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(54) **LOCOMOTIVE WIRELESS VIDEO  
RECORDER AND RECORDING SYSTEM**

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(57) **ABSTRACT**

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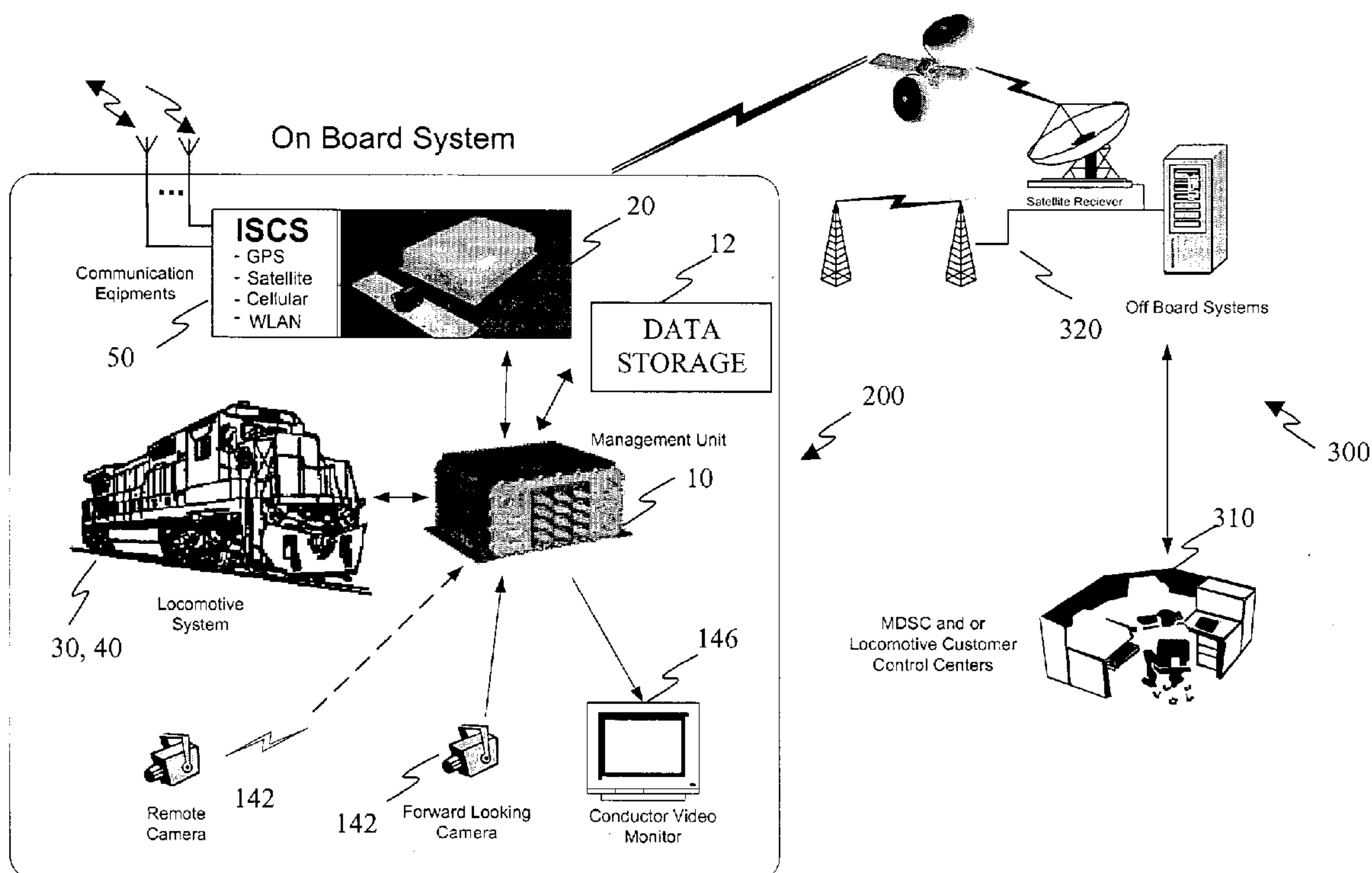
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(51) **Int. Cl.<sup>7</sup> ..... H04N 7/18**

A video recorder system carried on-board a railroad locomotive for recording images relating to events of interest in a vicinity of the locomotive and transmitting the images to a location off-board of the locomotive, the system comprising: an audio/video system with a camera mounted on the locomotive for imaging an environment in a vicinity of the locomotive, the camera transmitting imaging data indicative of images acquired; and data storage on-board the locomotive in communication with the camera for storing the imaging data. The system also includes a processor on-board the locomotive in communication with the data storage for identifying and retrieving selected imaging data of interest from the data storage. Optionally the system may further include a wireless communication system on-board the locomotive in communication with said processor for transmitting signals associated with the selected imaging data of interest to a location off-board of the locomotive and receiving commands and information from off board the locomotive.

