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[54] **SECURITY MONITORING AND TRACKING SYSTEM**

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[52] **U.S. Cl.** **342/457;** 342/450; 342/389; 340/539; 340/63

[58] **Field of Search** 343/457, 450, 451, 453, 343/389; 340/539, 63

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Attorney, Agent, or Firm—Hoffman, Wasson & Fallow

[57] **ABSTRACT**

A method and apparatus for positively indicating the position of a land-based vehicle, a marine vessel or an aircraft, utilizing a security system provided in the secured mode of transportation monitored by a central station. Navigational information transmitted by LO-RAN-C transmitters or satellite transmitters are received and then retransmitted to the central station which determines the exact latitude/longitude coordinates of the secured mode of transportation. The secured mode of transportation also includes a security panel for monitoring the condition of various parameters. An interface is connected to the security panel and the navigational receiver for coordinating the transmission of information relating to the conditions monitored by the security panel as well as the information received by the navigational receiver before they are sent to a radio for transmission to the central station.

29 Claims, 2 Drawing Figures

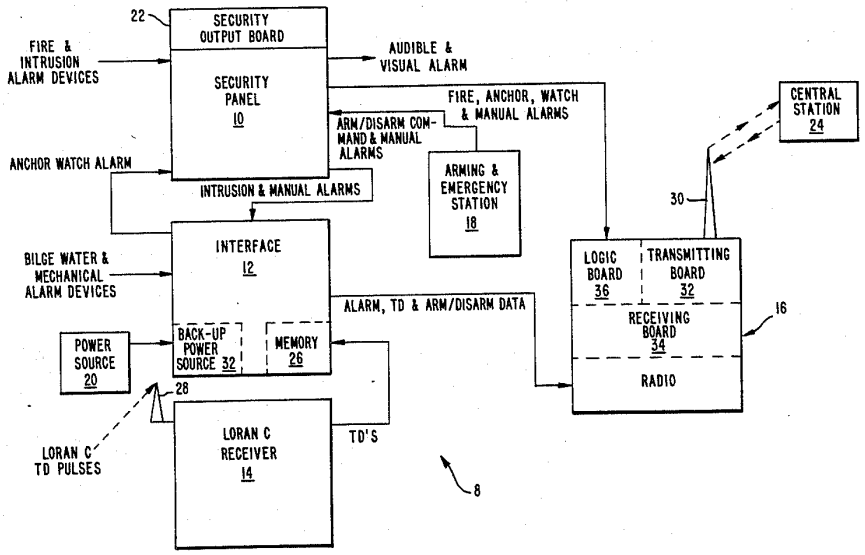

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FIG. 1.

