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(54) **Apparatus to monitor traffic**

(57) Apparatus to monitor vehicle traffic in a road (15), comprising sensor means able to detect the presence of vehicles (14) passing along the road (15) and to emit corresponding transit signals. The sensor means are arranged at intervals along a carriageway of the road

(15) and are connected to transceiver means (11) able to receive and process the transit signals in order to generate corresponding processed signals and to send them to at least a control unit (12), which is able to coordinate the transceiver means (11) and is connected to an operational center (13) which controls the traffic.

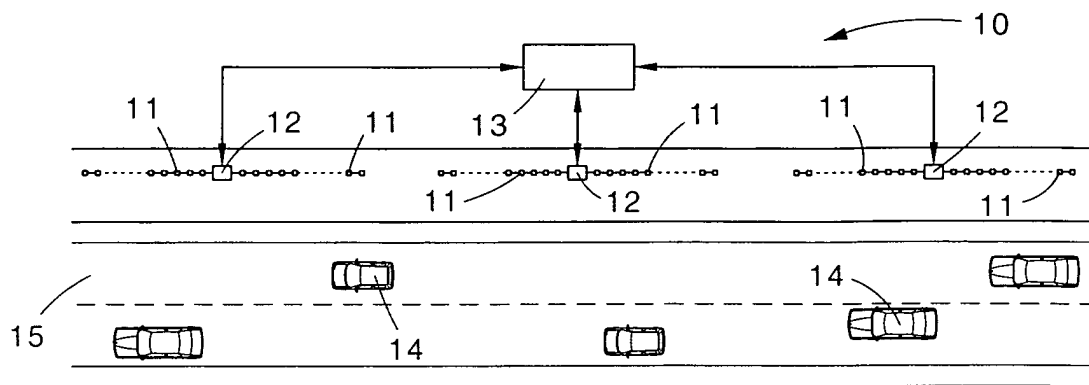


fig. 1

Description

FIELD OF THE INVENTION

[0001] The present invention concerns an apparatus to monitor vehicle traffic in a road, such as a motorway, a main road or suchlike, with which it is possible to control and manage in real time both the traffic of vehicles in movement and also any possible anomaly caused by accidents or otherwise. The monitoring apparatus according to the present invention uses devices which are easy to install and maintain, arranged along the road and able to be adapted to the different traffic conditions. Moreover, the apparatus can also be used in association with devices located on board the vehicles passing and able to transmit/receive service signals.

BACKGROUND OF THE INVENTION

[0002] It is known that, in order to monitor vehicle traffic, or to detect and signal an event along the road, such as a queue, an accident, a health emergency or suchlike, some cameras are positioned at determined points where the traffic is particularly heavy or dangerous; the cameras are connected to a control center, to which they send the images of the traffic.

[0003] The control center is connected to luminous panels located along the roads monitored. An operator coordinates and manages from the control center all the information to be supplied by means of the luminous panels, to signal to the road users the traffic situation on the roads they are driving along.

[0004] On the contrary, in zones not controlled by cameras, which are the majority, possible accidents are signaled only by the drivers themselves, who telephone the traffic control center or send urgent messages from the roadside emergency telephones arranged in fixed positions every two kilometers along the motorways or other main roads, which are also connected to the control center, in order to request intervention.

[0005] Devices to monitor traffic and to signal an accident have the disadvantage that they do not allow to signal a situation of heavy traffic situation or an accident in real time and in a sure manner to the vehicles which are approaching, so as to prepare the drivers to modify their driving conditions sufficiently in advance. Moreover the emergency telephones cannot be used if the people concerned are unable to move, as for example in the case of serious accidents, or motorway "pile-ups".

[0006] The Applicant has devised and embodied the present invention to overcome these shortcomings, and to obtain further advantages.

SUMMARY OF THE INVENTION

[0007] The present invention is set forth and characterized essentially in the main claim, while the dependent claims describe other innovative characteristics of

the invention.