**Locomotive Wireless Video Recorder & Diagnostic System**



Locomotive Wireless Video Recorder & Diagnostic System

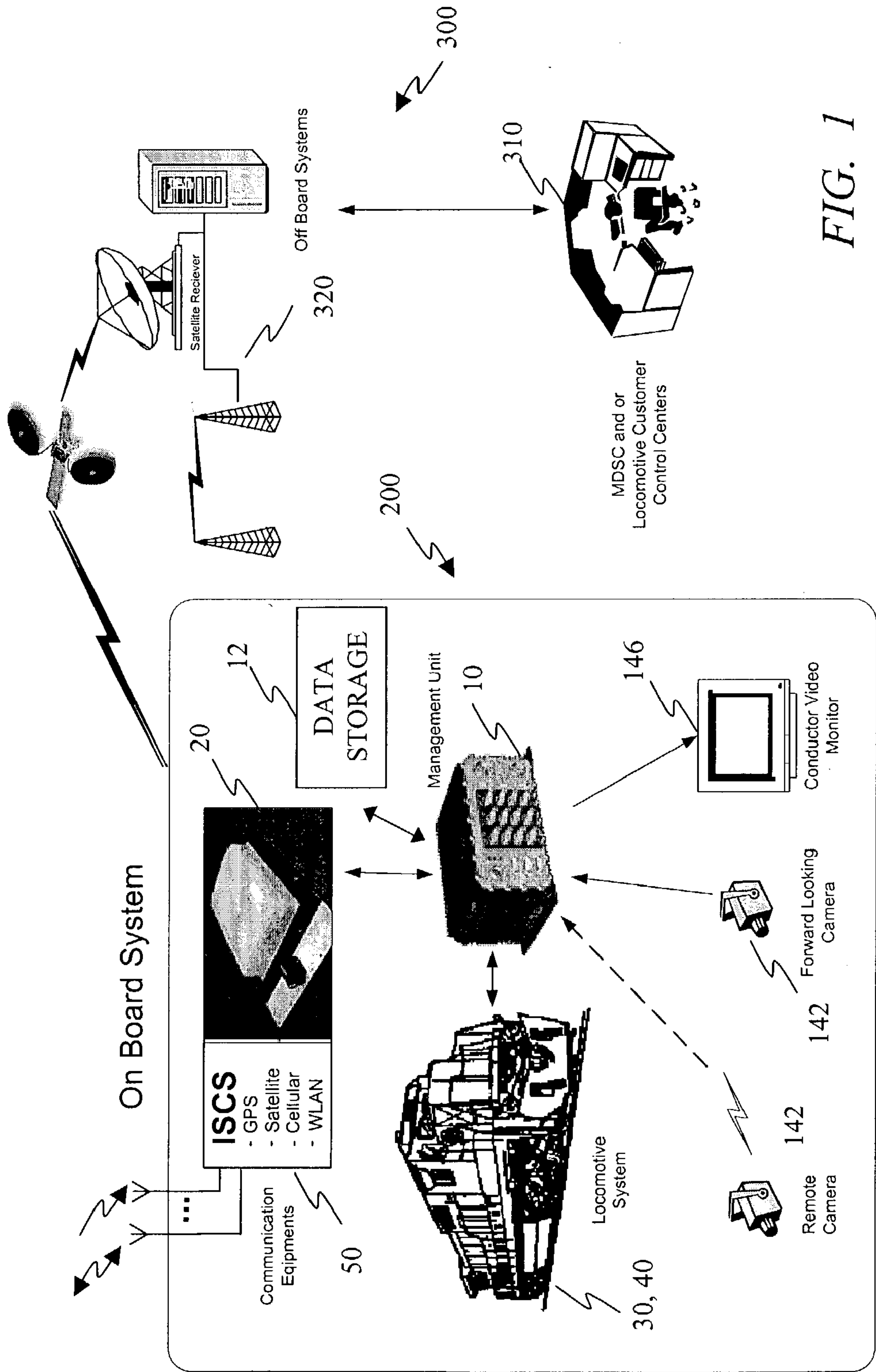


FIG. 1

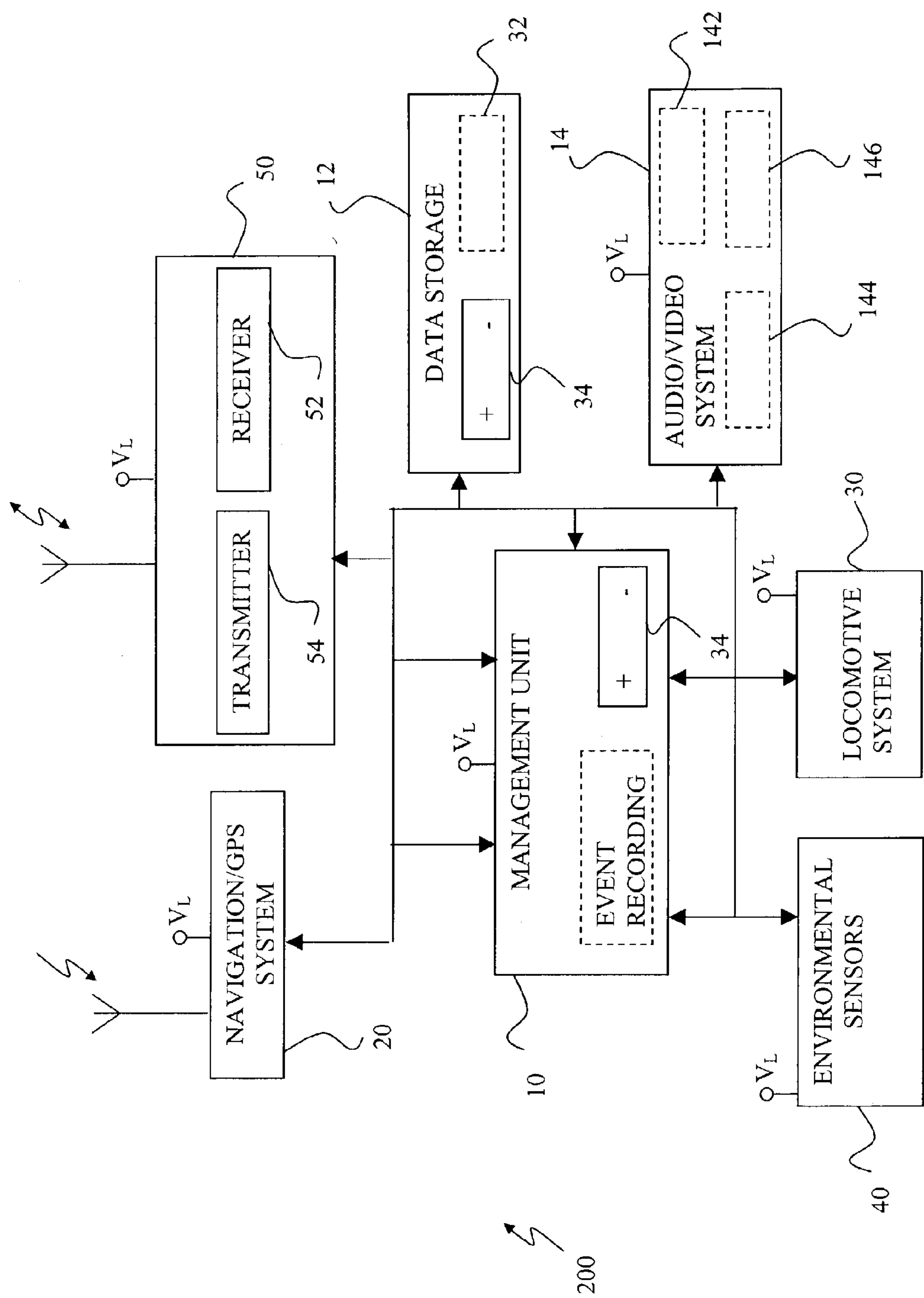


FIG. 2

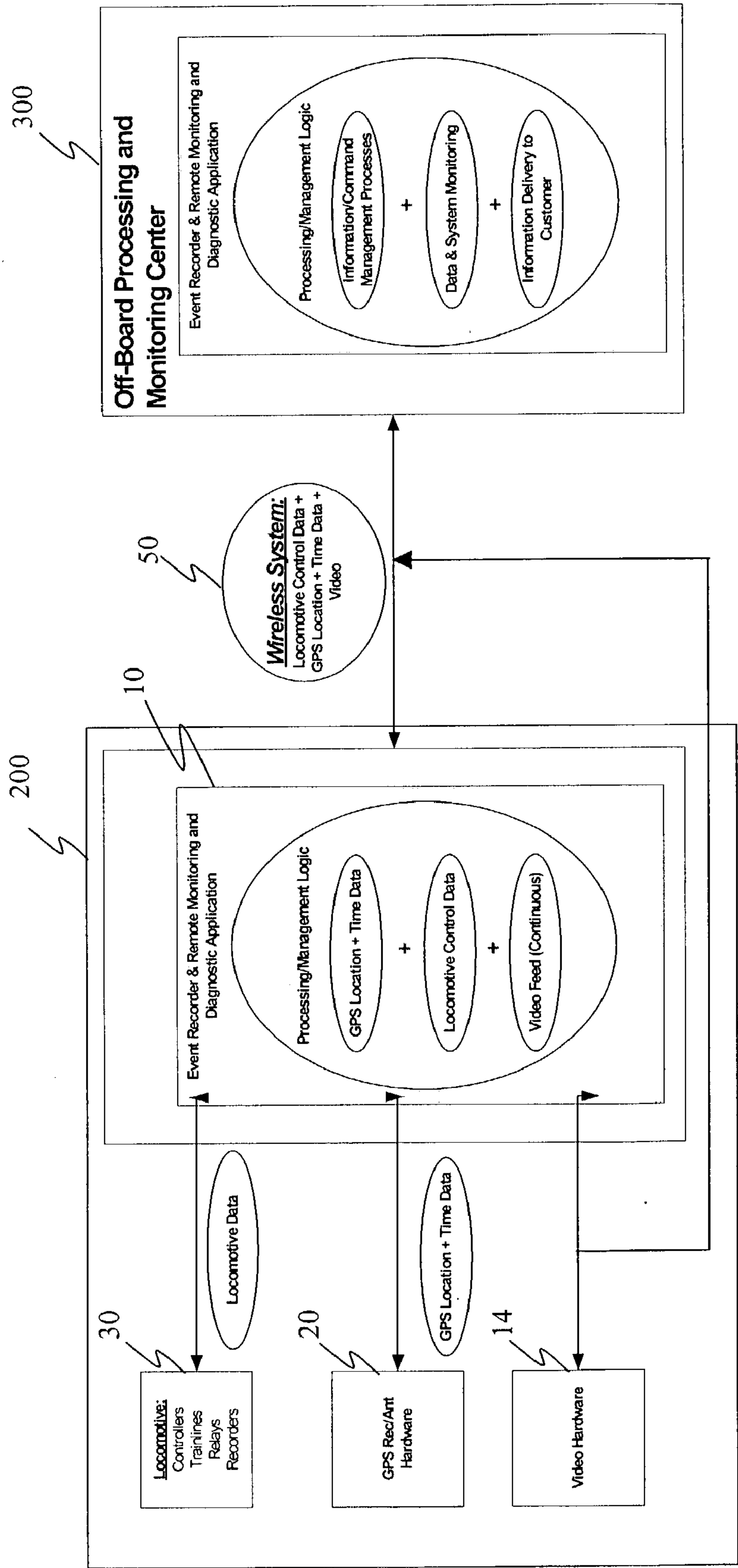


FIG. 3



## LOCOMOTIVE WIRELESS VIDEO RECORDER AND RECORDING SYSTEM

### CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. provisional application No. 60/385,645 filed Jun. 4, 2002 the contents of which are incorporated by reference herein in their entirety.

### BACKGROUND

[0002] The invention relates to integrated diagnostic, telemetry and recording systems for use in a locomotive.

[0003] Event recorders exist for use with locomotives. Such event recorders receive data corresponding to numerous parameters such as speed, acceleration, etc., from the locomotive control system over a communications channel (e.g., RS 422 interface). Upon the occurrence of an event the event recorder stores locomotive data in a memory module. An exemplary locomotive event recorder is produced by Electrodynamics, Inc.

[0004] Locomotive audio/video recording systems are also known in the art. An exemplary locomotive audio/video recording system is the RailView system available from Transportation Technology Group. In such audio/video recording systems, video data and optionally audio data are stored to a high capacity, memory device such as a floppy disk drive, hard disk drive or magnetic tape.

[0005] Another locomotive video system is disclosed in U.S. Pat. No. 5,978,718 for use in rail traffic control. For trains traveling on a route equipped with a wayside signaling system, the operating authority guides each train via wayside signal devices dispersed at various intervals throughout the length of the railway route. Though trains can be guided safely along unsignaled routes, wayside signaling systems are preferable, especially on heavily trafficked routes, as they can be used to guide trains even more safely and more quickly along such signaled routes with less distance between them. In the video system of the '718 patent, a rail vision system is employed to visually read signal aspect information from each wayside signal device of a wayside signaling system. The system can be configured to warn a train operator of the more restrictive signal aspects and impose brake application should the train operator fail to acknowledge the warning. The rail vision system includes a signal locating system and a rail navigation system. The rail navigation system determines the position that the train occupies on the railway track and provides the signal locating system with data as to the whereabouts of the upcoming wayside signal device relative to the position of the train. The signal locating system isolates upcoming wayside signal devices and reads the information therefrom as the train approaches. The signal locating system provides the information read therefrom to the rail navigation system. The rail navigation system can then warn the train operator of restrictive signal aspects, and should the train operator fail to acknowledge the warning, impose a brake application.

[0006] It should be noted that the foregoing background information is provided to assist the reader in understanding the instant invention. Accordingly, any terms used herein are not intended to be limited to any particular narrow interpretation unless specifically stated otherwise in this document.