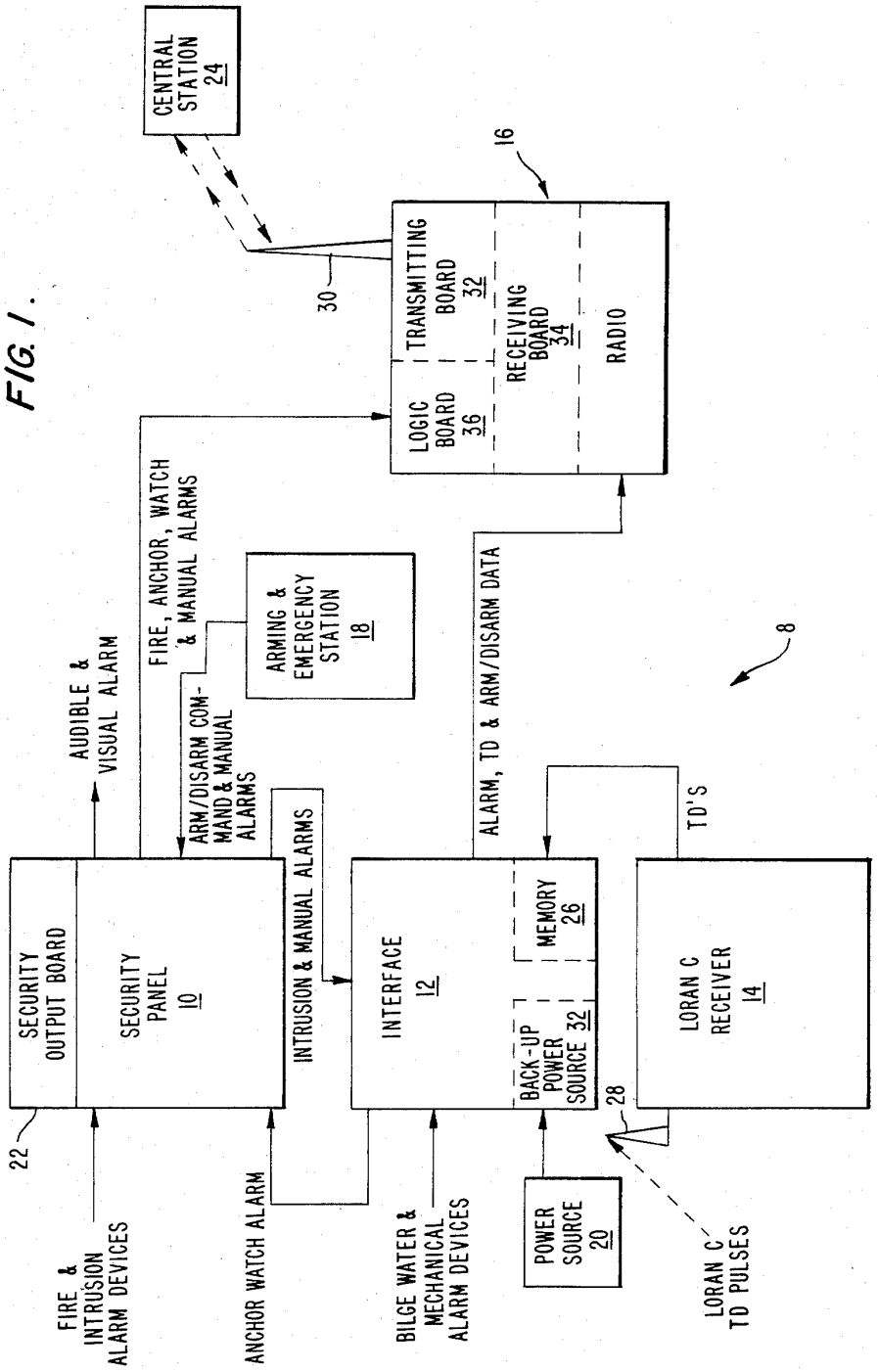
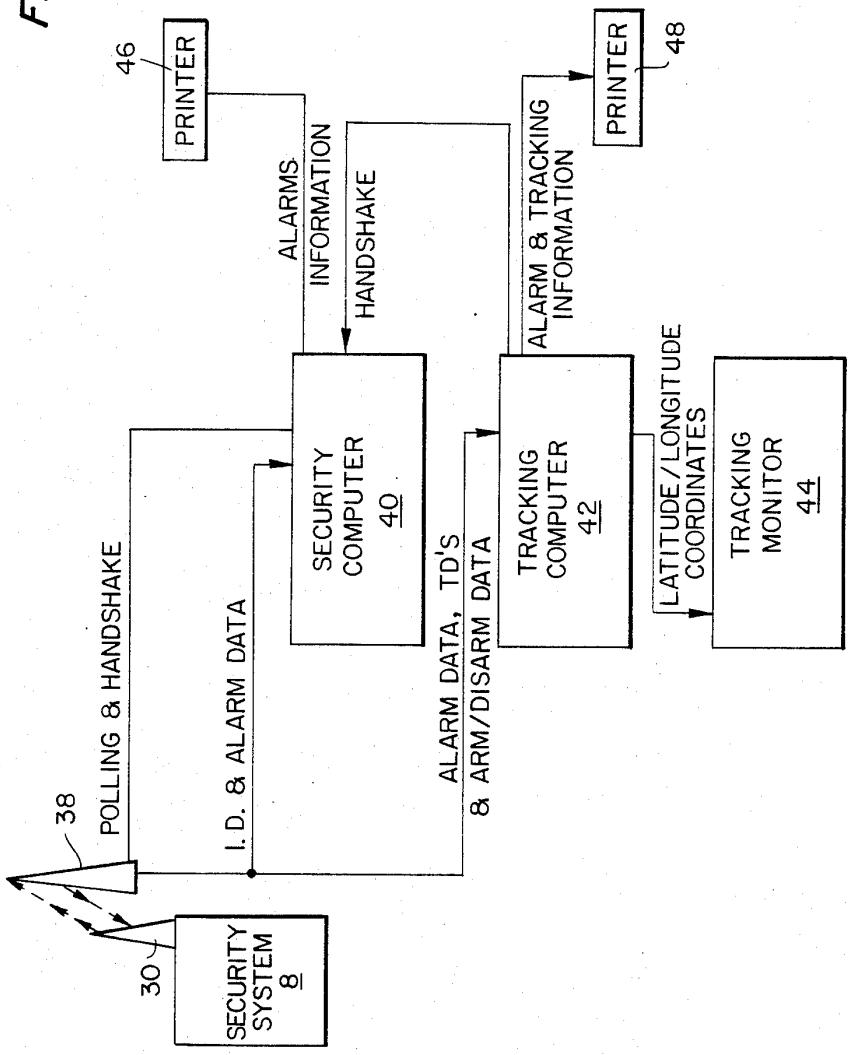


