 further comprising the steps of:

receiving positioning signals from at least one reference transmitter; and

generating positioning data representative of the position of the integrated sonar and mapping system based upon the positioning signals received from the at least one reference transmitter.

13. A method according to Claim 12 wherein said displaying step comprises the step of displaying a visual representation of the positioning data indicative of the position of the integrated sonar and mapping system.

14. A method according to Claim 13 wherein said displaying step further comprises the step of concurrently displaying graphical representations of the cartographic data and the positioning data such that the operator can determine the relative position of the integrated sonar and mapping system to the map.

15. A method according to Claim 11 wherein said displaying step comprises the step of concurrently displaying graphical representations of both the cartographic data and the echo data such that visual images of at least a portion of the map and at least some of the objects within the body of water which reflect the sonar signals are simultaneously displayed for the operator.

16. A method according to Claim 11 wherein said providing step comprises the steps of providing cartographic data representative of a background map and providing cartographic data representative of a detailed map, and wherein said displaying step comprises the step of displaying graphical representations the cartographic data representative of both the background map and the detailed map.

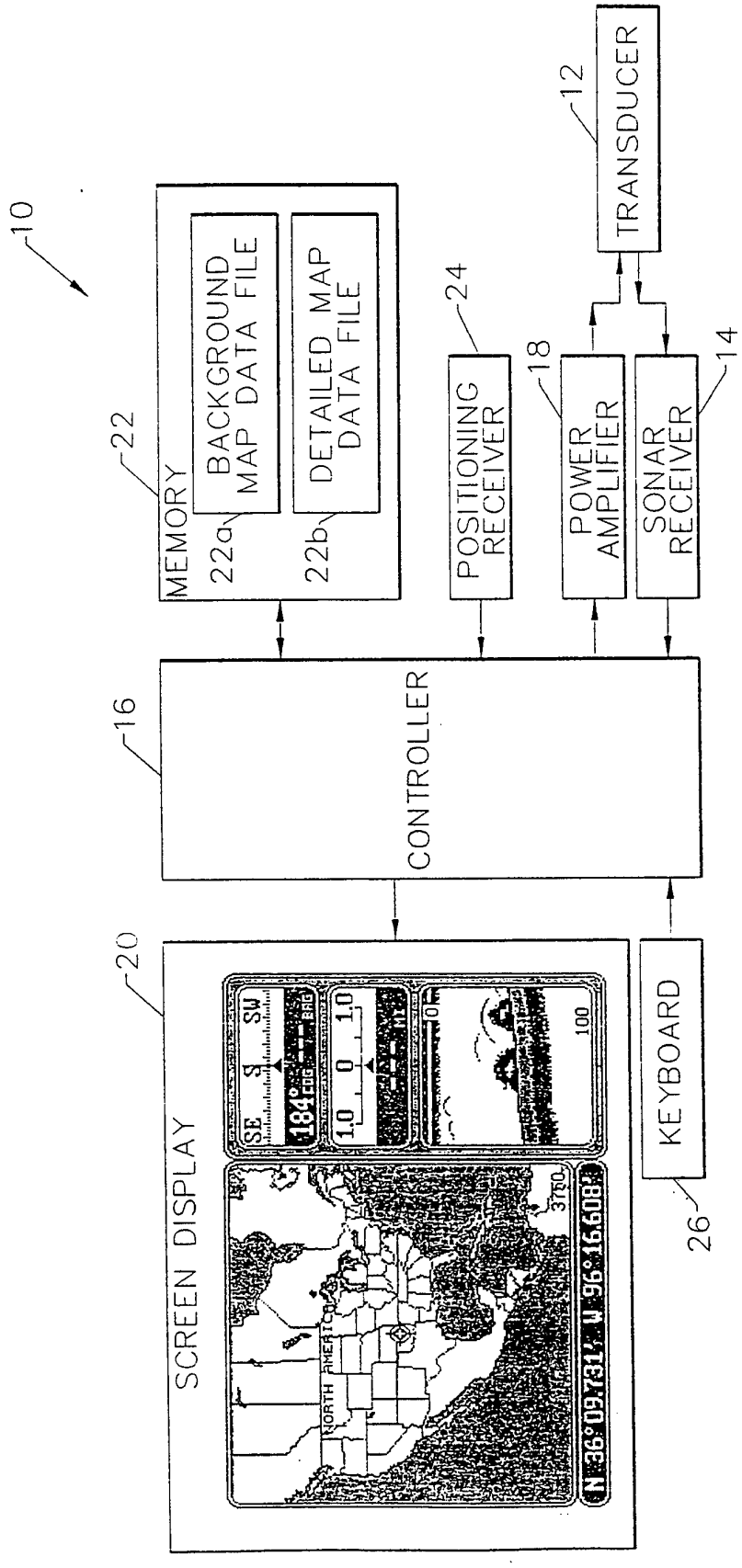
10
12
TRANSDUCER
22
MEMORY
22a
BACKGROUND MAP DATA FILE
22b
DETAILED MAP DATA FILE
24
POSITIONING RECEIVER
18
POWER AMPLIFIER
14
SONAR RECEIVER
16
CONTROLLER
20
SCREEN DISPLAY
KEYBOARD
26

FIG. 1.

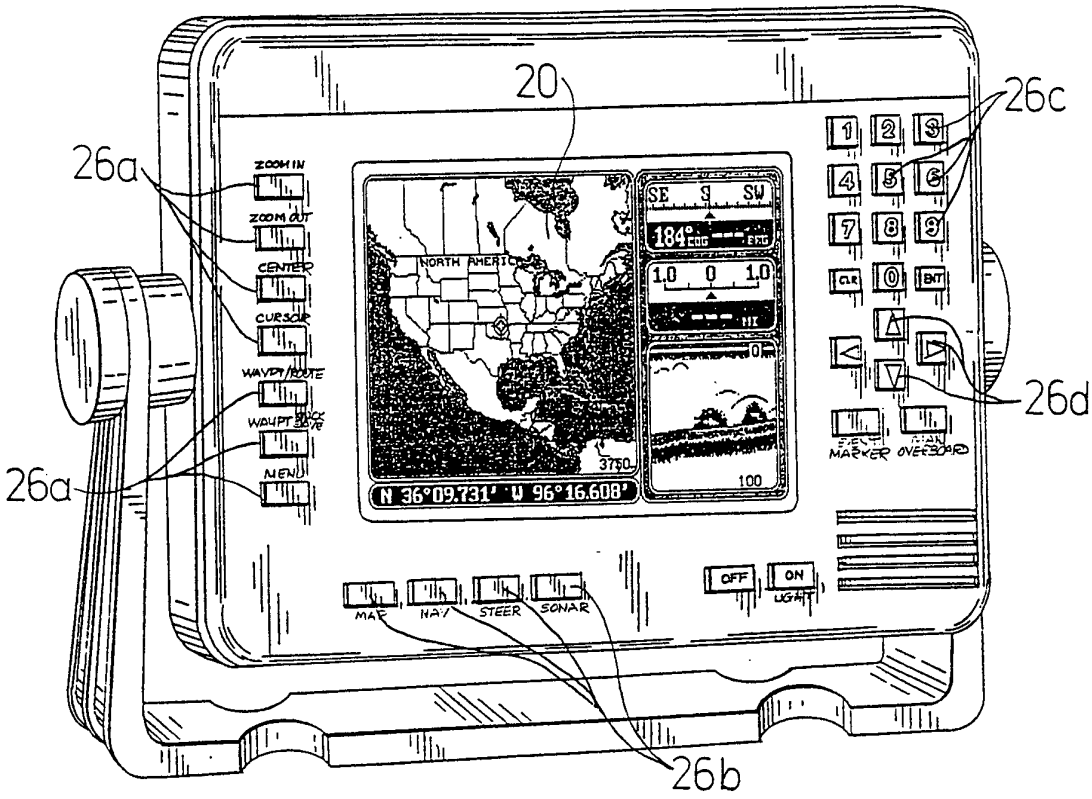
20
26a
26a
26c
26d
26b
ZOOM IN
ZOOM OUT
CENTER
CURSOR
WAYPT/ROUTE
WAYPT
MENU
NORTH AMERICA
SE S SW
184°
1.0 0 1.0
N 36°09.731' W 96°16.608'
MAP
NAV
STEER
SONAR
OFF
ON
LIGHT
MAN OVERBOARD

FIG. 2.

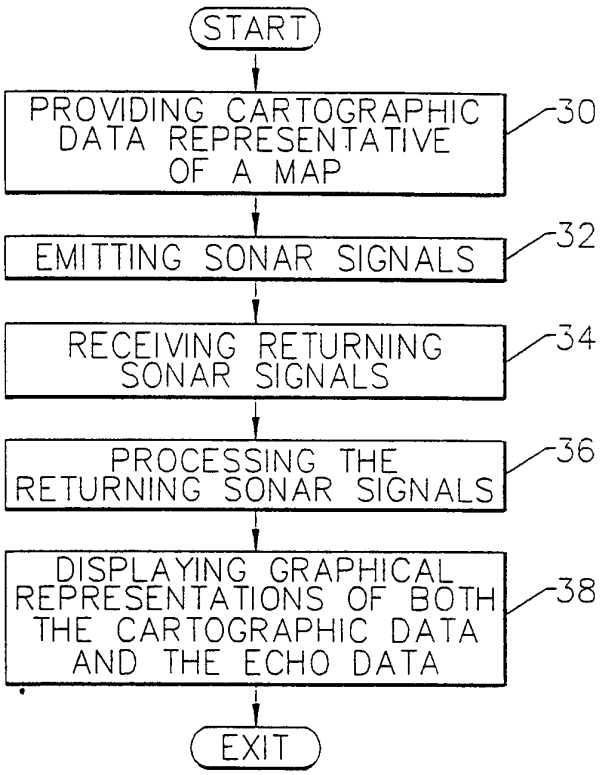
START
PROVIDING CARTOGRAPHIC DATA REPRESENTATIVE OF A MAP
30
EMITTING SONAR SIGNALS
32
RECEIVING RETURNING SONAR SIGNALS
34
PROCESSING THE RETURNING SONAR SIGNALS
36
DISPLAYING GRAPHICAL REPRESENTATIONS OF BOTH THE CARTOGRAPHIC DATA AND THE ECHO DATA
38
EXIT

FIG. 3.

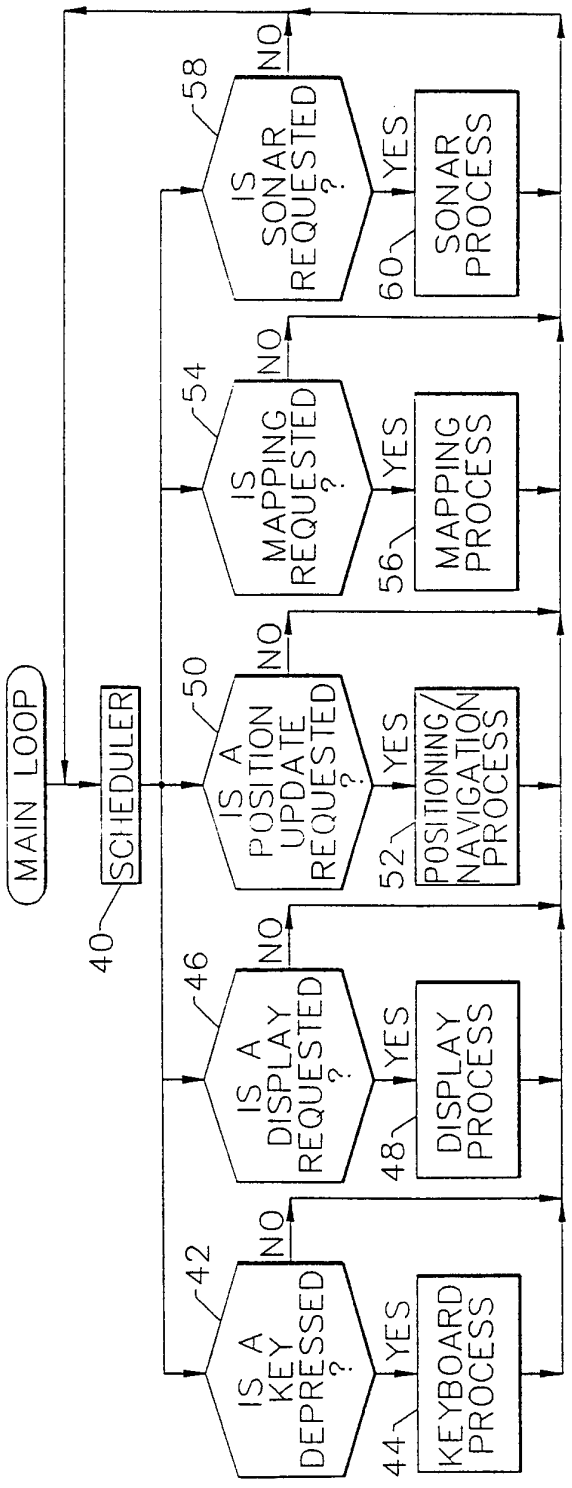
MAIN LOOP
SCHEDULER
40
IS A KEY DEPRESSED ?
42
NO
YES
KEYBOARD PROCESS
44
IS A DISPLAY REQUESTED ?
46
NO
YES
DISPLAY PROCESS
48
IS A POSITION UPDATE REQUESTED ?
50
NO
YES
POSITIONING/ NAVIGATION PROCESS
52
IS MAPPING REQUESTED ?
54
NO
YES
MAPPING PROCESS
56
IS SONAR REQUESTED ?
58
NO
YES
SONAR PROCESS
60

FIG. 4.