[0007] There is therefore, a need in the railroad industry for a system that could inform the operator of the train, of the status wayside signaling system, and store and transmit information related to the wayside signaling and locomotive operating parameters and diagnostics without the aforementioned disadvantages. Specifically, it would be desirable to develop a system that can visually read the signal aspect information from each wayside signal device, and further monitor wayside and crossing status. Furthermore, such a system could monitor locomotive diagnostics and record important information at selected intervals for later evaluation. Finally, such a system could facilitate incident evaluation with communications enabling immediate link of gathered data to a remote operator.

### SUMMARY

[0008] Disclosed herein in an exemplary embodiment is a video recorder system carried on-board a railroad locomotive for recording images relating to events of interest in a vicinity of the locomotive and transmitting the images to a location off-board of the locomotive, the system comprising: an audio/video system with a camera mounted on the locomotive for imaging an environment in a vicinity of the locomotive, the camera transmitting imaging data indicative of images acquired; and data storage on-board the locomotive in communication with the camera for storing the imaging data. The system also includes a processor on-board the locomotive in communication with the data storage for identifying and retrieving selected imaging data of interest from the data storage. Optionally the system may further include a wireless communication system on-board the locomotive in communication with said processor for transmitting signals associated with the selected imaging data of interest to a location off-board of the locomotive and receiving commands and information from off board the locomotive. The system also optionally includes: a plurality of sensors for gathering data regarding other parameters associated with the operation of the locomotive at the time of an event; and a navigation system operatively coupled with the management unit configured to transmit and receive commands instructions, and data to the management unit. The system may further include a the data storage device being a solid-state, non-volatile memory of sufficient storage capacity to provide long-term data storage of data and video data for a significant period of time associated with an event.

### BRIEF DESCRIPTION OF THE DRAWINGS

[0009] **FIG. 1** is a block diagram of an exemplary locomotive video recorder and recording system in accordance with an exemplary embodiment of this invention;

[0010] **FIG. 2** is a block diagram depicting an exemplary on board system with an integrated diagnostic, telemetry and recording system; and

[0011] **FIG. 3** depicts an exemplary data flow diagram an exemplary locomotive video recorder and recording system.

### DETAILED DESCRIPTION OF AN EXEMPLARY EMBODIMENT

[0012] Disclosed herein is a locomotive video recorder and recording system comprising a combination of video technologies, wireless information systems, and locomotive transportation systems which enable configurable event



based, image and parameter data recording, remote monitoring, and diagnostic services that aid in resolving various railroad transportation issues. Referring to **FIG. 1**, the locomotive video recorder and recording system shown generally as **5** comprises an on-board group of systems **200** and “off-board” systems **300**. An event recorder functionality includes recording and transmitting relevant video, geographic data, and locomotive operating parameters to assist in resolving issues related to RR crossing accidents, train derailments, collisions, and wayside equipment inspection and maintenance. In addition, this video recorder and recording system **5** can be used to perform remote monitoring and diagnostics of track conditions, wayside equipment, and operator train management.