FIG. 2.



SECURITY MONITORING AND TRACKING SYSTEM

BACKGROUND OF THE INVENTION

Crime statistics provided by the Coast Guard and local police organizations have shown that in the last several years, the number of burglaries, vandalism and the theft of both land-based vehicles and marine vessels have increased dramatically. For example, Coast Guard statistics indicate that 75,000 vessels have been reported stolen in the last five years and insurance companies report that claims in excess of $200,000,000.00 have been reported each year. Furthermore, the Coast Guard has reported that in the year 1982 alone, nearly 50,000 calls for assistance were answered for pleasure craft and that over 150,000 people were assisted and nearly 5,700 lives saved.

Consequently, various systems have been developed which endeavor to monitor the current position and status of either a land-based vehicle, such as personal automobiles, fleets of cars, trucks, taxis or police cruisers, mobile homes or vans and pleasure crafts such as yachts. Additionally, other systems have been developed for monitoring a vehicle or vessel for the presence of a malfunction, a fire condition or an unauthorized intrusion.

Motorola Communications and Electronics, Inc. of Schaumburg, Ill. is currently developing a land-based tracking system for determining the current position of vehicles provided with an existing mobile communications system between a central dispatcher and each individual vehicle. This system, which could be employed by police departments, taxi companies and fleets of trucks, utilizes a LORAN-C chain employing a single master and only two secondary transmitters to determine the particular latitude/longitude coordinates of the vehicles. However, problems have developed in implementing this system since each of the receivers provided in the land-based vehicle determine the particular coordinates of that vehicle and then transmits these coordinates to the central dispatching station. Since the LORAN-C signal is a ground wave, the velocity of the wave is altered by a variety of natural or man-made sources of interference, as well as being adversely affected by the particular terrain over which it passes. Although the Motorola system is cognizant of these problems, they chose to correct any inaccuracies by compensating for the errors generated by these sources of interference in the unit installed in each vehicle, each unit geared to a particular regional area. Therefore, regardless of whether these compensation techniques adequately rectify the errors generated by the LORAN-C transmissions, these compensation factors would have absolutely no application or use if the particular vehicle was no longer in its assigned region. Additionally, this system is used merely to determine the position of the vehicle and cannot be applied to monitor more than one manually set condition of the vehicle, nor can it be utilized to adequately determine whether the vehicle has been stolen.

