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- [54] **MOBILE TRACKING UNITS EMPLOYING MOTION SENSORS FOR REDUCING POWER CONSUMPTION THEREIN**
- [75] Inventors: **Kenneth B. Welles, II**, Scotia; **Jerome J. Tiemann**, Schenectady; **Harold W. Tomlinson, Jr.**, Scotia, all of N.Y.
- [73] Assignee: **General Electric Company**, Schenectady, N.Y.
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- [51] Int. Cl.⁶ **G01S 3/02**
- [52] U.S. Cl. **342/357; 342/457; 364/445**
- [58] Field of Search **342/357, 457; 364/445**

Improve Service, Tim Slifkin, Elexor Assoc. Inc. pp. 1-5.

Primary Examiner—Thomas H. Tarcza
Assistant Examiner—Dao L. Phan
Attorney, Agent, or Firm—Marvin Snyder

[57] **ABSTRACT**

A mobile tracking unit capable of operating in a power-starved environment for a vehicle tracking system includes a navigation set for generating data corresponding to a respective vehicle position. The navigation set is periodically energized at a selected activation rate F_G while the vehicle is moving to generate the vehicle position data. The tracking unit includes an electromagnetic emitter which is capable of transmitting the vehicle position data and which is periodically energized at a selected activation rate F_{EM} while the vehicle is moving to transmit at least the vehicle position data. A motion sensor is employed for generating data indicative of vehicle motion. A tracking unit controller receives the vehicle motion data and controls the navigation set and the emitter based upon the vehicle motion data so that when the vehicle is stationary each of activation rates F_G and F_{EM} can be respectively decreased by a predetermined factor, thus reducing the overall power consumption of the tracking unit. The tracking unit controller is further designed to return to activation rates F_G and F_{EM} upon the motion sensor sensing renewed vehicle motion, thus avoiding loss of vehicle position data during times of renewed vehicle motion.

[56] **References Cited**

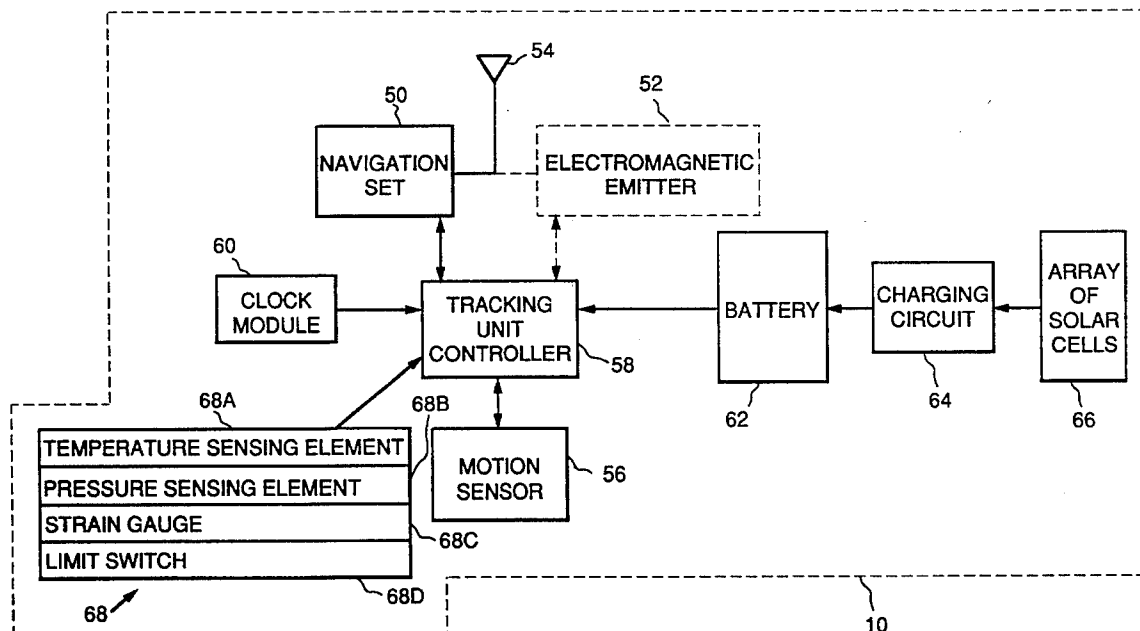
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28 Claims, 3 Drawing Sheets