[0013] The data collection, processing, and wireless transmission provided by the locomotive wireless video recorder and recording system **5**, enable a user to quickly respond to issues that occur in and around the many locomotives moving throughout a railroad network. Event data transmission may be configured to occur based on various locomotive conditions, geographic locations, and situations. In addition, event data may be either pulled (requested) or pushed (transmitted) from the locomotive. For example, data can be sent from a locomotive to an off-board data and monitoring center **310** based on selected operating conditions (e.g., emergency brake application), geographic location (e.g., in the vicinity of a railroad crossing), selected or derived operating areas of concern (e.g., high wheel slip or locomotive speed exceeding area limits), or time driven messages (e.g., sent once a day). An off-board central monitoring and data center **310** may also request and retrieve the data from specific locomotives on demand.

[0014] Wireless communication connectivity also enables the off-board data and monitoring center **310** to provide additional functions including remote monitoring and diagnostics of the system and remote configuration management of the mobile on-board systems **200**.

[0015] **FIG. 2** is a block diagram depicting an exemplary on board system **200** with integrated diagnostic, telemetry, and video recording system **5** hereinafter denoted system **5**. The system **5** includes a management unit or processor, hereinafter denoted management unit **10**, which provides command and control of various interfaces and processes as may be accomplished. In addition, the management unit **10** may further include diagnostics and event recording capabilities. Event recording, for example, determines selected parameters to observe, evaluate, and if desired save or record.

[0016] The management unit **10** may include, without limitation, a computer or processor, logic, memory, storage, registers, timing, interrupts, and the input/output signal interfaces as required to perform the processing prescribed herein. The management unit **10** receives inputs from various sensors and systems and generates output signals thereto. **FIG. 3** depicts the top-level block diagram of the processing functions and data flow of the integrated diagnostic, telemetry and recording system **5**. It will be appreciated that while in an exemplary embodiment most processing is described as resident in the management unit **10**, such a configuration is illustrative only. Various processing and functionality may be distributed among one or more system elements without deviating from the scope and breadth of the claims.

[0017] In an exemplary embodiment, the management unit **10** performs or facilitates the following processes:

- [0018] Collection of data from various inputs (video, GPS, locomotive data);
- [0019] Processing of data;
- [0020] Recordation and Storage of data;
- [0021] Logical computations to determine appropriate system actions (send data, file management, video controls);
- [0022] Control of video equipment (on/off, time and location activation, image quality settings, etc);
- [0023] Association of audio/video data with parameter and event data;
- [0024] Interfaces with the wireless network;
- [0025] Processes commands from the off-board data and monitoring center; and
- [0026] System diagnostics and health status.

[0027] The event recording capability of the management unit **10** receives locomotive data from the locomotive system **18** including, but not limited to acceleration, speed, direction, braking conditions, wheel slip and the like. The management unit **10** and/or a data storage **12** may continually direct and facilitate the storage of various locomotive data in the data storage **12** on a first-in, first-out basis. This allows the system to capture locomotive data leading up to an event. Alternatively, the management unit **10** may initiate storing locomotive data in the data storage **12** upon detection of an event or via operator control on-board the locomotive or from a off-board data and monitoring center **310**. Detection of an event is performed using known techniques (e.g., vehicle sensors, such as accelerometers, speed sensors, locomotive operational sensors, and the like).

[0028] The management unit **10** in performing the above-mentioned processes may utilize various signals along with and in comparison to a database of stored information (described below). The database **32** may be employed to facilitate correlation of selected data with a selected or specified events. Moreover, the database **32** may be employed to identify a type of event or events and a selected set of images, operational parameter, or environmental parameter data that is preferably associated or relevant to such an event. The database **32** may be utilized for example, to determine not only the position that the train occupies on the railway track but also the location relative to the position of the train of an upcoming target of interest or desired input for event and video recording. For example, a wayside signal device, crossing, bridge, curve in the track, and the like. This information may be used to determine gating of sensors, or the cameras **142** of the audio/video system **14**, for example, in an exemplary embodiment, the management unit **10** determines where the train is located in relation to the track route location data stored in the abovementioned onboard database **32**. Through such processing, the geographical coordinates of the train may be compared with the abovementioned database information to determine not only on which track the train is traveling but also the particular segment and position that the train occupies on that track.



[0029] When the management unit **10** has determined or established the expected location and position of a desired input, e.g., upcoming crossing, wayside signaling device, and the like, the management unit **10** may optionally direct the audio video system **14** and the sensing means **142**, e.g., camera or particular camera to focus on the upcoming desired input, for example, an up coming wayside signal device. Additionally, the management unit **10** may direct recordation of selected parameters related to the operation of the locomotive or environmental parameters and data. These data may then readily be associated with selected video data to provide detailed insight into the operation of the locomotive and past events.

[0030] In another exemplary embodiment, the management unit **10** may be employed to facilitate operation of an on-board system diagnostics and health monitoring for the system **5**, or components thereof. For example, in an exemplary embodiment, the management unit **10**, data storage **12** and a communication system **50** may be employed to detect, store, and transmit to the off-board central data center **310** relevant operating system parameters and information such as diagnostics and/or failure of the management unit **10**, data storage or other components of the system **5**. The diagnostics may further identify component status, and failure or inoperability including, but not limited to, loss of power loss or operation of the audio/video system **14** and components thereof, loss of imaging data, time, and location of failures.

[0031] The on-board systems **200** may also include data storage **12**. The data storage **12** is configured to exhibit sufficient capacity to capture and record data to facilitate performance of the functions disclosed herein. The data storage **12** provides of suitable storage capacity, such as 2 gigabytes of memory in a exemplary embodiment. In one embodiment, the data storage **12** uses flash memory. Data storage **12** may also include non-volatile random access memory (RAM). Moreover, as part of the data storage **12**, in one configuration, the management unit **10** may include non-volatile memory for storage of diagnostic and status data.

[0032] As shown in **FIG. 2**, the data storage **12** includes a housing **13**, with the housing preferably protecting a data storage device **12** against mechanical and electrical damage during an event (e.g., selected locations, operating conditions, or an accident involving the locomotive) to preserve data held in data storage device **12**. The data storage device **12** is preferably a solid-state, non-volatile memory of sufficient storage capacity to provide long-term data storage of the locomotive data, environmental data, video data and audio data for a significant period of time (e.g., 15 minutes) associated with a selected event. Once again, it will be appreciated that while the data storage device **12** are described herein as separate entities from the management unit **10** either or both could be configured to be separate or combined, as well as being combined with other elements of the system **5** disclosed herein. Additionally it should be appreciated the while a particular partitioning of the processing and functionality is disclosed herein, such partitioning is illustrative only to facilitate disclosure. Many other arrangements and partitions of like functionality may now readily be apparent.