A second vehicle tracking system is presently being developed by II Morrow, Inc. of Salem, Oreg. This system is in many respects very similar to the Motorola system in that it can only be used for land-based vehicles, the determination of the exact coordinates of a particular vehicle is directly calculated by the unit provided in each vehicle and no provision is made for automatically monitoring the condition of the vehicle.

Therefore, no existing system is presently available which adequately and accurately monitors the position of either a land-based vehicle, airplane or a sea-going vessel, determines whether that vehicle or vessel is currently being stolen and continuously monitors various operating parameters of that particular vehicle, airplane or vessel.

SUMMARY OF THE INVENTION

The disadvantages of the prior art are overcome by the present invention which is directed to a method of positively determining the exact position of a land-based mobile unit, air vehicle or a sea-going vessel. It should be noted that this method, as well as the security monitoring system described hereinbelow, has equal applicability to any mode of transportation and, therefore, for purposes of clarity, we will limit our description to the utilization of this method and system with respect to a sea-going vessel.

The method of tracking the vessel utilizes a LORAN-C transmitting network to provide the raw data used with a known triangulation computation technique for positively indicating the position of the vessel. Generally speaking, a typical LORAN-C system includes a master transmitting station and at least four "slave" transmitters. The master station transmits a coded series of pulses used to synchronize the operation of the "slave" transmitters. After a predetermined coding delay, each "slave" transmitter will transmit a group of coded pulses. A LORAN-C receiver placed upon the vessel receives both the signals transmitted by the master as well as all of the signals transmitted by the "slave" transmitters. Since the exact latitude/longitude coordinates of each of these stations is known, the time-delays (TDs) between the transmissions by the "slave" transmitters and the receipt of these signals by the vessel is used, through the standard triangulation technique, to determine the exact latitude/longitude coordinates of the vessel. All of the prior art systems presently available complete all of the computations using the received TDs in the unit provided on the monitored vehicle or vessel.

Since the LORAN-C transmitters transmit a ground wave of relatively low frequency (between 90 and 110 KHz) the accuracy of this system is compromised because the signal is affected by the terrain over which it travels. The present invention overcomes the problems of the prior art by performing the triangulation computations at a central monitoring station. The onboard receiver receives the transmitted TDs and merely transmits the raw data to the central station. Each of the central stations communicates with the vessels through the use of one or a plurality of fixed, non-mobile antennas. Upon installation, the exact latitude/longitude coordinates of the fixed, non-mobile antennas are determined. Each antenna is provided with a LORAN-C receiver and receives the same navigational pulses generated by the LORAN-C transmitters received by the vessels. The navigational pulses received by the fixed antenna are used to determine the latitude/longitude coordinates of the antenna and are compared to the known coordinates of each antenna at computers provided at each central station. This difference information is used in conjunction with the TDs transmitted from each vessel to automatically determine the exact position of the vessel with great accuracy.

The present invention also provides a security monitoring apparatus provided on the sea-going vessel. This apparatus coordinates the outputs of various sensing devices provided on the vessel as well as responding to polling or scanning of the vessel by the central station. Although the various parameters monitored by the security system can be changed according to the demands and requirements of each user, the following parameters are listed merely to indicate the various usages to which the present invention could be applied.

First and foremost, the present invention can monitor and determine whether the vessel is presently being utilized without authorization. This "anchor-watch" feature employs the LORAN-C navigational technique described hereinabove. In this situation, the TDs transmitted by the LORAN-C transmitters are retained by the vessel. When the system is armed, it can determine if the vessel is moved outside of a particular radius, such as 1/10th of a mile. The interval between the transmissions of each of the master's transmissions is approximately one second and therefore, each time the time delays are received by the vessel, a computation is performed to determine the exact position of the vessel. This exact position is then compared to the position of the vessel when the anchor has been armed, and when the present position crosses the circumference of a circle having a radius of, in this situation, 1/10th of a mile, the central station is automatically alerted.