[0008] One purpose of the invention is to achieve an apparatus to monitor vehicle traffic with which it is possible to identify anomalies in the traffic and possible accidents in real time and also in conditions of poor visibility.

[0009] Another purpose of the present invention is to achieve an apparatus with which to monitor the traffic in a continuous and uniform manner, in a whole section of road, even extensive.

[0010] A further purpose of the present invention is to achieve an apparatus to monitor vehicle traffic with which it is possible to signal anomalies in the traffic, practically in real time, also to vehicles which are upstream of the anomaly and which are not equipped with signaling devices or devices to receive alarms.

[0011] In accordance with these purposes, the apparatus according to the present invention comprises sensor means which are arranged at intervals along the carriageway of a road, to detect the presence of each vehicle passing along the road and to emit a corresponding transit signal. Transceiver devices, connected to the sensor means, are able to receive and process the transit signal in order to generate a corresponding processed signal and to send it to at least a control unit. The latter is able to coordinate the transceiver devices and send the processed signals to an operational traffic control center.

[0012] The transceiver devices are located in fixed positions at pre-determined distances from each other, between about 50 and 200 m along a road and are able to receive and process the signals arriving from the sensors.

[0013] The sensors used consist of seismographs, geo-graphs, microphones or suchlike, which are able to detect the elastic vibrations or the sound waves due to the passage of the vehicles. A pre-determined number of sensors, for example from 2 to 10, is connected to each transceiver device.

[0014] Each transceiver device, to which a code to identify position by the control unit is assigned, is connected chain-wise with other transceiver devices so as to form groups of about 10-40 units, managed by the control unit. Each transceiver device can send processed alarm signals or traffic anomaly signals, not only to the control unit but also to the other transceiver devices to which it is connected, or send and/or receive signals from vehicles provided with terminals for short-range transmission/reception. By short-range we mean a transmission radius of between about 50 and 200 meters.

[0015] When sudden variations in the type of vibration of the ground occur, or excessive noises with respect to a traffic situation considered normal and standard, the signals arriving from the sensors and processed by each transceiver device are interpreted as alarm signals. Each control unit receiving from and sending to the transceiver devices the various signals indicative of the

same interval between two vehicles, but translated in time, is able to evaluate, in real time, the certainty of the possible alarm. The alarm is sent in this way in real time from the control unit, through the operational center, to a road information service or an emergency center.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] These and other characteristics of the present invention will become apparent from the following description of a preferential form of embodiment, given as a non-restrictive example with reference to the attached drawings wherein:

- fig. 1 is a schematic representation of the apparatus to monitor traffic according to the present invention;
- fig. 2 is an enlarged and schematic detail of fig. 1;
- fig. 3 is a block diagram of a transceiver device in fig. 1;
- fig. 4 is a block diagram of a control unit in fig. 1;
- fig. 5 is a block diagram of a transceiver terminal in fig. 1;
- fig. 6 is a block diagram of a variant of the transceiver device in fig. 3;
- fig. 7 is a block diagram of a variant of the control unit in fig. 4;
- fig. 8 is a front schematic view of the transceiver device in fig. 6;
- fig. 9 is a graphic representation of transit signals over time.

DETAILED DESCRIPTION OF A PREFERENTIAL FORM OF EMBODIMENT OF THE INVENTION

[0017] With reference to fig. 1, the apparatus 10 to monitor vehicle traffic according to the present invention comprises a plurality of peripheral transceiver units 11 arranged at regular intervals on each side of a road 15, in which vehicles 14 are able to pass. The peripheral units 11 are connected to each other by cable so as to form groups of around 10-40 units. Each of these groups is managed by a corresponding central processing unit 12 or control unit, which is also located along the side of the road 15 in a substantially median zone between the different peripheral units 11 which it controls.

[0018] All the central processing units 12 are connected by cable both with each other and also with an operational center 13 from which the traffic situation is controlled over an entire road 15, even of a large extension.