[0033] The data storage **12** may also utilized to store a database **32** composed of a variety of information that may

be used in conjunction with data and parameters acquired. In particular, the database may be employed to correlate acquired data with a selected event or events. For example, the database may be employed in cooperation with a navigation system **20**, for example, a Global Positioning System (GPS) to facilitate position determination, localizing, and determination or evaluation for gating of data and video recording functions as a function of position, location, time, wayside status, and the like, as well as combinations including at least one of the foregoing. The database may include data including, but not limited to: (i) the locations of railway track routes, and track mapping (ii) the locations and orientations of curves and switches in those railway track routes, (iii) the location of each wayside device on each railway track route, (iv) the type of each wayside device (e.g., crossing gates, switches, signals, background shape, number of lights, possible color combinations), (v) the direction which each wayside device points (e.g., eastbound or westbound, etc.) and the particular track to which each wayside device relates (e.g., main track or siding), (vi) the position of each wayside device with respect to the particular track and the direction which the train is traveling (e.g., to the right, left, overhead), (vii) the distance from each wayside device at which imaging of the object should start, and (viii) the operation of the wayside device (e.g., lights are operating, horn or bell is operating, the crossing gate arms are moving etc.). As explained below, the database may also feature data pertaining to (x) the location of every highway or other type of crossing on all relevant railway track routes and (xi) the distance from each crossing at which imaging should start. This location data is pegged to the identity of each railway route typically by reference to milepost distances. Moreover, the database may include various operational and environmental parameters associated with a various types of events. The database **32** may be employed to identify a for particular type of event, the environmental and operational parameter data that would be relevant to a selected event.

[0034] Coupled to the data storage **12**, and optionally to the management unit **10** is an audio/video system **14**. The audio/video system **14** generates audio data and video data that is either stored directly in the data storage **12** or stored in coordination with operational and environmental parameter data available in the system **5**. In an exemplary embodiment, the audio/video system **14** acquires digital audio and digital video information. However, optionally analog equipment may be employed. The audio/video system **14** includes one or more cameras and/or microphones directed as desired to obtain desired video and audio information. The audio/video system **14** includes a input or sensing means **142** that can for example, take the form of any one of a variety of known cameras and/or microphones including the types of cameras that feature aiming and zooming mechanisms that can be externally controlled to aim the camera at an upcoming object with high clarity even at relatively long distances. Further, in an exemplary embodiment, a sensing means **142** with control of lighting effects, resolution, volume control for audio, frequency of imaging, data storage, and information concerning audio/video system parameters may be utilized. The sensing means **142** e.g., camera and/or microphone, is used to generate a video signal indicative of an image of the object, such as an upcoming wayside device, crossing, or track conditions onto which it is focused. Additionally, the audio/video system **14** and



more particularly the sensing means **142** may further take advantage of video technologies that facilitate low/no light image collection or collection of specific images. For example infrared and detection of specific images, e.g., flashing red crossing lights.

[0035] The audio/video system **14** may also include a processing means **144** that may take the form of any one of several types of hardware and software embodiments known in the signal processing art for handling and processing the captured data. Using any number of well established signal processing techniques, the processing means **144** is to be used to process the video signals generated by the sensing means e.g., camera(s) and/or microphones **142** so that the upcoming wayside signal device, the signal aspect information therefrom, crossing, or track conditions, is rendered discernable. The particular techniques and hardware/software implementation selected for the processing means **144** is well known and a function of desired capabilities, characteristics, cost, and the like.

[0036] The audio/video signal generated by the sensing means **142** e.g., camera and/or microphone may be processed by the processing means **144** in an attempt to render the upcoming desired input, as well as any information appearing thereabout, discernable. Further, the processing may include a determination of characteristics of the upcoming desired input, for example, particular signal information, crossing status or obstruction, crossing gate status, crossing gate light status, crossing gate audible warning, and the like.

[0037] The sensing means **142** e.g., camera(s) and/or microphone(s) may be directed out the front of the locomotive. Additionally, sensing means **142** may be directed to either side, or to the rear of the locomotive or multiple cameras may be used to capture images from multiple areas. Such a configuration preserves a visual record of the wayside signaling information, crossing status, and items on or near the track in the event of a mishap. Moreover, and in conjunction with the event and data recording capability of the management unit **10**, the video data may be captured and stored in a universal time-tagged manner with other locomotive parameters, such as diagnostics, and locomotive operational characteristics and parameters to facilitate incident investigation and operator evaluation. Additionally, one or more microphone(s) may be employed to record audio such as, wayside equipment lights, sound and operation, locomotive operational sounds, or the application of the locomotive horn.

[0038] The audio/video system **14** may optionally feature a display unit **146** to show the train operator a wide variety of data intelligence gathered or information to facilitate operation or diagnostics of the locomotive. The display unit **146** may feature selected video data and operational parameters including, but not limited to, wayside signal aspects, speed, power and the like. The display unit **146** may also feature a graphical display used to provide the train operator with the actual video image generated by the camera(s) **142**. It may also be used to display supplemental information such as the profile of the upcoming portion of railway track, the estimated distance required to brake the train, the territorial coverage of the railway operating authority or other data, and the like.

[0039] The audio/video system **14** may also be used to detect and react to obstructions on the railway track. This

configuration would assist operators of trains that travel along railway routes that intersect with highways or other types of railway track crossings.

[0040] The video data and audio data (if used) may be stored continuously in the data storage **12** on a first-in, first-out basis employing a continuous looping approach. Upon occurrence of an event, the audio/video data is preserved in data storage **12**. This enhances the ability to determine the cause of an event. The capacity of the data storage **12** can be increased as required to store additional audio/video data or locomotive data. Again, this allows the management unit to direct the recording of a predetermined amount of video/audio data leading up to an event. Alternatively, the audio/video system **14** may be configured to initiate imaging/observing, and transmitting video/audio data to the data storage **12** for recordation upon detection of an event, selected event, or based upon operational and environment parameters and the like.

[0041] By collecting locomotive data, audio/video data, and environmental data, and the like in data storage **12**, the integrated diagnostic, telemetry and video recording system **5** facilitates analysis of locomotive events. The addition of environmental and locomotive operating parameter data stored in the same data storage **12** simplifies configuration of the system **5**, integration, and further enhances the ability to investigate locomotive events. Moreover, as disclosed herein, linking the storage and event or data recording capabilities as disclosed with a remotely configurable communications system **50** further facilitates data capture, analysis and incident investigation as may be directed by an off-board data and monitoring center **310**.

[0042] Continuing now with **FIGS. 1 and 2**, the integrated diagnostic, telemetry and video recording system may further include a communications system **50** integrated with data storage **12** and optionally the audio/video system **14** and management unit **10**. In an exemplary embodiment, the communications system **50** includes multiple communications systems employed as may facilitate a particular communication or environment including, but not limited to wireless satellite communications system, a cellular communications system, radio, private networks, a Wireless Local Area Network WLAN, and the like, as well as combinations including at least one of the foregoing. In an exemplary embodiment the wireless communication system may be employed to transmit image data, environmental and operational parameter data corresponding to a selected event or events to the off-board data and monitoring center **300**.

[0043] The wireless communication system **50** may comprise an onboard receiver **52** and transmitter **54**. The wireless communication system **50** provides a means to transmit the data between locomotives and from the locomotive to an off-board processing center **300**. Optionally, the wireless communications system may be employed for communication to the system **5** for diagnostics, data downloads, uploads and the like. Additionally, the wireless communication system **50** provides a means to receive commands and requests from the off-board processing center **300**. For example commands pertaining to transmission protocol, channel, transmission format, transmission timer, packet size, frequency, and the like as well as combinations including at least one of the foregoing. Moreover, data may also be



retrieved from the locomotive mounted management unit **10** via manual (wired) interfaces and downloads to another computer or even management unit **10** memory removal.