Additionally, the central station would be automatically alerted if the security monitoring apparatus senses the presence of an unauthorized intrusion upon the vessel, the presence of excessive heat in key areas indicating the presence of a fire, the mechanical breakdown of various devices on the vessel such as the engine, generator or low voltage battery condition, high bilge water level, the presence of excessive moisture in various key areas on the vessel, and the proper arming of the entire security system.

Furthermore, the present invention includes a system which allows the occupants of the vessel to manually alert the central station of various situations such as an emergency or May-Day condition, a medical emergency, the presence of a man-overboard or the fact that the occupants on the vessel are presently being ambushed or burglarized. As was true with the conditions which automatically alert the central station, this listing of manually alerted conditions is not deemed to be comprehensive of all of the conditions which can be monitored but have been included to illustrate the various conditions which can be controlled.

Communications between the vessel and the central station are accomplished by a two-way radio utilizing a full duplex radio frequency. This radio is capable of both receiving and transmitting signals simultaneously and would respond to the periodic polling generated by the central station as well as alarm signals manually or automatically generated by the onboard security system.

The information received by the central station is channeled into various computers or monitors. The computers monitor the security of the vessel and personnel provided at the central station would notify the proper authorities if a fault condition is sensed. A tracking computer is used to determine the exact position of the vessel and a tracking monitor is employed to visually display the position of the vessel. Various printers are also employed to generate a hard copy of the security status of the vessel as well as positioning information of the vessel.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects, features and advantages of the present invention will become more apparent from the following description when read in conjunction with the accompanying drawings, in which:

FIG. **1** is a block diagram of the onboard security system; and

FIG. **2** is a block diagram of the central monitoring

DETAILED DESCRIPTION OF THE PRESENT INVENTION

The security system of the present invention provided on the secured vessel is shown in FIG. **1**. As previously mentioned, this invention has equal applicability to be utilized on a land-based vehicle as well as an airplane. However, for purposes of simplicity, we shall describe the operation of the present invention with respect to its use on a marine vessel, it being acknowledged that the various parameters which are monitored would change according to the particular mode of transportation which is to be protected. The onboard security system **8** includes a security panel **10**, an interface **12**, a LORAN-C receiver **14** as well as a two-way full duplex transmitting radio **16**.

The security panel **10** is directly affixed to any convenient console such as would be present in the cockpit of the vessel. This panel is capable of monitoring various conditions such as the presence of a fire and burglary intrusions. Various sensors responsive to these conditions are provided in a multitude of locations throughout the vessel and are hard-wired into the panel itself. Certainly, the exact number of protected zones which are monitored would change to accommodate the particular vessel which is to be protected. However, for purposes of illustration only, the present invention utilizes nine separate input zones which are armed or disarmed through the use of an arming and emergency station **18** directly or indirectly connected to the panel **10**. The security panel **10** supplies power for the monitoring devices through the interface **12** which in turn is supplied with power from the vessel's own onboard power supply **20**. Although the present invention would automatically transmit a signal to the central station if one of the sensors is activated, the security panel **10** also includes a security output board **22** which automatically triggers the radio **16**. Additionally, the security panel **10** provides both audible and visual alarm indications provided by the tripped sensors. As can be appreciated variously sounding alarms are provided for different purposes such that an individual aboard the vessel would be able to quickly differentiate between the fire and burglary alarms or any other condition sensed by the security system. Any intrusion-type alarms could be utilized in the eight burglary zone of the security system, these alarms normally consisting of contact devices mounted on door or hatch openings and/or motion detectors which monitor key areas of the vessel. Additionally, a number of manual switches provided on the arming and emergency station **18** can be utilized to manually input alarms into the security panel **10**. These alarms could be utilized for May-Day, medical or man-overboard emergencies. The output board **22** is used to trip either the interface **12** or the radio **16** in order to initiate alarm signal transmissions to a central station **24**. The tripping of the interface **12** or the radio **16** by the

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