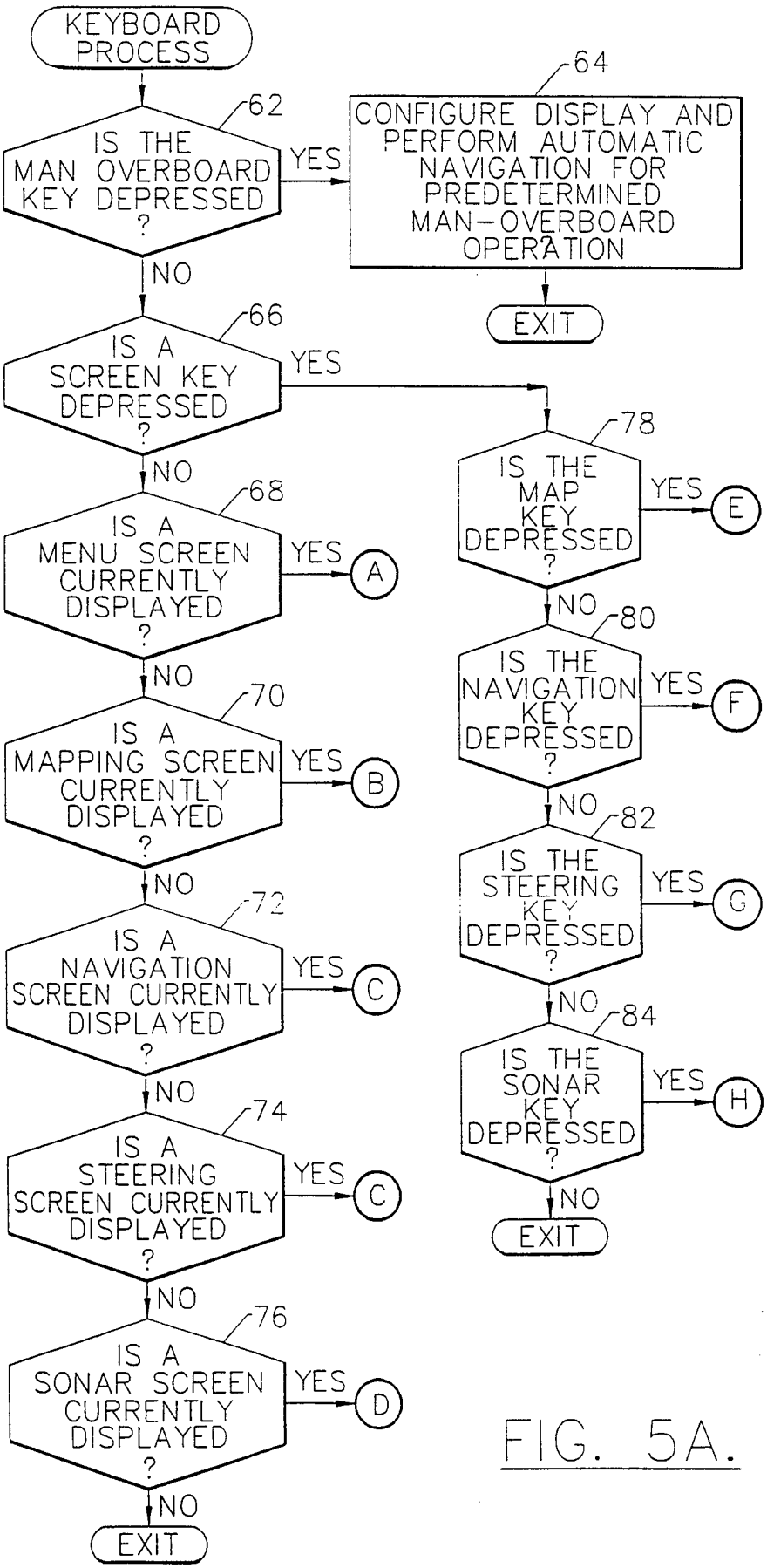
KEYBOARD PROCESS
62
IS THE MAN OVERBOARD KEY DEPRESSED ?
YES
64
CONFIGURE DISPLAY AND PERFORM AUTOMATIC NAVIGATION FOR PREDETERMINED MAN-OVERBOARD OPERATION
EXIT
NO
66
IS A SCREEN KEY DEPRESSED ?
YES
NO
68
IS A MENU SCREEN CURRENTLY DISPLAYED ?
YES
A
NO
70
IS A MAPPING SCREEN CURRENTLY DISPLAYED ?
YES
B
NO
72
IS A NAVIGATION SCREEN CURRENTLY DISPLAYED ?
YES
C
NO
74
IS A STEERING SCREEN CURRENTLY DISPLAYED ?
YES
C
NO
76
IS A SONAR SCREEN CURRENTLY DISPLAYED ?
YES
D
NO
EXIT
78
IS THE MAP KEY DEPRESSED ?
YES
E
NO
80
IS THE NAVIGATION KEY DEPRESSED ?
YES
F
NO
82
IS THE STEERING KEY DEPRESSED ?
YES
G
NO
84
IS THE SONAR KEY DEPRESSED ?
YES
H
NO
EXIT

FIG. 5A.

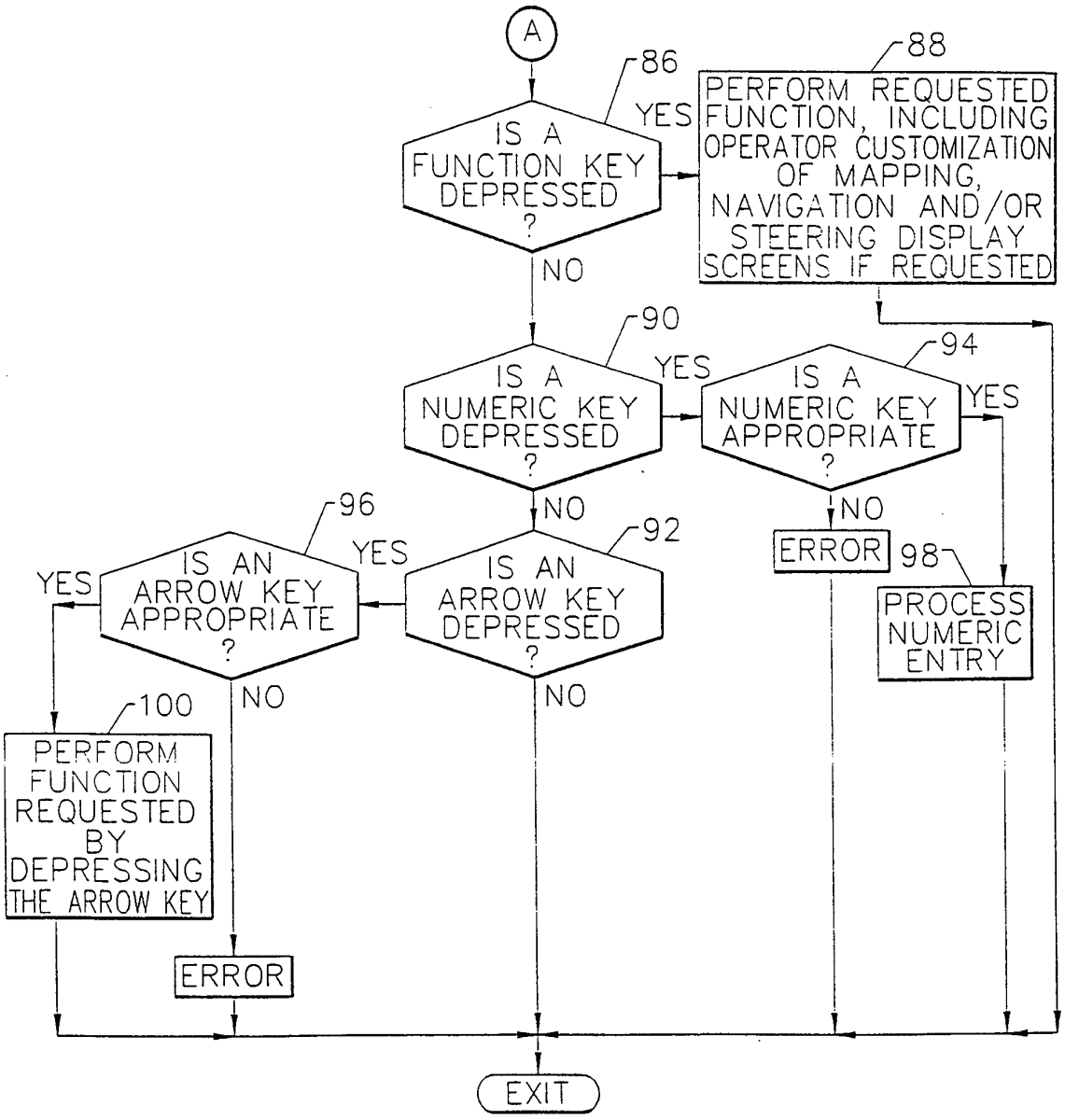
A
86
IS A FUNCTION KEY DEPRESSED ?
YES
88
PERFORM REQUESTED FUNCTION, INCLUDING OPERATOR CUSTOMIZATION OF MAPPING, NAVIGATION AND/OR STEERING DISPLAY SCREENS IF REQUESTED
NO
90
IS A NUMERIC KEY DEPRESSED ?
YES
94
IS A NUMERIC KEY APPROPRIATE ?
YES
NO
ERROR
98
PROCESS NUMERIC ENTRY
NO
96
IS AN ARROW KEY APPROPRIATE ?
YES
92
IS AN ARROW KEY DEPRESSED ?
YES
NO
NO
100
PERFORM FUNCTION REQUESTED BY DEPRESSING THE ARROW KEY
ERROR
EXIT

FIG. 5B.

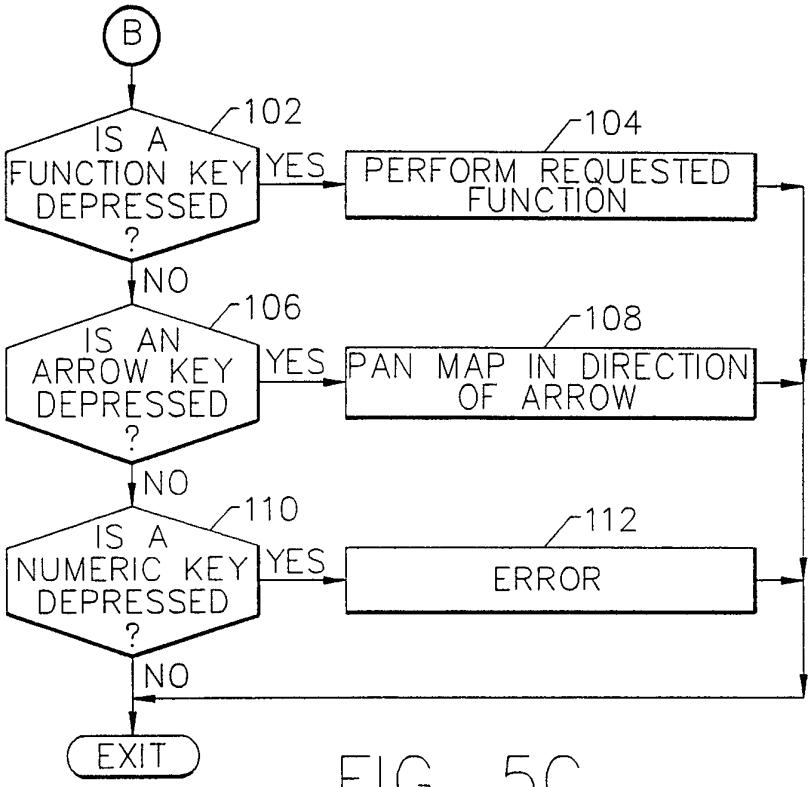
B
102
IS A FUNCTION KEY DEPRESSED ?
YES
104
PERFORM REQUESTED FUNCTION
NO
106
IS AN ARROW KEY DEPRESSED ?
YES
108
PAN MAP IN DIRECTION OF ARROW
NO
110
IS A NUMERIC KEY DEPRESSED ?
YES
112
ERROR
NO
EXIT

FIG. 5C.