[0044] Continuing once again with **FIGS. 1 and 2**, the integrated diagnostic, telemetry and video recording system **5** may further include a navigation system **20**. The navigation system **20** may be employed to determine the position of the train/locomotive occupies on the globe. In an exemplary embodiment, the navigational system takes the form of a Global Positioning System hereinafter GPS, which can receive signals and determine global coordinates, such as latitude and longitude, directional information, velocity and time. The GPS provides geographic, movement, and time data to the management unit **10** to facilitate correlation of selected image, operational and environmental parameter data with a chronological time and/or geographic location. Time tag data may include, but not be limited to, chronological time, time of transmission and the like. Geographic data may include, but not be limited to, latitude, longitude, velocities and the like. In an exemplary embodiment, the GPS system includes, but is not limited to a locomotive mounted antenna and receiver/computer that processes signals from low earth orbiting satellites to provide the above-mentioned data.

[0045] In an exemplary embodiment, the GPS receiver should preferably be accurate enough to identify a curve or a switch on which the train is located. Thus, the data that the GPS receiver itself may provide may only be an approximation of the exact position of the train. The GPS may further be coupled with other navigational aids to further facilitate accurate position location and determination. The GPS information may further be coupled with the stored information about the track to further facilitate a determination of where the locomotive, (and thereby the train) is on the track relative to fixed waypoints or entities, for example a wayside signaling device or crossing.

[0046] The locomotive system **30** includes, but is not limited to, various sensor and data sources that provide inputs to the data storage **12** and/or management unit **10**. One source is the locomotive control system that provides data about the operational performance and status of the locomotive. For example, data on power commands, engine speed, locomotive speed, traction feedback, pneumatic brakes, brake pressures, dynamic braking, load, throttle, operating faults, ambient temperature, commanded parameters and the like. Another data source is the locomotive “trainlines”—these (discrete) signals run between locomotives in a train and provide operation status of the locomotive. For example, the “trainlines” include data on operator’s power/brake command, direction call, power mode, and the like. Moreover, data can also be collected directly from various locomotive and environmental sensors **40**, control circuits and devices, e.g., track geometry monitors, smoke and fire detectors, chemical or fuel detectors, engine on relay and emergency brake relay or other data collection devices, such the data event recorder, locomotives horn and bell indication and the like. Other environmental and operational parameters that may be observed and recorded may include but not be limited to: weather conditions, e.g., rain, snow, fog, and the like; horn and lights, track conditions, track topology, elevation direction and heading.

[0047] Returning to **FIGS. 1 and 2**, the off-board data processing center **300** interfaces with the wireless commu-

nication system and manages the files and commands to and from the locomotives. The off-board data processing center **300** employs a wireless communications system **320** to interface with on-board systems. The wireless communication system **320** may include but not be limited to a transmitter and receiver for satellite communications, radio, cellular, and the like, as well as combinations including at least one of the foregoing. The off-board data processing center **300** processes the data into valuable data for the users. A monitoring and diagnostic service center (MDSC) **310** processes the data collected by the system and provides the event replay services and diagnostic recommendations. The MDSC also uses the system to perform remote monitoring of the locomotive and surrounding elements such as the rail, signaling, and crossing equipment. The MDSC **310** with the communications system **320** transmits request to the on board systems **200** for selection of desired images, environmental and operational parameter data. Advantageously, the system may be employed to select specified data to be stored and/or transmitted to the off-board MDSC **310** under selected conditions such as when the locomotive approaches or reaches a desired location, wayside signaling device, at a specified time, and the like. The MDSC **310** may also be employed to remotely modify the configuration of the onboard communications system **50**. The MDSC also monitors the health of the audio/video system **14**, locomotive system **30**, navigational system **20**, and a wireless communications system **50** and performs required maintenance (e.g., hardware and software version tracking). Raw data and diagnostic recommendations are exchanged with various customers by the MDSC via web pages or business-to-business file transfers.

[0048] The management unit **10**, data storage **12**, audio/video recording system **14**, communications system **50**, navigation system **20**, locomotive control system **18** and environmental sensors **40** may be powered during normal operation from a locomotive power supply  $V_L$ . The source of locomotive power supply  $V_L$  may be a generator driven by the locomotives engine. The management unit **10**, data storage **12**, audio/video recording system **14**, communications system **50**, and navigation system **20**, may optionally include auxiliary power supplies such as batteries **34**. During failure or disruption of the locomotive power supply  $V_L$ , auxiliary power supplies **34** are utilized to facilitate continued operation. Alternatively, instead of separate auxiliary power supplies for each component, an auxiliary power supply could supplement locomotive power supply  $V_L$  in the event of a failure or disruption locomotive power supply  $V_L$  to supply selected components of the system **5**. In an exemplary embodiment, the data storage **12** and audio/video recording system **14** may be powered with auxiliary power supplies **34**. Optionally, the management unit **10**, communications system **50**, navigation system **20**, locomotive control system **18** and environmental sensors **40** may also be powered with one or more auxiliary power supplies **34**.

[0049] It will be understood that a person skilled in the art may make modifications to the preferred embodiment shown herein within the scope and intent of the claims. While the present invention has been described as carried out in a specific embodiment thereof, it is not intended to be limited thereby but is intended to cover the invention broadly within the scope and spirit of the claims.



What is claimed is:

1. A video recorder system carried on-board a railroad locomotive for recording images relating to events of interest in a vicinity of the locomotive and transmitting the images to a location off-board of the locomotive, the system comprising:

a camera mounted on the locomotive for imaging an environment in a vicinity of the locomotive, said camera transmitting imaging data indicative of images acquired;

data storage on-board the locomotive in communication with said camera for storing said imaging data;

a processor on-board the locomotive in communication with said data storage for identifying and retrieving selected imaging data of interest from said data storage; and

a wireless communication transmitter on-board the locomotive in communication with said processor for transmitting signals associated with said selected imaging data of interest to a location off-board of the locomotive,

wherein images relating to an event of interest are communicated to the off-board location.

2. The video recorder system of claim 1 wherein at least one of operation of said camera, storing of said imaging data, and said transmitting of said imaging data is initiated by a parameter indicative of the occurrence of an event, to provide said imaging data to said off-board location on a near real time basis to said event of interest.

3. The video recorder system of claim 2 wherein said parameter comprises at least one of: activation of a locomotive horn, activation of pneumatic brakes, activation of dynamic braking, change of load on locomotive engine, change of an engine throttle setting, and change of an engine speed.

4. The video recorder system of claim 1 further including a wireless communication receiver on-board the locomotive in communication with said transmitter at a location off-board of the locomotive said receiver receiving signals from said transmitter at said location off-board to direct operation of a wireless communication transmitter on-board the locomotive.

5. The video recorder system of claim 1 wherein said off-board location is a data center remote from the locomotive.

6. The video recorder system of claim 1 wherein said camera is an infrared camera.

7. The video recorder system of claim 1 further comprising a microphone for monitoring sound associated with the events of interest and transmitting audio data to said data storage device, wherein said processor correlates said audio data with said imaging data associated therewith.

8. The video recorder system of claim 1 wherein said imaging data acquired, identified and retrieved is displayed on the locomotive.