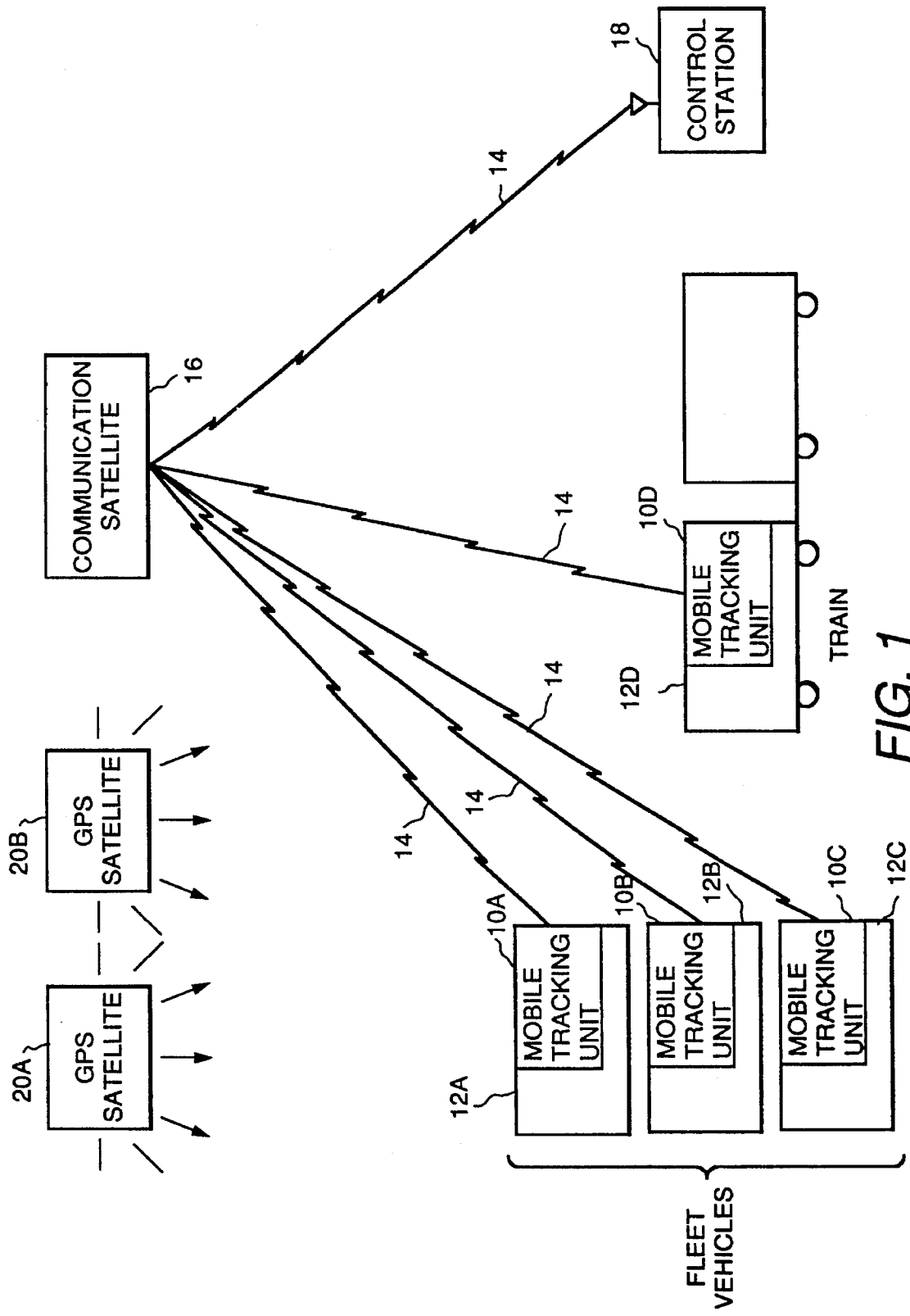


FIG. 1

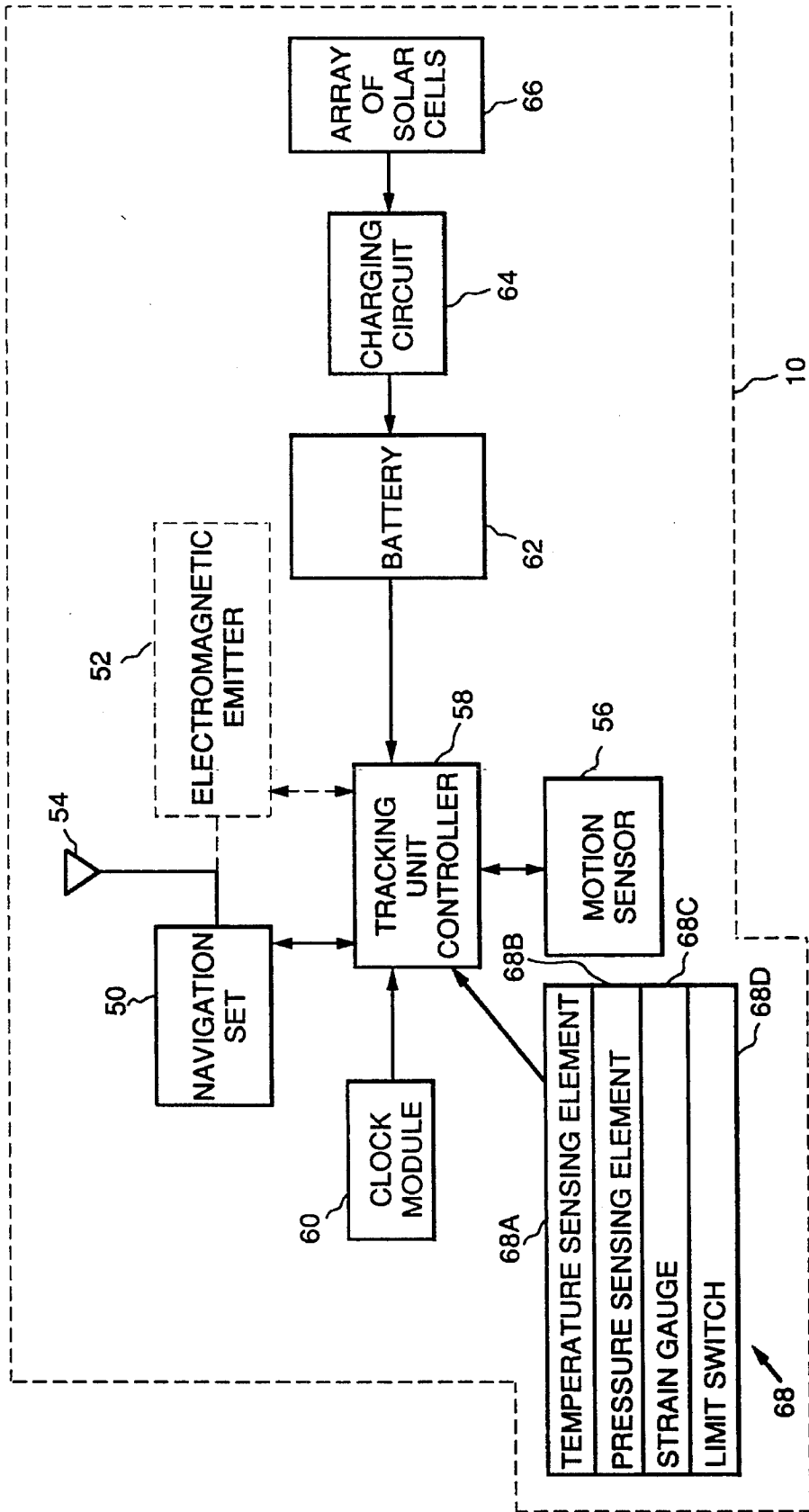


FIG. 2

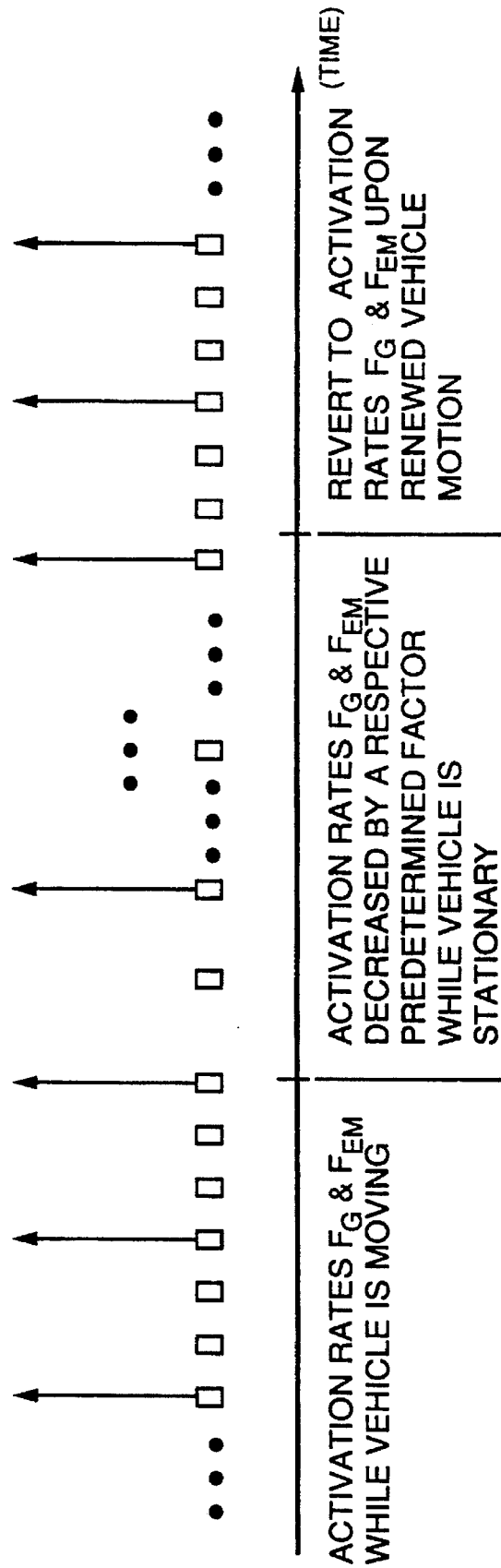


FIG. 3

MOBILE TRACKING UNITS EMPLOYING MOTION SENSORS FOR REDUCING POWER CONSUMPTION THEREIN

BACKGROUND OF THE INVENTION

The present invention relates to mobile tracking units for a vehicle tracking system and, more particularly, to mobile tracking units employing motion sensors for reducing power consumption therein under predetermined conditions.

A significant requirement for mobile tracking units used in vehicles which generally lack a power source, such as freight railcars, shipping containers and the like, is to have relatively low electrical power consumption characteristics. Mobile tracking units used in a power-starved environment must be substantially power efficient in order to provide reliable and economical operation. Typically, the mobile tracking unit includes a navigation set, such as a Global Positioning System (GPS) receiver or other suitable navigation set, responsive to navigation signals transmitted by a set of navigation stations which can be either space- or earth-based. In each case, the navigation set is capable of providing data indicative of the vehicle location based on the navigation signals. In addition, the mobile tracking unit can include a suitable electromagnetic emitter for transmitting to a remote location the vehicle position data and other data acquired with sensing elements in the vehicle. Since both the navigation set and the emitter are devices which, when energized, generally consume a large portion of the overall electrical power consumed by the mobile tracking unit, it is desirable to control the respective rates at which such devices are respectively activated so as to reduce the overall power consumption of the mobile tracking unit. For presently available mobile tracking units, use of a motion sensor, such as an accelerometer, has been suggested to detect shock or impact events which the vehicle encounters during routine use. However, no suggestion has been made of using the motion sensor for controlling the respective rates at which the aforementioned devices are activated so as to substantially reduce the overall power consumption of the mobile tracking unit.