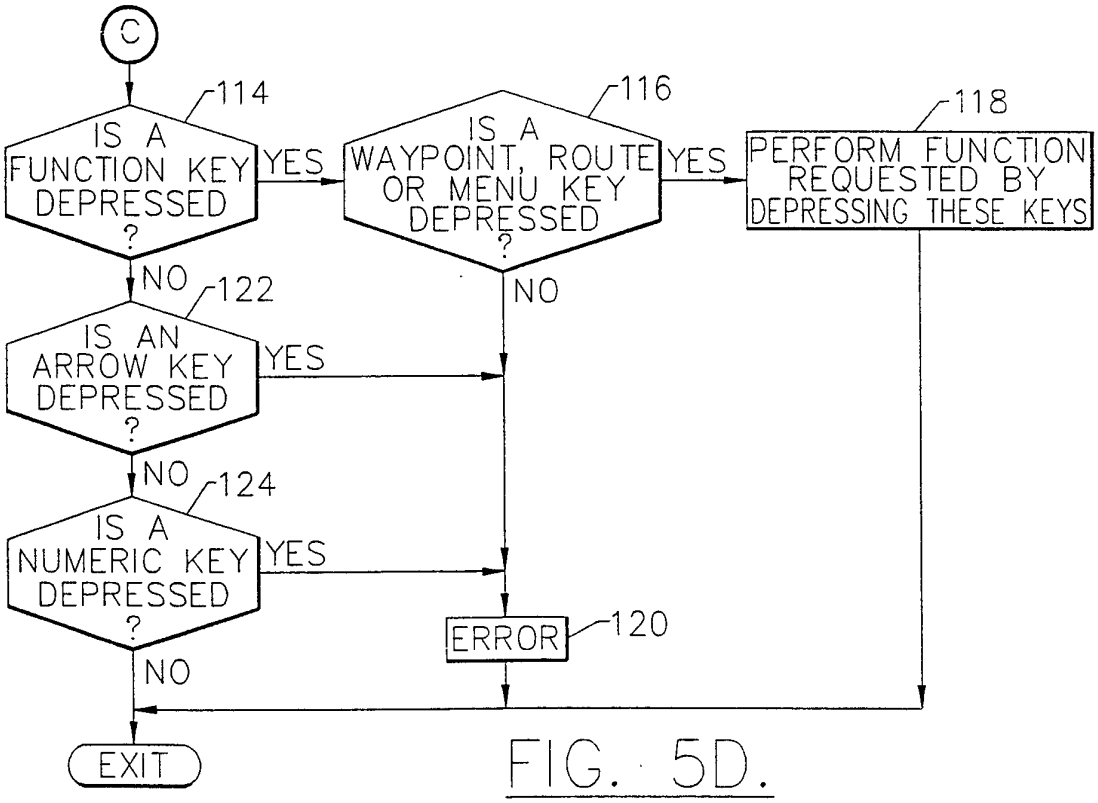
C
114
IS A FUNCTION KEY DEPRESSED ?
YES
116
IS A WAYPOINT, ROUTE OR MENU KEY DEPRESSED ?
YES
118
PERFORM FUNCTION REQUESTED BY DEPRESSING THESE KEYS
NO
NO
122
IS AN ARROW KEY DEPRESSED ?
YES
NO
124
IS A NUMERIC KEY DEPRESSED ?
YES
ERROR
120
NO
EXIT

FIG. 5D.

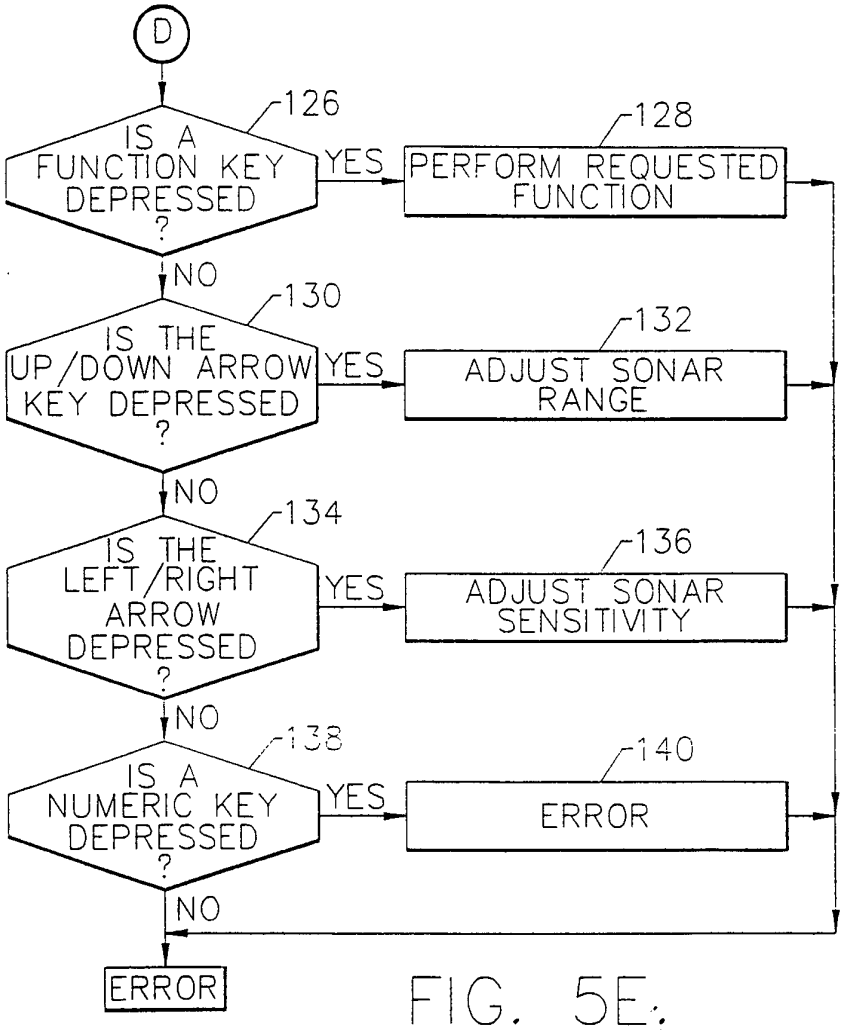
D
126
IS A FUNCTION KEY DEPRESSED ?
YES
128
PERFORM REQUESTED FUNCTION
NO
130
IS THE UP/DOWN ARROW KEY DEPRESSED ?
YES
132
ADJUST SONAR RANGE
NO
134
IS THE LEFT/RIGHT ARROW DEPRESSED ?
YES
136
ADJUST SONAR SENSITIVITY
NO
138
IS A NUMERIC KEY DEPRESSED ?
YES
140
ERROR
NO
ERROR

FIG. 5E.

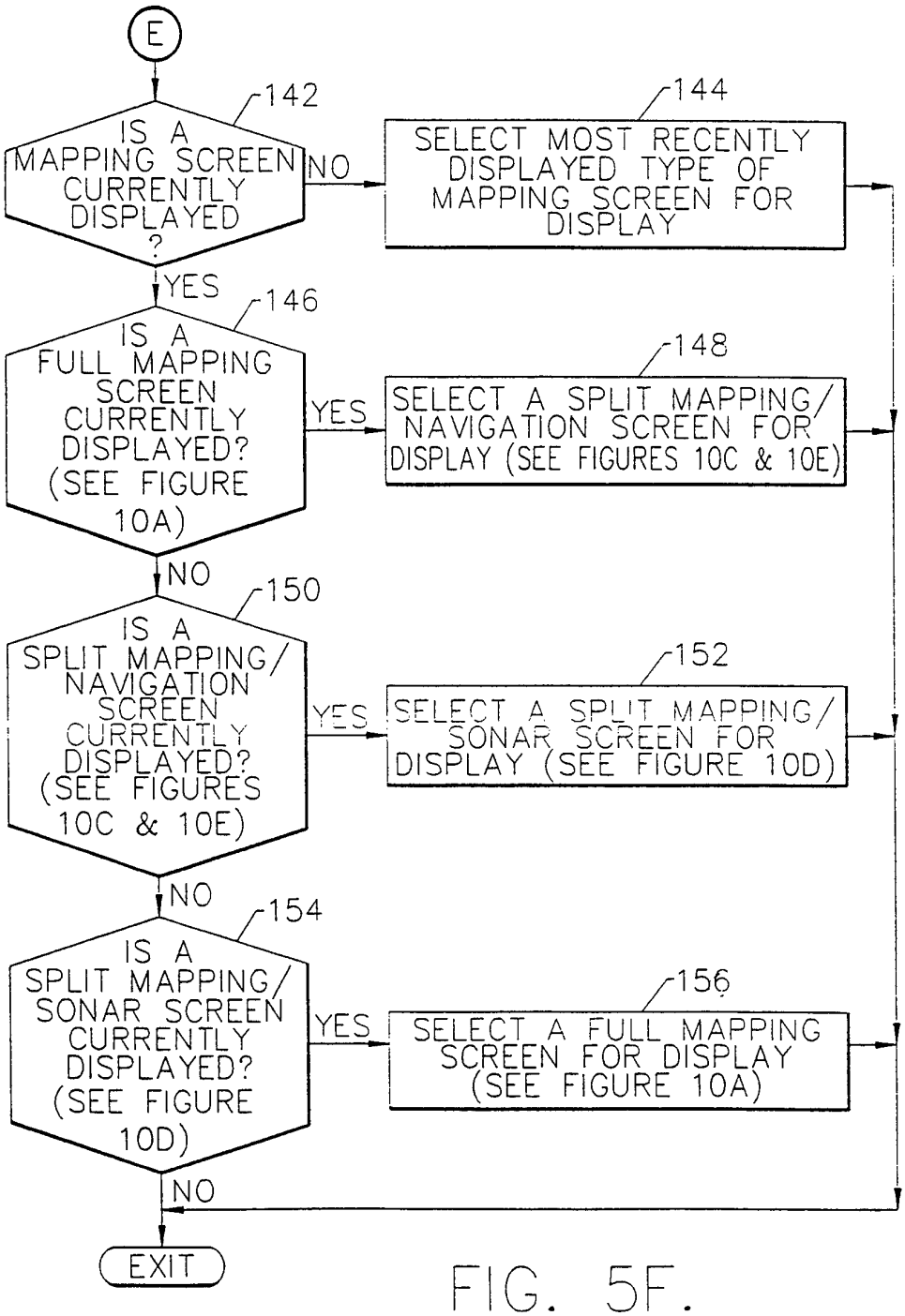
E
142
IS A MAPPING SCREEN CURRENTLY DISPLAYED ?
NO
144
SELECT MOST RECENTLY DISPLAYED TYPE OF MAPPING SCREEN FOR DISPLAY
YES
146
IS A FULL MAPPING SCREEN CURRENTLY DISPLAYED? (SEE FIGURE 10A)
YES
148
SELECT A SPLIT MAPPING/ NAVIGATION SCREEN FOR DISPLAY (SEE FIGURES 10C & 10E)
NO
150
IS A SPLIT MAPPING/ NAVIGATION SCREEN CURRENTLY DISPLAYED? (SEE FIGURES 10C & 10E)
YES
152
SELECT A SPLIT MAPPING/ SONAR SCREEN FOR DISPLAY (SEE FIGURE 10D)
NO
154
IS A SPLIT MAPPING/ SONAR SCREEN CURRENTLY DISPLAYED? (SEE FIGURE 10D)
YES
156
SELECT A FULL MAPPING SCREEN FOR DISPLAY (SEE FIGURE 10A)
NO
EXIT

FIG. 5F.