9. The video recorder system of claim 1 wherein the locomotive has a primary electrical power supply and the video recorder system comprises an auxiliary electrical power supply that is separate and independent in its operation from said primary power supply, with said auxiliary

electrical power supply providing electrical power to said camera, said processor, said data storage and said wireless communication transmitter.

10. The video recorder system of claim 9 wherein the auxiliary power supply provides electrical power to at least one of said processor, said wireless communication transmitter.

11. A video recorder system carried on-board a railroad locomotive for recording images relating to events of interest in a vicinity of the locomotive while being controlled from a location off-board of the locomotive, the system comprising:

a camera mounted on the locomotive for imaging an environment in a vicinity of the locomotive said camera transmitting imaging data indicative of images acquired;

data storage on-board the locomotive in communication with said camera for storing said imaging data;

a processor on-board the locomotive in communication with said camera said data storage for controlling operation thereof; and

a wireless communication receiver on-board the locomotive in communication with said processor and a transmitter at a location off-board of the locomotive said receiver receiving signals from said transmitter at said location off-board to direct operation of said camera and storage of said imaging data in said data storage,

wherein images relating to an event of interest in the vicinity of the locomotive, which are of interest at said location off-board are acquired and captured in said data storage upon direction therefrom.

12. The video recorder system of claim 11 wherein said location off-board transmits signals for changing a configuration of the video recorder system on-board the locomotive.

13. The video recorder system of claim 12 wherein said configuration comprises at least one of camera zoom, camera angle, camera focus, lighting effects, image resolution, frequency of imaging signal, data storage parameters, and data storage location.

14. The video recorder system of claim 11 wherein the locomotive has a primary electrical power supply and the video recorder system comprises an auxiliary electrical power supply that is separate and independent in its operation from said primary power supply, with said auxiliary electrical power supply providing electrical power to said camera and said data storage.

15. The video recorder system of claim 14 wherein the auxiliary power supply provides electrical power to at least one of said processor, said wireless communication transmitter.

16. The video recorder system of claim 11 further comprising a microphone for monitoring sound associated with the events of interest and transmitting audio data to said data storage device, wherein said processor correlates said audio data with said imaging data associated therewith.

17. The video recorder system of claim 11 wherein said location off-board is a data center remote from the locomotive.

18. A video recorder system carried on-board a railroad locomotive for transmitting images relating to events of interest in a vicinity of the locomotive while being controlled from a location off-board of the locomotive, the system comprising:



a camera mounted on the locomotive for imaging an environment in a vicinity of the locomotive said camera transmitting imaging data indicative of images acquired;

data storage on-board the locomotive in communication with said camera for storing said imaging data;

a wireless communication transmitter on-board the locomotive for transmitting imaging data to a location off-board of the locomotive;

a processor on-board the locomotive in communication with said wireless communication transmitter, and said data storage for controlling their operation;

a wireless communication receiver on-board the locomotive in communication with said processor and a transmitter off-board of the locomotive, said receiver receiving signals from said location off-board to access said imaging data stored in said data storage and transmit said imaging data to said location off-board; and

wherein images relating to an event of interest in the vicinity of the locomotive, which are of interest at said location off-board of the locomotive are transmitted to said location off-board upon direction therefrom.

**19.** The video recorder system of claim 18 wherein said transmitter off-board transmits signals for changing a configuration of said wireless communication transmitter on-board.

**20.** The video recorder system of claim 19 wherein said configuration comprises at least one of transmission protocol, transmission channel, transmission timer and data packet size.

**21.** The video recorder system of claim 20 further comprising a microphone for monitoring sound associated with the events of interest and transmitting audio data to said data storage device, wherein said processor correlates said audio data with said imaging data associated therewith.

**22.** The video recorder system of claim 18 further including said camera in communication with said processor for direction and selection of images relating to an event of interest in the vicinity of the locomotive.

**23.** A video recorder system carried on-board a railroad locomotive for recording images relating to events of interest in the vicinity of the locomotive and a time of occurrence such images and events, the system comprising:

a camera mounted on a locomotive for imaging an environment in a vicinity of the locomotive said camera transmitting imaging data indicative of images acquired;

data storage on-board the locomotive in communication with said camera for storing said imaging data;

a wireless receiver on-board the locomotive receiving signals indicative of a chronological date and time, constituting time tag data, at a time of transmission of the signals; and

a processor on-board the locomotive in communication with said wireless communication receiver, and said data storage to correlate time tag data with said imaging data,

wherein said time tag data are correlated with associated image data of said event of interest.

**24.** The video recorder system of claim 23 wherein said signals indicative of a chronological date and time are provided by a GPS satellite.

**25.** The video recorder system of claim 24 further comprising a wireless communication transmitter on-board the locomotive in communication with said processor for transmitting said imaging data and time tag data associated therewith to a location off-board of the locomotive.

**26.** The video recorder system of claim 25 wherein said processor activates said wireless communication transmitter to transmit said imaging data and time tag data at instances based on said imaging data and time tag data received from said GPS satellite.

**27.** The video recorder system of claim 23 further comprising a microphone for monitoring sound associated with the events of interest and transmitting audio data to said data storage device, wherein said processor correlates said audio data with said imaging data associated therewith.

**28.** The video recorder system of claim 23 further including said camera in communication with said processor for direction and selection of images relating to an event of interest in the vicinity of the locomotive and a time of occurrence such images and events.

**29.** A video recorder system carried on-board a railroad locomotive for recording images relating to events of interest in the vicinity of the locomotive and a location of such events, the system comprising:

a camera mounted on a locomotive for imaging an environment in a vicinity of the locomotive said camera transmitting imaging data indicative of images acquired;

data storage on-board the locomotive in communication with said camera for storing said imaging data;

a global positioning system wireless receiver on-board the locomotive receiving signals indicative of a location of the locomotive; and

a processor on-board the locomotive in communication with said global positioning system wireless receiver, and said data storage to correlate location data with associated imaging data;

wherein location data indicative of a location of the locomotive at which an event of interest occurred are associated with imaging data therefrom.

**30.** The video recorder system of claim 29 wherein said processor activates said data storage to record said imaging data when the locomotive travels to a predetermined location.

**31.** The video recorder system of claim 29 further including said camera in communication with said processor for direction and selection of images relating to an event of interest in the vicinity of the locomotive and a time of occurrence such images and events.

**32.** The video recorder system of claim 29 further comprising a wireless communication transmitter on-board the locomotive in communication with said processor for transmitting signals indicative of said imaging data to a location off-board, with said processor activating said wireless communication transmitter when the locomotive travels to a predetermined location.

**33.** The video recorder system of claim 29 wherein said processor activates said camera to image selected imaging data when the locomotive travels to a predetermined location.



**34.** The video recorder system of claim 33 further comprising a track map database including wayside site location information, with said processor being in communication with said track map database and locating the locomotive relative to a wayside site of interest and activating said camera to image and said data storage to record said imaging data when the locomotive is in a vicinity of a site of interest.

**35.** The video recorder system of claim 34 wherein the camera acquires said imaging data relative to operation of wayside equipment at said site of interest.

**36.** The video recorder system of claim 34 wherein said camera acquires said imaging data relative to non-railway objects at said site of interest.