[0019] Each vehicle 14 passing, especially in the case of heavy or high speed vehicles, at the moment when it passes over the road 15, causes a vibration in the ground and makes a noise. The vibrations and sound waves, which together we shall call transit signals ST, are detected and recorded by a plurality of sensors 16, in this case consisting of seismographs or geo-graphs located in the ground and/or microphones, infrared sensors, electromagnetic wave radar, ultrasound radar, lo-

cated on the side of the carriageway.

[0020] Each peripheral unit 11 (figs. 2 and 3) is connected to a set number of sensors 16, for example three, and comprises: a unit 17 to manage the sensors 16 in order to select and "clean" the transit signals ST; a first microprocessor 18 to process the transit signal ST to generate a processed signal SE; a first short-range radio transceiver 19; a memory 21, in which the code identifying the position of the peripheral unit 11 is memorized; and an interface 22 connected to a line 30 of the cable connection network, which is connected to the other peripheral units 11 and with the corresponding central processing unit 12. The same line 30 can be shared by several peripheral units 11 by means of a TDM (Time Division Multiplexing, i.e. a time division technique for sharing a transmission means/channel) or FDM (Frequency Division Multiplexing, i.e. a frequency division technique for sharing a transmission means/channel).

[0021] Each peripheral unit 11 is fed by means of an electric cable arranged in the line 30 connecting to the central processing unit 12, fed by the network of the operational center 13.

[0022] The plurality of transit signals ST, recorded by the sensors 16 nearest the point of transit of the vehicle on the road, is collected and managed by the unit 17 which manages the peripheral unit 11 connected thereto and processed by the first microprocessor 18.

[0023] The processed signal SE is transmitted from the peripheral unit 11 by means of the interface 22 to the connection network 30 and from this to the central processing unit 12 and/or, by means of the first transceiver 19, also to the vehicles 14 passing in the short-range area with respect to the peripheral unit 11, also provided with short-range transceiver terminals 23 (fig. 5) to receive or signal possible emergency situations.

[0024] The central processing unit 12 (fig. 4) comprises: a first interface 42 connected to the line 30 connecting to the peripheral units 11 to receive and/or send the processed signal SE; a second DSP microprocessor 24 (Digital Signal Processing, i.e. a processor for processing digital signals) to further process the processed signal SE to generate a first alarm signal SA and to identify the position of the accident or traffic anomaly; and a second interface 26 connected with the other central processing units 12 and the operational center 13. The first interface 42 can advantageously be equal to the interface 22 of the peripheral unit 11.

[0025] The central processing units 12 can advantageously be located in the roadside emergency telephones already present and already fed electrically, which are normally located every two kilometers along the roads 15.

[0026] Each central processing unit 12 is also equipped with sirens and/or flashing lights 25 to communicate visually possible accidents to all drivers, even to those vehicles 14 which are not equipped with transceiver terminals 23.

[0027] Each transceiver terminal 23 (fig. 5) installed on board a vehicle 14 comprises, for example, a second low power transceiver 27, in the range of 1-10 mW, for receiving a processed signal SE from a peripheral unit 11 and/or transmitting a second short-range alarm signal on the radio, for example on the 433 MHz band, or the 2.4 GHz radio frequency band, which are so-called free frequencies with greater capacity for traffic; a third microprocessor 28 to process the processed signal SE transmitted by the peripheral unit 11 to generate the second alarm signal; a led or alphanumerical display 29 and beepers to show the emergency situation inside the vehicle 14; a membrane keyboard 31 connected to the third microprocessor 28. The transceiver terminals 23 are of limited size, in the range of about 12x7x2 cm, and are fed at 12 or 24 V by means of a connector which can be connected to the electric feed socket of the vehicle 14 itself.

[0028] The apparatus 10 as described heretofore functions as follows: each peripheral unit 11 receives the transit signals $ST_1, ST_2, \dots, ST_n$ detected by the sensors 16 connected thereto. The transit signals ST can be similar to each other (fig. 9), as in the case of regular traffic, or different from each other in the case of traffic variations. The transit signals ST are processed by the peripheral units 11 into processed signals SE, which are sent to the peripheral unit 11 adjacent and upstream with respect to the first and/or central processing unit 12.