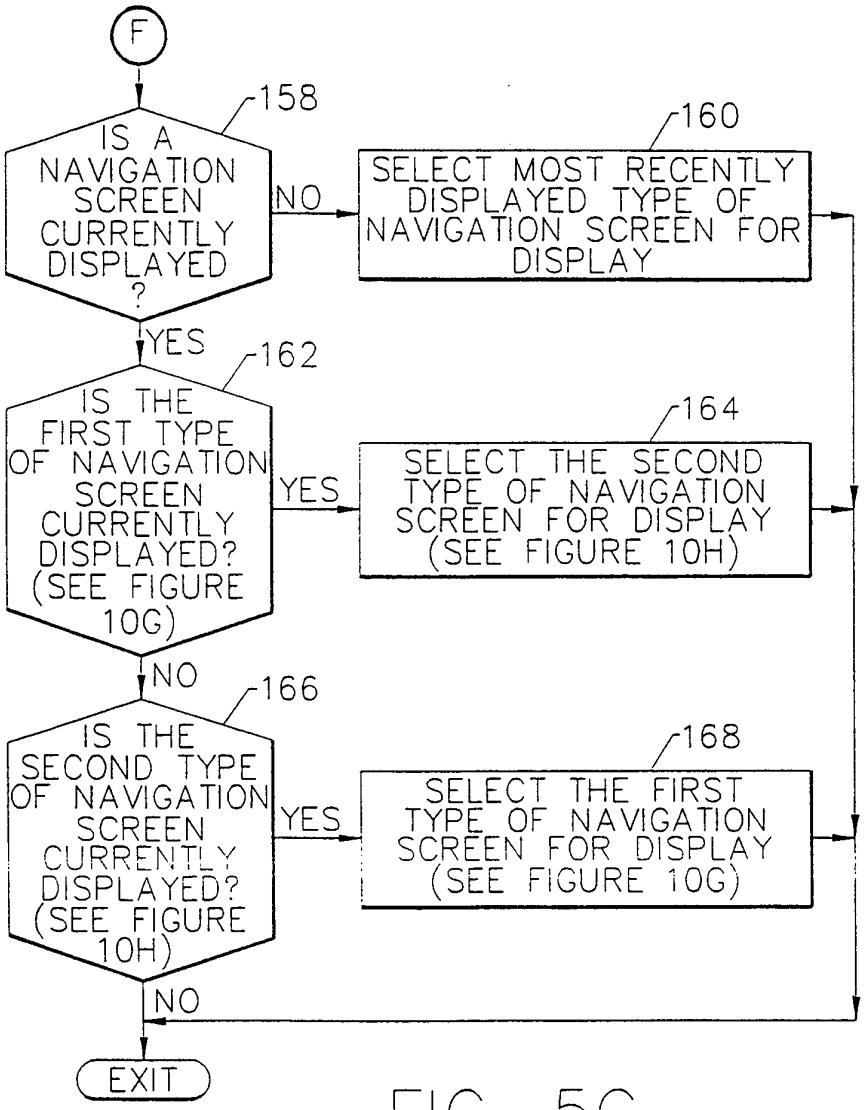
F
158
IS A NAVIGATION SCREEN CURRENTLY DISPLAYED ?
NO
160
SELECT MOST RECENTLY DISPLAYED TYPE OF NAVIGATION SCREEN FOR DISPLAY
YES
162
IS THE FIRST TYPE OF NAVIGATION SCREEN CURRENTLY DISPLAYED? (SEE FIGURE 10G)
YES
164
SELECT THE SECOND TYPE OF NAVIGATION SCREEN FOR DISPLAY (SEE FIGURE 10H)
NO
166
IS THE SECOND TYPE OF NAVIGATION SCREEN CURRENTLY DISPLAYED? (SEE FIGURE 10H)
YES
168
SELECT THE FIRST TYPE OF NAVIGATION SCREEN FOR DISPLAY (SEE FIGURE 10G)
NO
EXIT

FIG. 5G.

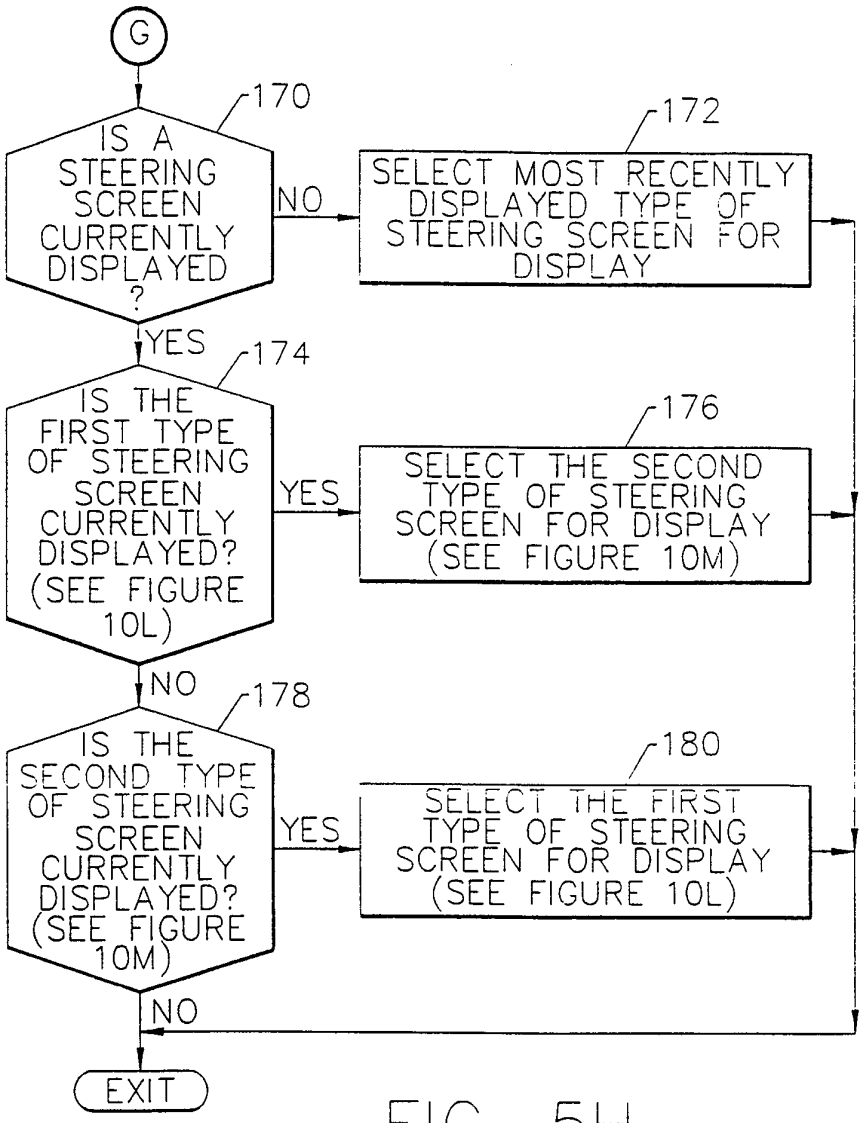
G
170
IS A STEERING SCREEN CURRENTLY DISPLAYED ?
NO
172
SELECT MOST RECENTLY DISPLAYED TYPE OF STEERING SCREEN FOR DISPLAY
YES
174
IS THE FIRST TYPE OF STEERING SCREEN CURRENTLY DISPLAYED? (SEE FIGURE 10L)
YES
176
SELECT THE SECOND TYPE OF STEERING SCREEN FOR DISPLAY (SEE FIGURE 10M)
NO
178
IS THE SECOND TYPE OF STEERING SCREEN CURRENTLY DISPLAYED? (SEE FIGURE 10M)
YES
180
SELECT THE FIRST TYPE OF STEERING SCREEN FOR DISPLAY (SEE FIGURE 10L)
NO
EXIT

FIG. 5H.

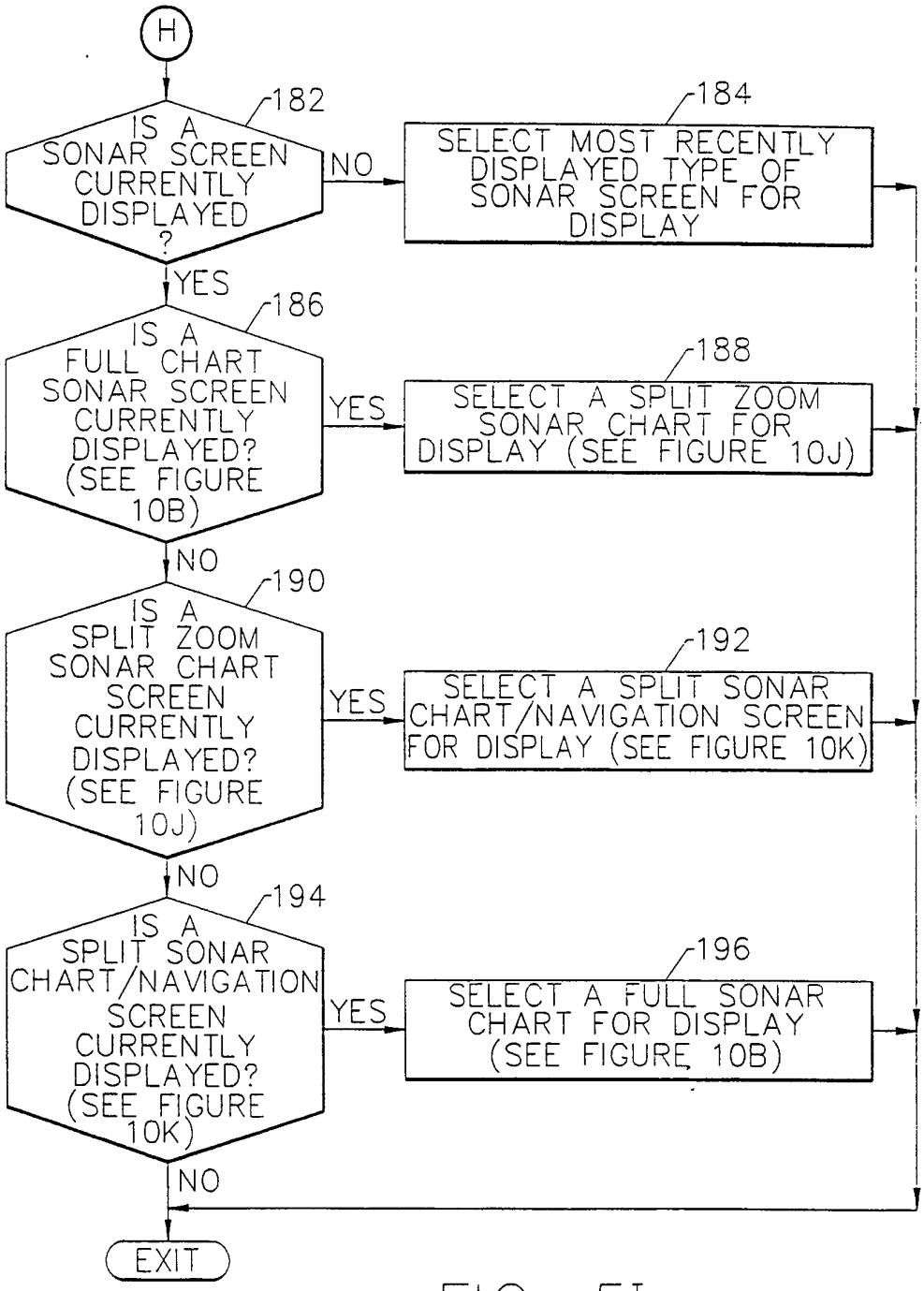
H
182
IS A SONAR SCREEN CURRENTLY DISPLAYED ?
NO
184
SELECT MOST RECENTLY DISPLAYED TYPE OF SONAR SCREEN FOR DISPLAY
YES
186
IS A FULL CHART SONAR SCREEN CURRENTLY DISPLAYED? (SEE FIGURE 10B)
YES
188
SELECT A SPLIT ZOOM SONAR CHART FOR DISPLAY (SEE FIGURE 10J)
NO
190
IS A SPLIT ZOOM SONAR CHART SCREEN CURRENTLY DISPLAYED? (SEE FIGURE 10J)
YES
192
SELECT A SPLIT SONAR CHART/NAVIGATION SCREEN FOR DISPLAY (SEE FIGURE 10K)
NO
194
IS A SPLIT SONAR CHART/NAVIGATION SCREEN CURRENTLY DISPLAYED? (SEE FIGURE 10K)
YES
196
SELECT A FULL SONAR CHART FOR DISPLAY (SEE FIGURE 10B)
NO
EXIT

FIG. 5I.

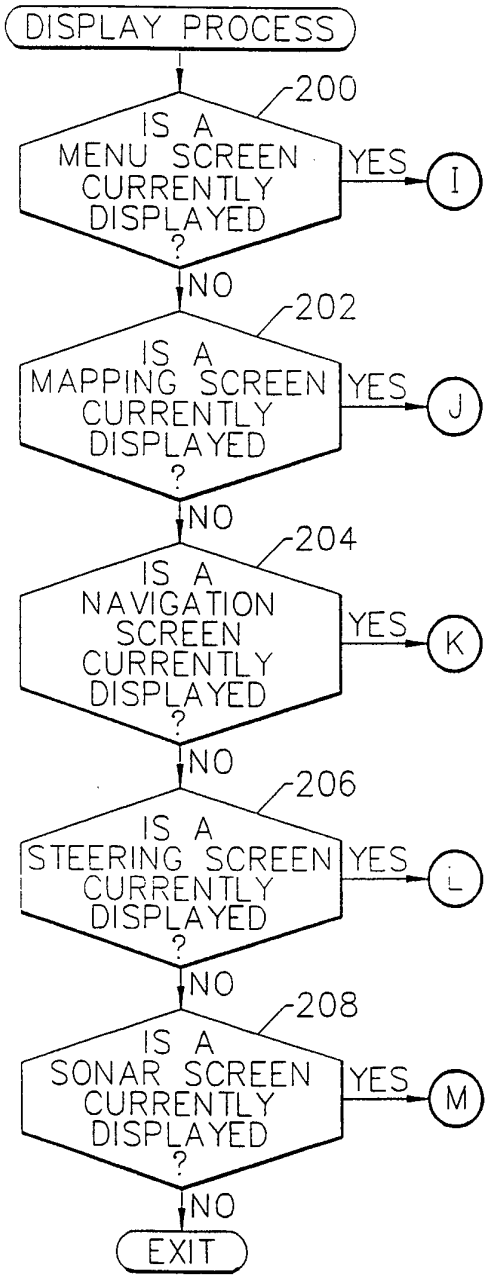
DISPLAY PROCESS
200
IS A MENU SCREEN CURRENTLY DISPLAYED ?
YES
I
NO
202
IS A MAPPING SCREEN CURRENTLY DISPLAYED ?
YES
J
NO
204
IS A NAVIGATION SCREEN CURRENTLY DISPLAYED ?
YES
K
NO
206
IS A STEERING SCREEN CURRENTLY DISPLAYED ?
YES
L
NO
208
IS A SONAR SCREEN CURRENTLY DISPLAYED ?
YES
M
NO
EXIT

FIG. 6A.