**37.** The video recorder system of claim 29 further comprising a microphone for monitoring sound associated with the events of interest and transmitting audio data to said data storage device, wherein said processor correlates said audio data with said imaging data associated therewith.

**38.** A video recorder system carried on-board a railroad locomotive for recording images and a plurality of sets of locomotive operating parameter data relating to an event of interest in a vicinity of the locomotive, with said event being one of a plurality of types of events and said parameter data being organized in different sets of data, the system comprising:

- a camera mounted on the locomotive for imaging an environment in a vicinity of the locomotive, said camera transmitting imaging data indicative of images acquired;

- a plurality of sensors disposed on-board the locomotive for monitoring a plurality of operating parameters of the locomotive, generating operating parameter data indicative of such parameters and transmitting such operating parameter data;

- data storage on-board the locomotive in communication with said camera for storing said imaging data, said data storage in communication with said plurality of sensors for storing said operating parameter data;

- a database identifying a type of event of said plurality of types of events and a set of parameter data of relevance to a selected type of event respectively; and

- a processor on-board the locomotive in communication with said data storage, and said database; and

wherein said processor associates a selected set of parameter data of relevance to a selected set of imaging data for said event.

**39.** The video recorder system of claim 38 wherein said set of locomotive operating parameter data comprise at least one of: locomotive speed data, pneumatic braking data, dynamic braking data, engine throttle notch setting data, wheel slip data, engine load data, fuel level data, and track curvature detection data.

**40.** The video recorder system of claim 38 further comprising a wireless receiver on-board the locomotive in communication with said processor for receiving signals from a location off-board of the locomotive for reconfiguring said data base to associate said types of events and said sets of locomotive operating parameter data differently.

**41.** A video recorder system carried on-board a railroad locomotive for recording images and sets of environmental parameter data relating to an event of interest in a vicinity of

the locomotive, with said event being one of a plurality of types of events and the environmental data being organized in different sets of data, the system comprising:

- a camera mounted on a locomotive for imaging an environment in a vicinity of the locomotive, said camera transmitting imaging data indicative of images acquired;

- a plurality of sensors disposed on-board the locomotive for monitoring a plurality of the environmental parameters occurring in the vicinity of the locomotive, said plurality of sensors generating environmental data indicative of such environmental parameters and transmitting such environmental data;

- data storage on-board the locomotive in communication with said camera for storing said imaging data, said data storage in communication with said plurality of sensors for storing said environmental data;

- a database identifying a type of event of said plurality of types of events and a set of environmental parameter data of relevance to a selected type of event; and

- a processor on-board the locomotive in communication with said data storage, said plurality of sensors, and said data base; and

- said processor associating a selected set of environmental parameter data of relevance to a selected set of imaging data for said event.

**42.** The video recorder system of claim 41 wherein said set of environmental parameter data comprises at least one of: data generated at a camera at a side of the locomotive, a camera on a railcar moved by the locomotive, a smoke detector and a microphone.

**43.** The video recorder system of claim 41 wherein said environmental parameter data relevance is comprises at least one of: weather condition data, track condition data, track topography data, elevation data, locomotive direction data and locomotive heading data.

**44.** The video recorder system of claim 41 further comprising a wireless receiver on-board the locomotive in communication with said processor for receiving signals from a location off-board of the locomotive for reconfiguring said data base to associate said types of events and said sets of environmental parameter data differently.

**45.** A video recorder system carried on-board a railroad locomotive for recording images and sets of video recorder system operating parameter data relating to a health of the video recorder system, the system comprising:

- a camera mounted on a locomotive for imaging an environment in a vicinity of the locomotive and for transmitting imaging data indicative of images acquired;

- a plurality of sensors for monitoring a plurality of operating parameters of the video recorder system, said plurality of sensors generating operating parameter data indicative of said operating parameters and transmitting such operating parameter data;

- data storage on-board the locomotive in communication with said camera for storing said imaging data, said data storage in communication with said plurality of sensors for storing said operating parameter data;



a processor on-board the locomotive in communication with said data storage, said plurality of sensors to identify and retrieve relevant system operating parameter data, wherein operating parameter data indicative of the health of the system are recorded.

**46.** The video recorder system of claim 45 further comprising a wireless communication transmitter on-board the locomotive in communication with said processor for transmitting data indicative of the health of the video recorder system to a location off-board of the locomotive.

**47.** The video recorder system of claim 45 wherein said operating parameter data comprises: data indicative of a loss of electrical power to the system, loss of camera functionality, loss of imaging data, time of system failure, location of system failure, processor failure, and data storage failure.

**48.** A method of video and data recording with a video recorder system for recording images relating to events of interest in a vicinity of locomotive and transmitting the images to a location off-board of the locomotive, the method comprising:

imaging an environment in a vicinity of the locomotive with a camera mounted on the locomotive, said camera transmitting imaging data indicative of images acquired;

storing said imaging data in data storage on-board the locomotive in communication with said camera;

identifying and retrieving selected imaging data of interest from said data storage with a processor on-board the locomotive in communication with said data storage; and

transmitting signals associated with said selected imaging data of interest to a location off-board of the locomotive with a wireless communication transmitter onboard the locomotive in communication with said processor.

**49.** The method of claim 48 further including receiving signals from a transmitter at said location off-board to direct operation of said camera and storage of said imaging data in said data storage with a wireless communication receiver onboard the locomotive in communication with said processor and a transmitter at a location off-board of the locomotive said receiver,

wherein images relating to an event of interest in the vicinity of the locomotive, which are of interest at said location off-board are acquired and captured in said data storage upon direction therefrom.

**50.** The method of claim 48 further including receiving signals with a wireless communication receiver on-board the locomotive in communication with said processor and a transmitter off-board of the locomotive to access said imaging data stored in said data storage and transmitting said imaging data to said location off-board; and

wherein images relating to an event of interest in the vicinity of the locomotive, which are of interest at said location off-board of the locomotive are transmitted to said location off-board upon direction therefrom.

**51.** The method of claim 48 further including receiving signals indicative of a chronological date and time, constituting time tag data, at a time of transmission of the signals with a wireless receiver on-board the locomotive; and

wherein said time tag data are correlated with associated image data of said event of interest.

**52.** The method of claim 48 further including determining a location said locomotive with a global positioning system on-board the locomotive; and

wherein location data indicative of a location of the locomotive at which an event of interest occurred are associated with imaging data therefrom.

**53.** The method of claim 48 further including:

monitoring a plurality of operating parameters of the locomotive;

generating operating parameter data indicative of such parameters;

identifying a type of event of a plurality of types of events and a set of parameter data of relevance to a selected type of event respectively; and

associating a selected set of parameter data of relevance to a selected set of imaging data for said event.

**54.** The method of claim 48 further including:

monitoring a plurality of environmental parameters of and in the vicinity the locomotive;

generating environmental parameter data indicative of such parameters;

identifying a type of event of a plurality of types of events and a set of environmental parameter data of relevance to a selected type of event respectively; and

associating a selected set of environmental parameter data of relevance to a selected set of imaging data for said event.

**55.** The method of claim 48 further including:

monitoring a plurality of operating parameters of said video recorder system;

generating operating parameter data indicative of such parameters; and

identifying and retrieving relevant operating parameter data, wherein operating parameter data indicative of the health of the system are recorded.

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