[0029] When an exceptional vibration of the ground, or an excessively high sound wave occurs, a peripheral unit 11 receives an anomalous processed signal SE directly from a peripheral unit 11 downstream which has detected this anomalous situation, or receives the first alarm signal SA from a central processing unit 12 or from a vehicle 14 equipped with a transceiver terminal 23.

[0030] In fact, each central processing unit 12 manages the processed signals SE arriving from all the peripheral units 11, so as to process and send the first alarm signal SA or warning signal to a peripheral unit 11 to warn of a possible accident, or to other central processing units 12 and to the operational center 13 to which it is connected.

[0031] According to a variant, (figs. 6-8), each peripheral unit 11 is also able to transmit and receive short-range signals by radio, on a frequency of 433 MHz, or 2.4 GHz, to/from an adjacent peripheral unit 11 or to a central processing unit 12, which is in a range of 50-200 meters, thus eliminating the connection cable of the peripheral units 11.

[0032] Each peripheral unit 11 also comprises a third transceiver 32 for the transmission and reception of processed signals SE from and to other peripheral units 11, and to the central processing unit 12, also provided with a third transceiver 32.

[0033] In this way each peripheral unit 11 receives processed signals SE from an adjacent peripheral unit downstream and transmits via radio to an adjacent peripheral unit 11 upstream. The processed signal SE is

transmitted from one peripheral unit 11 to the next as far as the central processing unit 12. In this case too each central processing unit 12 manages groups of about 10-40 peripheral units 11.

[0034] In this case, each peripheral unit 11 (fig. 8) is fed by means of a solar panel battery 36 and comprises an accumulator, connected to the solar panel 36, and a control unit 37 of the accumulator. The absence of connection cables makes it easier to position and locate the peripheral units 11 along the carriageway of the road 15.

[0035] Moreover, each peripheral unit 11 is provided with one or more cameras 40, able to film the events which occur along the road 15. The images taken are transmitted, for example, in a short-range from one peripheral unit to the other until they reach the central processing unit 12 and from this to the operational center 13 using the same connection network 30, to allow a control, even visual, of the situation of the vehicle traffic on the road 15.

[0036] According to another variant, not shown, each peripheral unit 11 comprises a GPS (Global Positioning System) localizing antenna and a card to decode and process the position coordinates, connected to the first microprocessor 18. In this way each peripheral unit 11 sends to another peripheral unit 11 and/or to the central processing unit 12 a processed signal SE associated with a signal indicating the position.

[0037] The positioning and repositioning of the peripheral units 11 is automatically configured by the GPS. The advantage of using GPS antennas is that in this way it is possible to eliminate the process of manually assigning the positioning of each peripheral unit 11 within the connection network which connects any peripheral unit 11 to the central processing unit 12.

[0038] It is clear however that modifications and/or additions of parts may be made to the apparatus to monitor traffic 10 as described heretofore, but these shall remain within the field and scope of the present invention.

[0039] For example in order to transmit the processed signals SE it is possible to use GSM or GPRS public networks or private networks in the 450/470 MHz band.

[0040] It is also clear that, although the present invention has been described with reference to specific examples, a person of skill shall certainly be able to achieve many other equivalent forms of apparatus, all of which shall come within the field of protection of the present invention.

Claims

1. Apparatus to monitor vehicle traffic in a road (15), comprising sensor means (16) able to detect the presence of vehicles (14) passing along said road (15) and to emit corresponding transit signals (ST), **characterized in that** said sensor means (16) are arranged at intervals along a carriageway of said