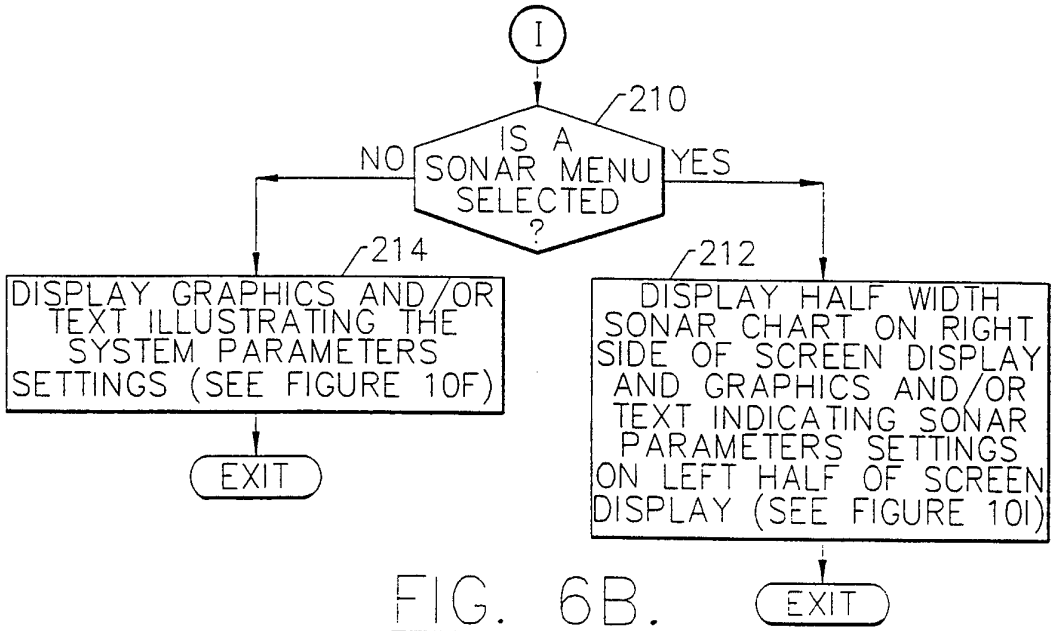
I
210
IS A SONAR MENU SELECTED ?
NO
YES
214
DISPLAY GRAPHICS AND/OR TEXT ILLUSTRATING THE SYSTEM PARAMETERS SETTINGS (SEE FIGURE 10F)
212
DISPLAY HALF WIDTH SONAR CHART ON RIGHT SIDE OF SCREEN DISPLAY AND GRAPHICS AND/OR TEXT INDICATING SONAR PARAMETERS SETTINGS ON LEFT HALF OF SCREEN DISPLAY (SEE FIGURE 10I)
EXIT
EXIT

FIG. 6B.

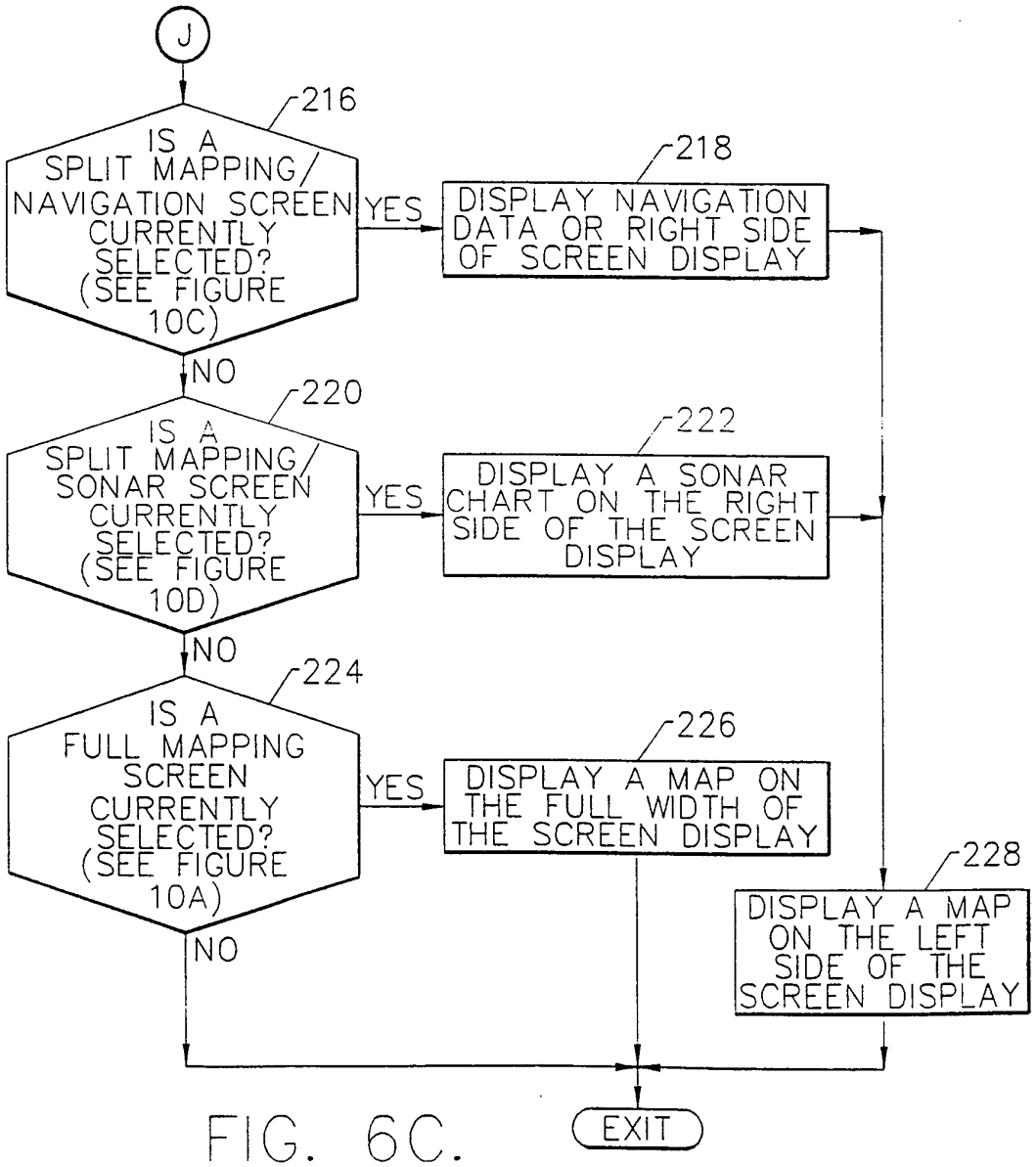
J
216
IS A SPLIT MAPPING/ NAVIGATION SCREEN CURRENTLY SELECTED? (SEE FIGURE 10C)
YES
218
DISPLAY NAVIGATION DATA OR RIGHT SIDE OF SCREEN DISPLAY
NO
220
IS A SPLIT MAPPING/ SONAR SCREEN CURRENTLY SELECTED? (SEE FIGURE 10D)
YES
222
DISPLAY A SONAR CHART ON THE RIGHT SIDE OF THE SCREEN DISPLAY
NO
224
IS A FULL MAPPING SCREEN CURRENTLY SELECTED? (SEE FIGURE 10A)
YES
226
DISPLAY A MAP ON THE FULL WIDTH OF THE SCREEN DISPLAY
228
DISPLAY A MAP ON THE LEFT SIDE OF THE SCREEN DISPLAY
NO
EXIT

FIG. 6C.

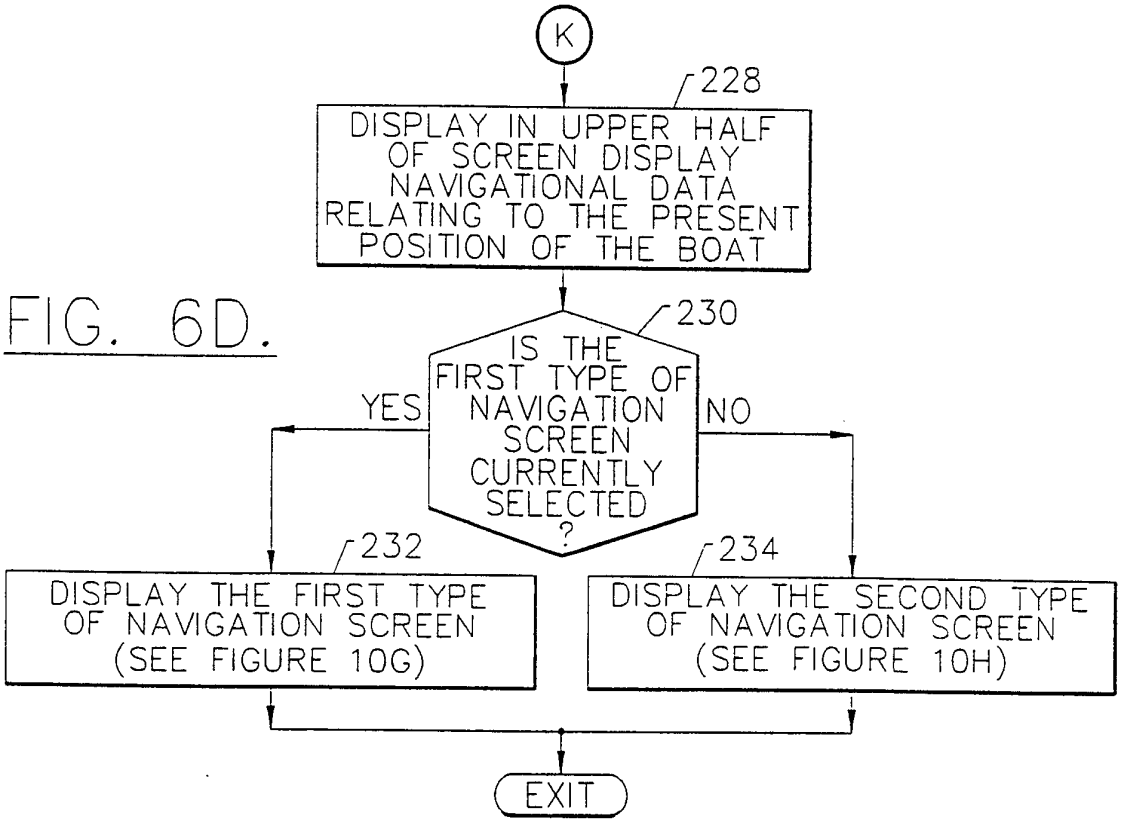
K
228
DISPLAY IN UPPER HALF OF SCREEN DISPLAY NAVIGATIONAL DATA RELATING TO THE PRESENT POSITION OF THE BOAT
230
IS THE FIRST TYPE OF NAVIGATION SCREEN CURRENTLY SELECTED ?
YES
NO
232
DISPLAY THE FIRST TYPE OF NAVIGATION SCREEN (SEE FIGURE 10G)
234
DISPLAY THE SECOND TYPE OF NAVIGATION SCREEN (SEE FIGURE 10H)
EXIT

FIG. 6D.