SUMMARY OF THE INVENTION

Generally speaking, the present invention fulfills the foregoing needs by providing a mobile tracking unit capable of operating in a power-starved environment and suitable for a vehicle tracking system. The tracking unit includes a navigation set for generating data substantially corresponding to a respective vehicle position. The navigation set is periodically energized at a selected activation rate F_G while the vehicle is moving to generate the vehicle position data. An electromagnetic emitter can be employed in the tracking unit for transmitting the vehicle position data, in which case such emitter is periodically energized at a selected activation rate F_{EM} , while the vehicle is moving, to transmit at least the vehicle position data. A motion sensor, such as an accelerometer or vibration sensor, is employed for generating data indicative of vehicle motion. A tracking unit controller is coupled to the motion sensor to receive the vehicle motion data and is designed to control the navigation set and the emitter based upon the vehicle motion data so that during times when the vehicle is substantially stationary, each of activation rates F_G and F_{EM} can be respectively decreased by a predetermined factor, thereby substantially reducing the overall power consumption of the tracking unit. The tracking unit controller is further designed to revert to activation rates

F_G and F_{EM} upon an indication from the motion sensor of renewed vehicle motion, thereby avoiding any substantial loss of vehicle position data during times of renewed vehicle motion.

A method of operating a mobile tracking unit for a vehicle location system in accordance with the present invention can include the following steps: providing a navigation set capable of generating data substantially indicative of a respective vehicle position; periodically energizing the navigation set at a selected activation rate F_G while the vehicle is moving to generate vehicle position data; providing an electromagnetic emitter (if optionally needed) capable of transmitting the vehicle position data; periodically energizing the electromagnetic emitter at a selected rate F_{EM} , while the vehicle is moving, to transmit at least the vehicle position data; generating data indicative of vehicle motion using a motion sensor; controlling the navigation set and the emitter based upon the vehicle motion data so that during times when the vehicle is substantially stationary, each of the activation rates F_G and F_{EM} is respectively decreased by a predetermined factor, thereby substantially reducing overall power consumption of tracking unit; and controlling the navigation set and the emitter to revert to activation rates F_G and F_{EM} upon an indication from the motion sensor of renewed vehicle motion, thereby avoiding any substantial loss of vehicle position data during times of renewed vehicle motion.

BRIEF DESCRIPTION OF THE DRAWINGS

The features of the invention believed to be novel are set forth with particularity in the appended claims. The invention itself, however, both as to organization and method of operation, together with further objects and advantages thereof, may best be understood by reference to the following description in conjunction with the accompanying drawings in which like numbers represent like parts throughout the drawings, and in which:

FIG. 1 is a block diagram of an exemplary vehicle tracking system which can employ a mobile tracking unit in accordance with the present invention;

FIG. 2 is a block diagram illustrating further details of the mobile tracking unit shown in FIG. 1; and

FIG. 3 is a graph showing respective exemplary activation rates for components of the mobile tracking unit wherein the activation rates are selected to reduce the overall power consumption of the mobile tracking unit in accordance with the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The present invention provides mobile tracking units capable of operating in a power-starved environment. The mobile tracking units can be conveniently employed for a vehicle tracking or monitoring system which at least provides vehicle location information using navigation data derived from an existing navigation system, such as the Global Positioning System (GPS) satellite constellation, thereby providing highly accurate, real-time, vehicle tracking capability. It will be appreciated that the present invention is not limited to GPS navigation, being that vehicle tracking systems that use other navigation systems such as Loran, Omega, Transit and the like, or even satellite range measurement techniques (as respectively described in U.S. Pat. Nos. 4,161,730 and 4,161,734, both by R. E. Anderson, issued Jul. 17, 1979, both assigned to the present assignee,

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