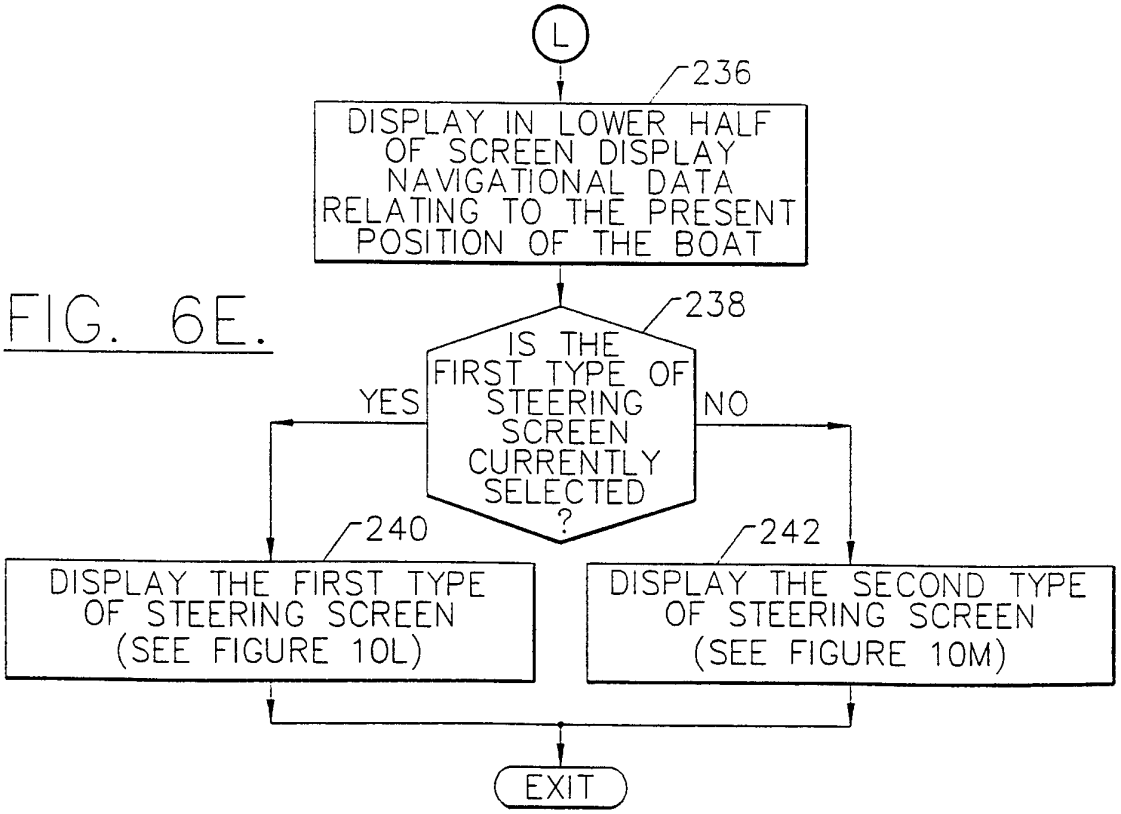
L
236
DISPLAY IN LOWER HALF OF SCREEN DISPLAY NAVIGATIONAL DATA RELATING TO THE PRESENT POSITION OF THE BOAT
238
IS THE FIRST TYPE OF STEERING SCREEN CURRENTLY SELECTED ?
YES
NO
240
DISPLAY THE FIRST TYPE OF STEERING SCREEN (SEE FIGURE 10L)
242
DISPLAY THE SECOND TYPE OF STEERING SCREEN (SEE FIGURE 10M)
EXIT

FIG. 6E.

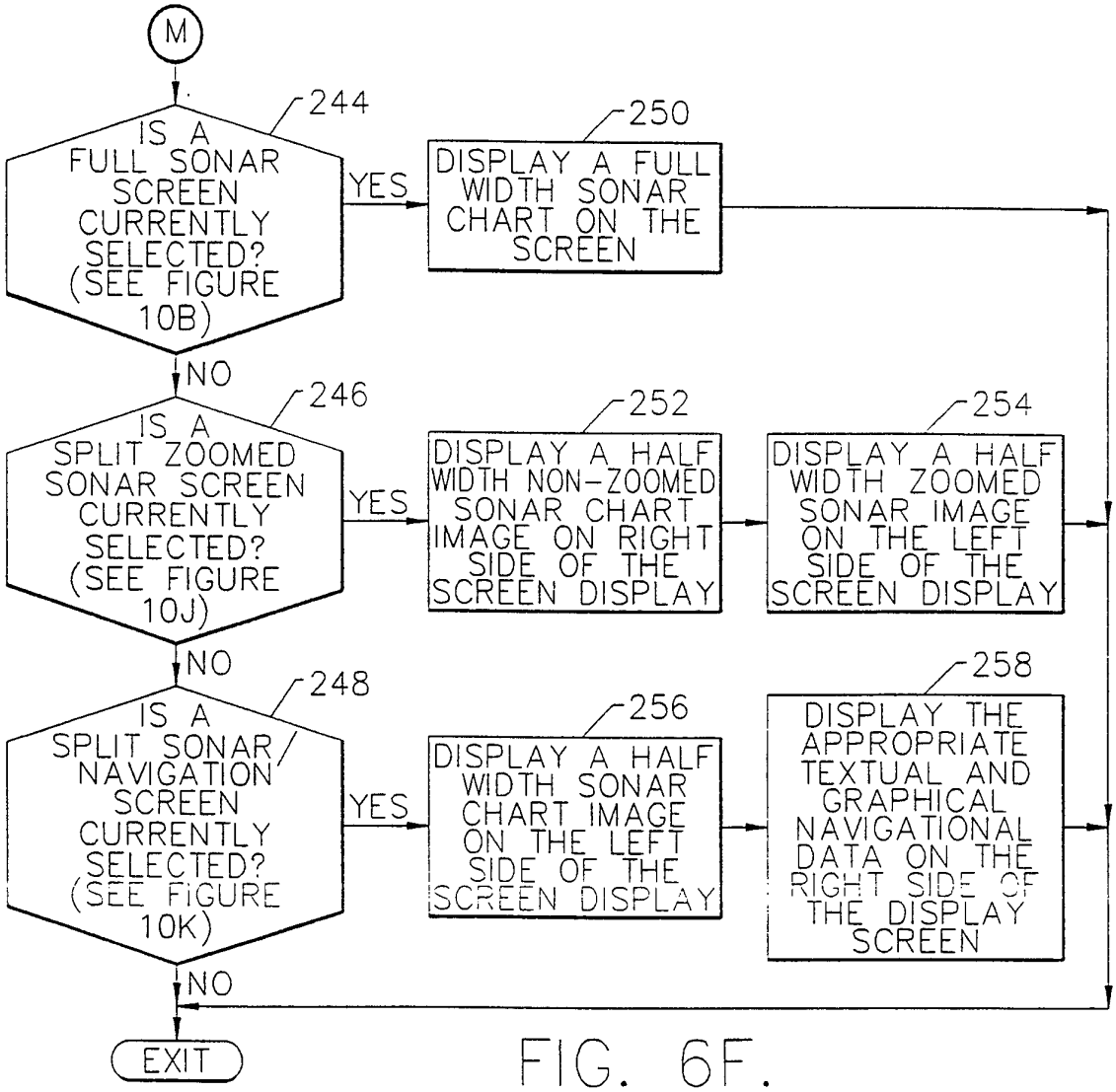
M
244
IS A FULL SONAR SCREEN CURRENTLY SELECTED? (SEE FIGURE 10B)
YES
250
DISPLAY A FULL WIDTH SONAR CHART ON THE SCREEN
NO
246
IS A SPLIT ZOOMED SONAR SCREEN CURRENTLY SELECTED? (SEE FIGURE 10J)
YES
252
DISPLAY A HALF WIDTH NON-ZOOMED SONAR CHART IMAGE ON RIGHT SIDE OF THE SCREEN DISPLAY
254
DISPLAY A HALF WIDTH ZOOMED SONAR IMAGE ON THE LEFT SIDE OF THE SCREEN DISPLAY
NO
248
IS A SPLIT SONAR/ NAVIGATION SCREEN CURRENTLY SELECTED? (SEE FIGURE 10K)
YES
256
DISPLAY A HALF WIDTH SONAR CHART IMAGE ON THE LEFT SIDE OF THE SCREEN DISPLAY
258
DISPLAY THE APPROPRIATE TEXTUAL AND GRAPHICAL NAVIGATIONAL DATA ON THE RIGHT SIDE OF THE DISPLAY SCREEN
NO
EXIT

FIG. 6F.

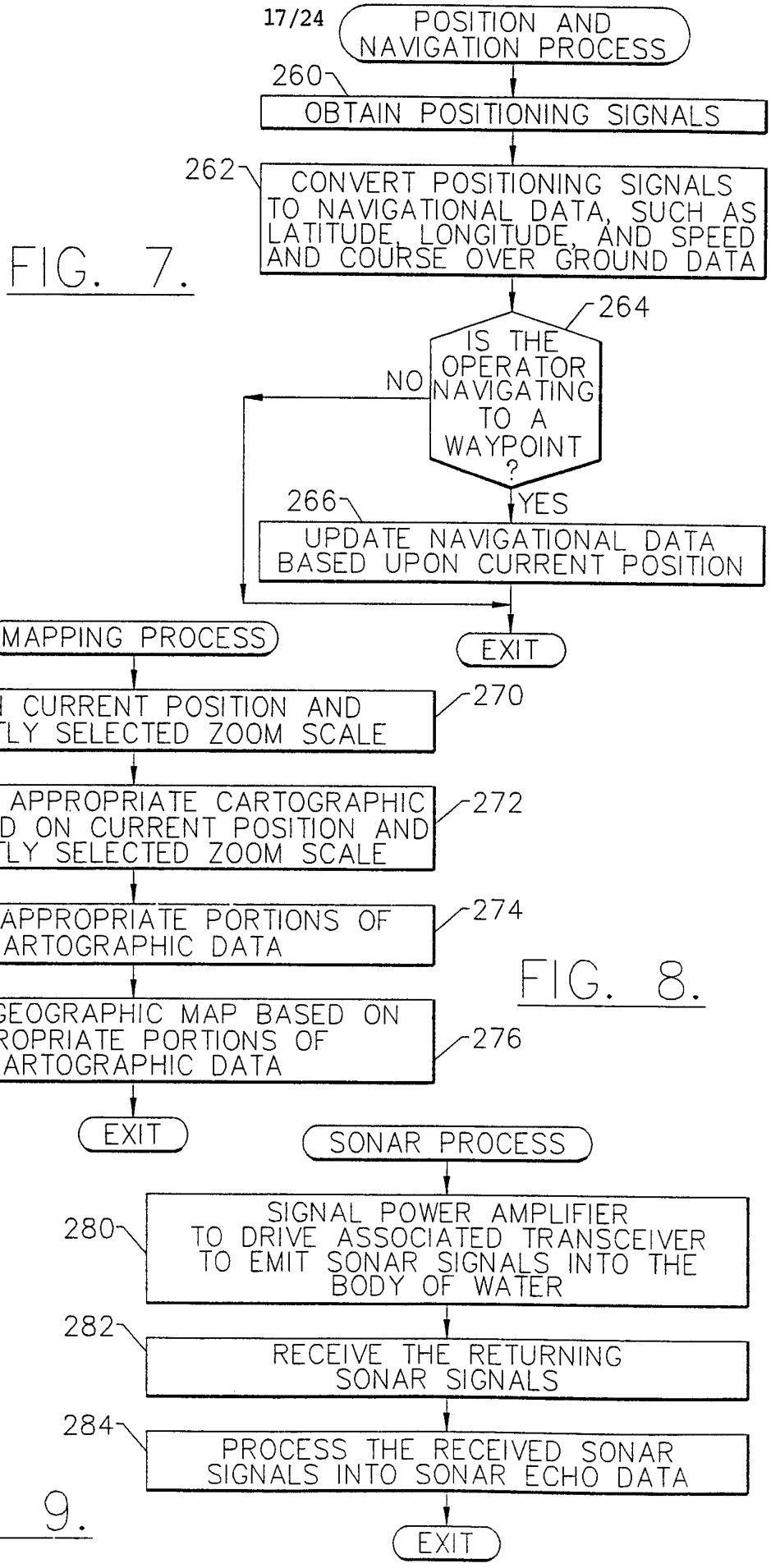

FIG. 7.

FIG. 8.

FIG. 9.

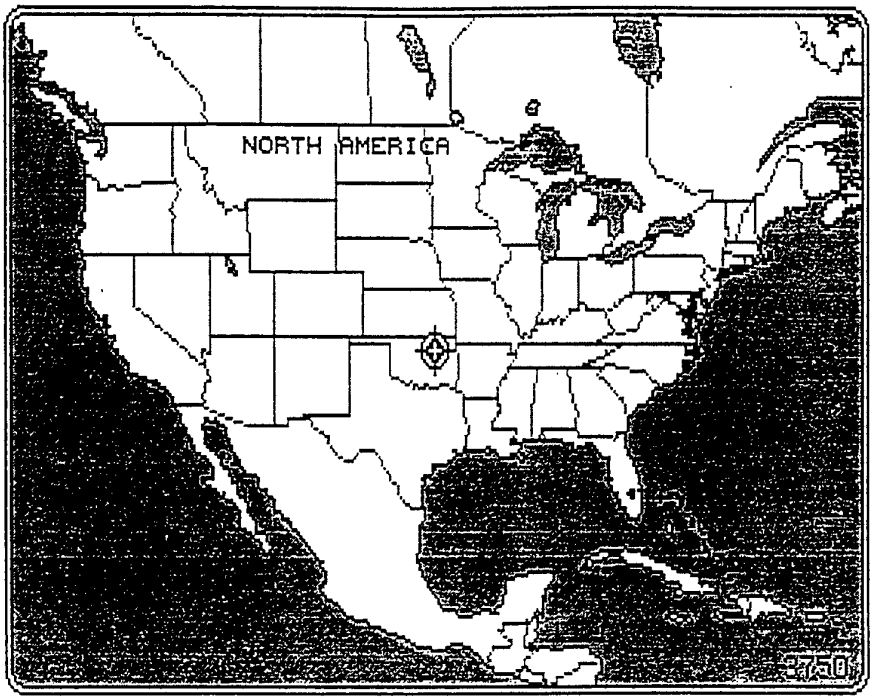

FIG. 10A.

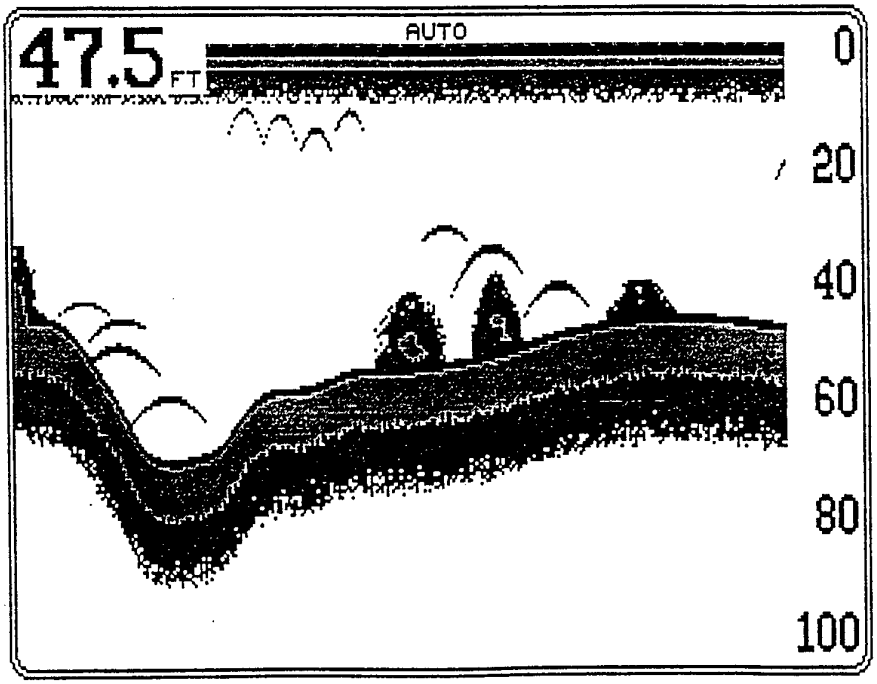

FIG. 10B.

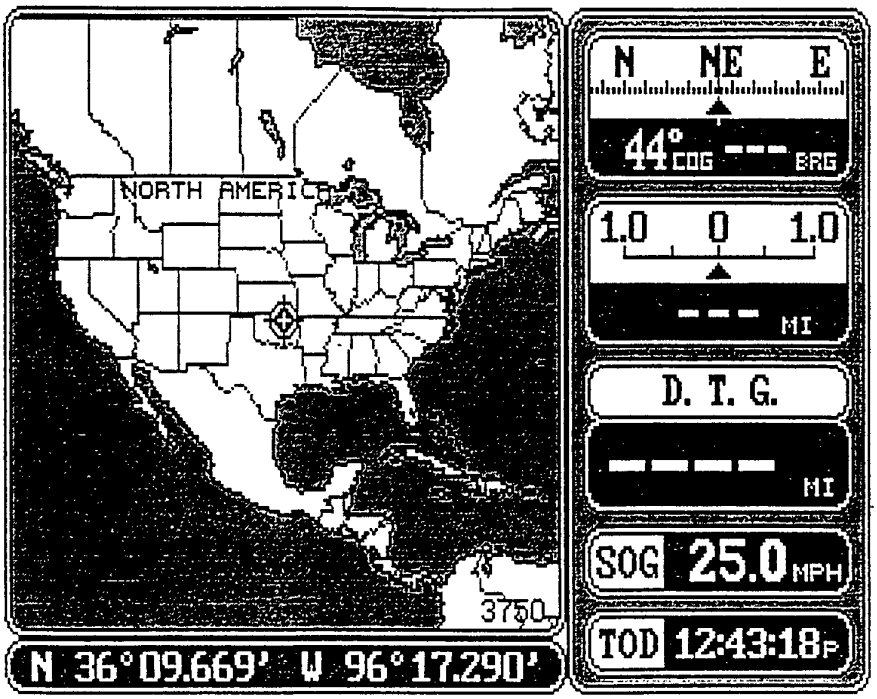

FIG. 10C.

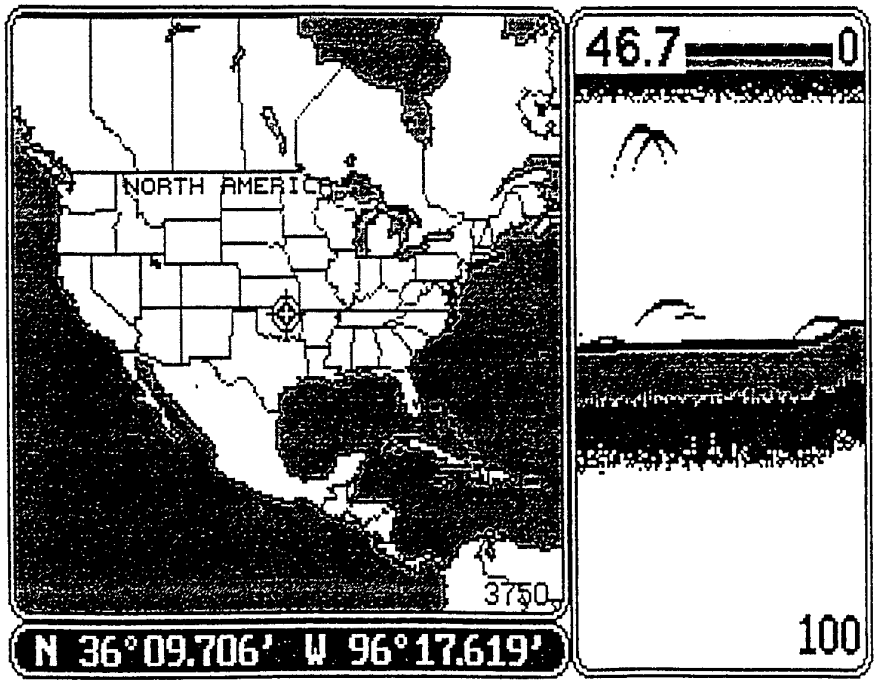

FIG. 10D.

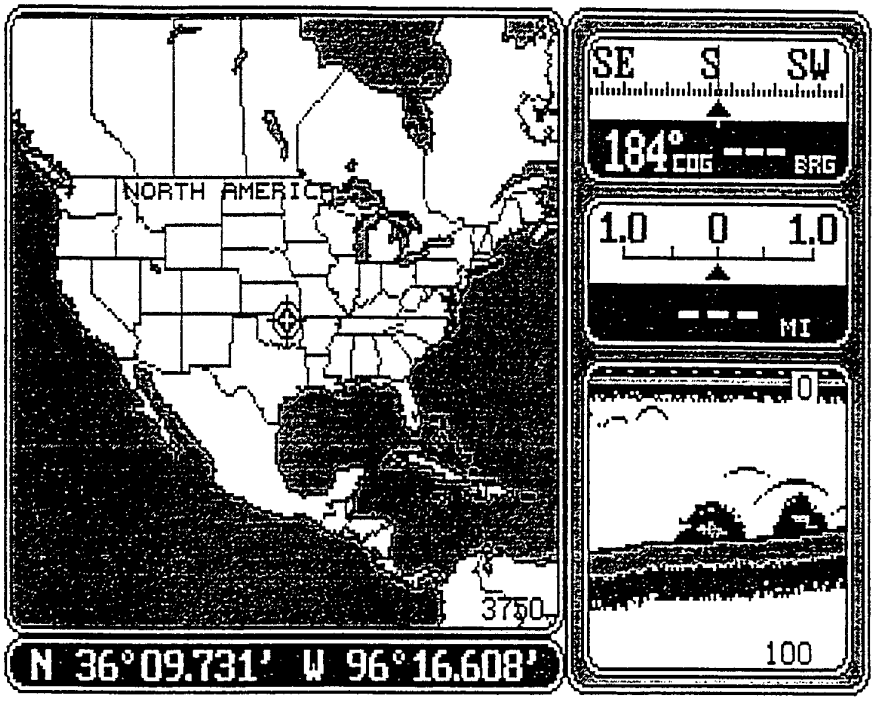

FIG. 10E.

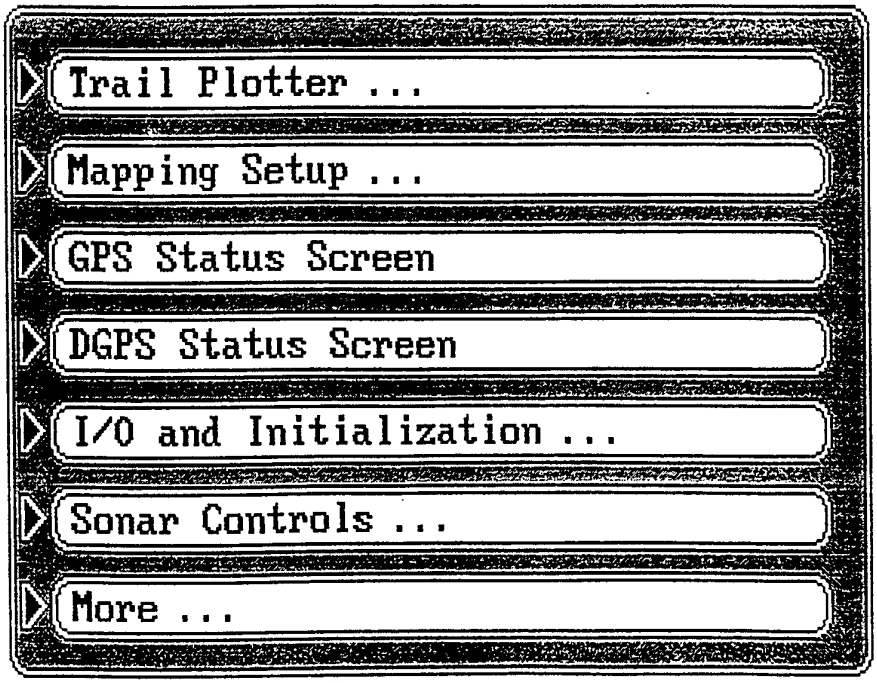

FIG. 10F.

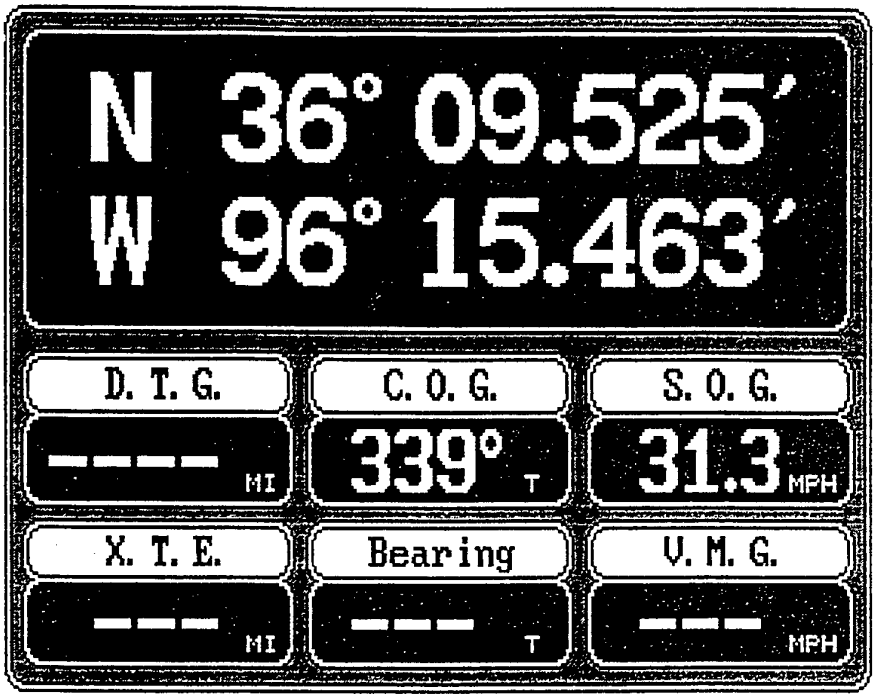

FIG. 10G.

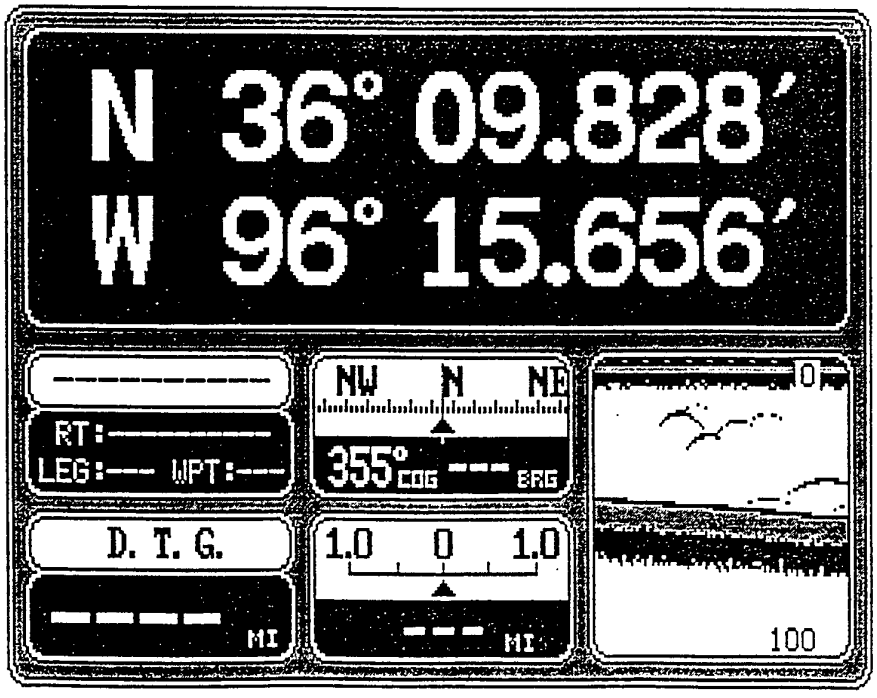

FIG. 10H.

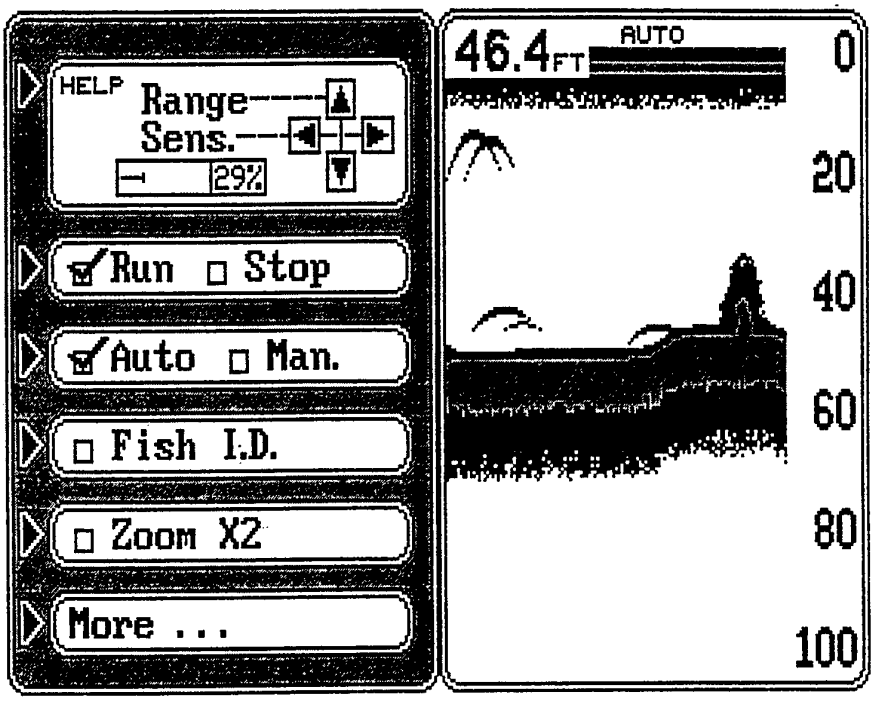

FIG. 10I.

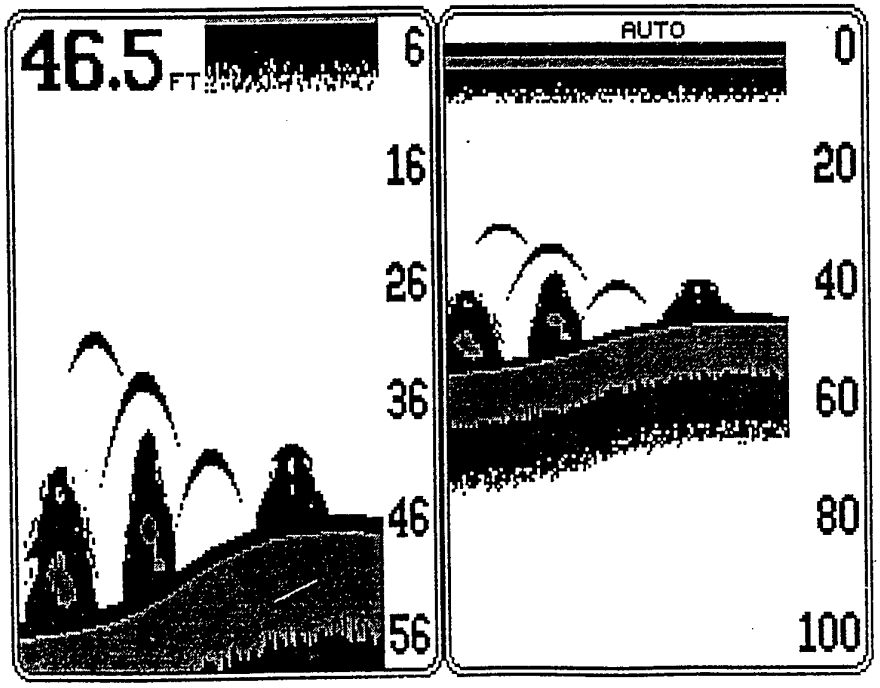

FIG. 10J.

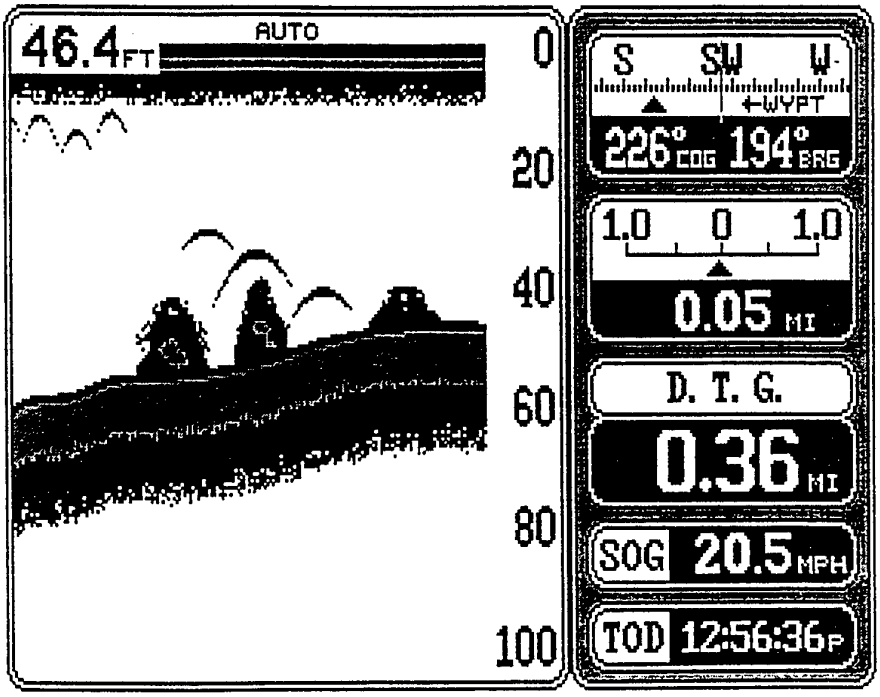

FIG. 10K.

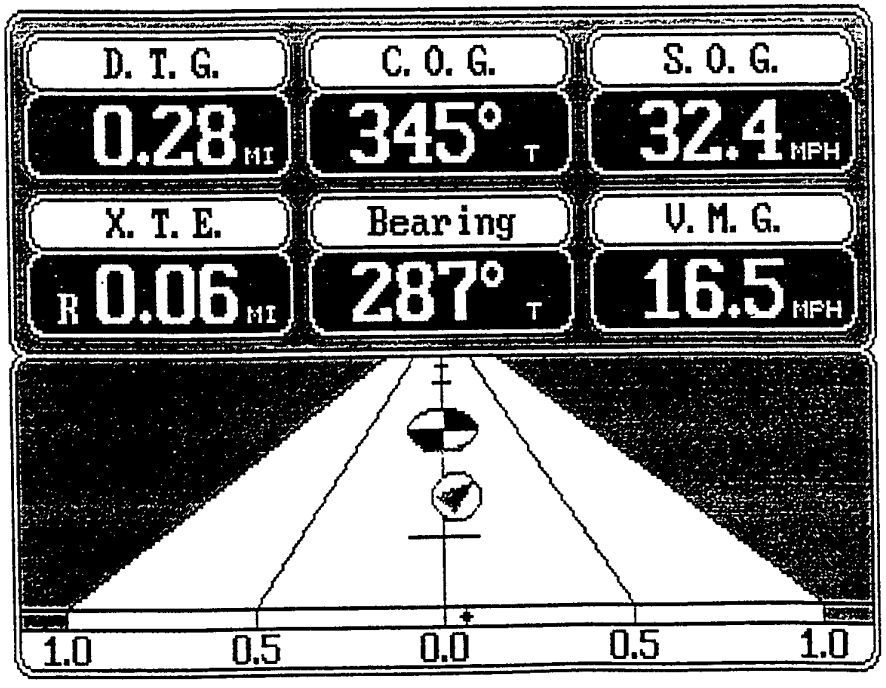

FIG. 10L.

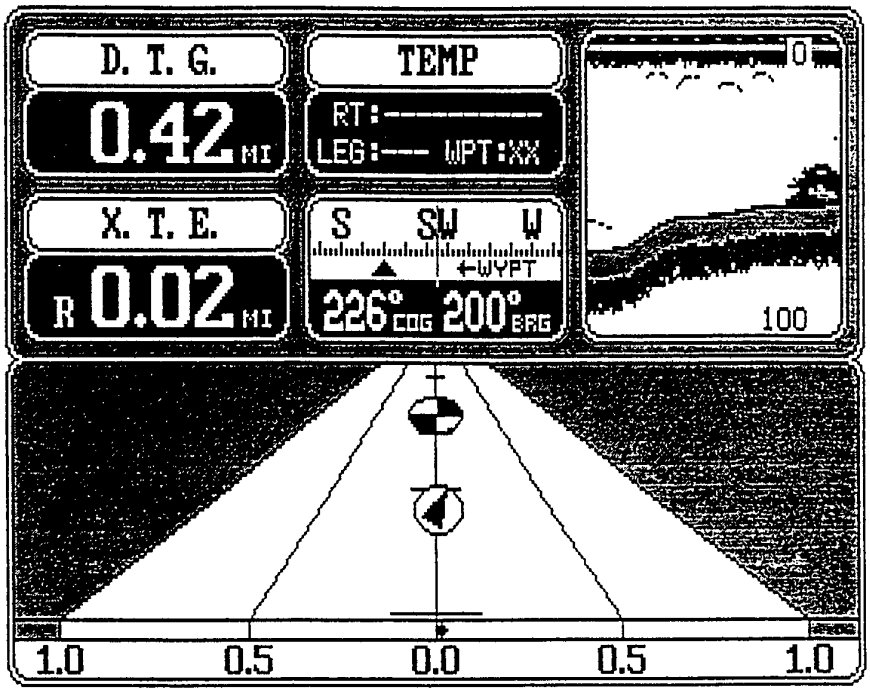
D. T. G.
0.42 MI
TEMP
RT:----------
LEG:--- WPT:XX
X. T. E.
R 0.02 MI
S SW W
←WYPT
226° COG 200° BRG
0
100
1.0
0.5
0.0
0.5
1.0

FIG. 10M.

INTERNATIONAL SEARCH REPORT

In. ional Application No
PCT/US 96/11845

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 G01S15/89 G01S15/02 G01S7/62

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 G01S

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	WO,A,85 01794 (NAVIGATION SCIENCES INC.) 25 April 1985 see the whole document ---	1-4,7,8, 11-14 5,9,15
Y	GB,A,2 205 703 (FURUNO ELECTRIC CO) 14 December 1988 see the whole document -----	5,9,15

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

1

Date of the actual completion of the international search	Date of mailing of the international search report
15 October 1996	12. 11. 96

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax (+31-70) 340-3016	Zaccà, F

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

In ional Application No
PCT/US 96/11845

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO-A-8501794	25-04-85	US-A- 4590569	20-05-86
		AU-B- 556558	06-11-86
		AU-A- 3558984	07-05-85
		CA-A- 1241416	30-08-88
		EP-A- 0160072	06-11-85
		JP-T- 61500187	30-01-86
GB-A-2205703	14-12-88	JP-B- 8023583	06-03-96
		JP-A- 63300983	08-12-88