- road (15) and are connected to transceiver means (11) able to receive and process said transit signals (ST) in order to generate corresponding processed signals (SE) and to send them to at least a control unit (12), which is able to coordinate said transceiver means (11) and is connected to an operational center (13) which controls the traffic.
2. Apparatus as in claim 1, **characterized in that** said sensor means (16) comprise seismographs, geographs and/or microphones, able to detect vibrations of the ground or sound waves caused by the passage of said vehicles (14).
 3. Apparatus as in claim 1 or 2, **characterized in that** said transceiver means (11) and said control unit (12) are connected with each other in a network (30).
 4. Apparatus as in claim 3, **characterized in that** each of said transceiver means (11) comprises a unit (17) to manage said sensors (16) able to select said transit signals (ST), a first microprocessor (18) to process said transit signal (ST) able to generate said processed signal (SE), a first short-range radio transceiver (19), a memory (21) and an interface (22) connected to said network (30).
 5. Apparatus as in claim 4, **characterized in that** said control unit (12) comprises an interface (42) connected to said network (30), a second microprocessor (24) to further process said processed signal (SE) to generate a first alarm signal (SA) and an interface (26) connected with others of said control units (12) and to said operational center (13).
 6. Apparatus as in any claim hereinbefore, **characterized in that** each of said vehicles (14) is provided with a transceiver terminal (23) able to send a second alarm signal and to receive said processed signal (SE), respectively to and from each of said transceiver means (11).
 7. Apparatus as in claim 6, **characterized in that** said transceiver terminal (23) comprises: a second transceiver (27) for the transmission of said second alarm signal and the reception of said processed signal (SE); a third microprocessor (28) to process said processed signal (SE); a led or alphanumerical display (29); and a membrane keyboard (31) connected to said third microprocessor (28) and able to be actuated manually.
 8. Apparatus as in any claim hereinbefore, **characterized in that** said control unit (12) is provided with sirens and flashing lights (25) able to communicate visually any possible accidents to vehicles not equipped with transceiver terminals (23).
 9. Apparatus as in any claim hereinbefore, **characterized in that** each of said transceiver means (11) and said control unit (12) are able to transmit and receive short-range radio signals, in the range of about 50 - 200 meters.
 10. Apparatus as in any claim hereinbefore, **characterized in that** each of said transceiver means (11) and each control unit (12) comprise a third short-range radio transceiver (32) respectively for the transmission and reception of processed signals (SE).
 11. Apparatus as in any claim hereinbefore, **characterized in that** each of said transceiver means (11) comprises a solar feed panel (36), an accumulator and a control unit (37) for said accumulator.
 12. Apparatus as in any claim hereinbefore, **characterized in that** each of said transceiver means (11) comprises one or more cameras (40) and is able to transmit the images taken by said cameras (40) to said control unit (12) and to said operational center (13), in order to allow a monitoring, even visual, of the situation of the vehicle traffic on said road (15).
 13. Apparatus as in any claim hereinbefore, **characterized in that** each of said transceiver means (11) comprises a GPS localization antenna and a card to decode and process the position coordinates.

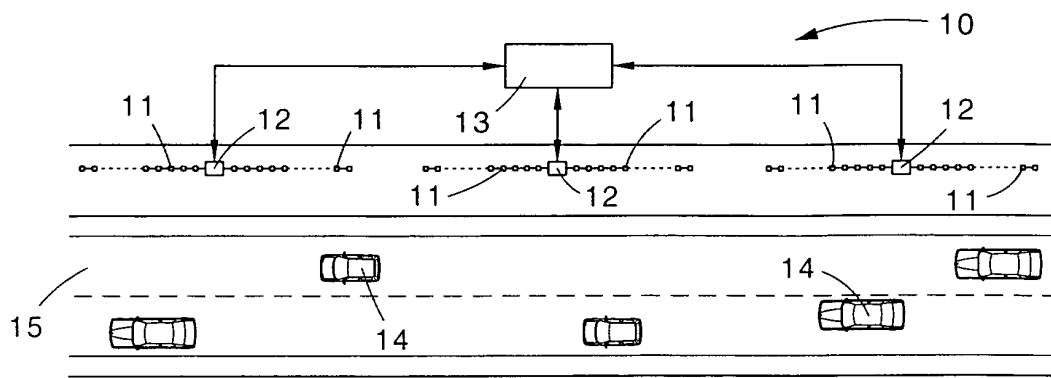


fig. 1

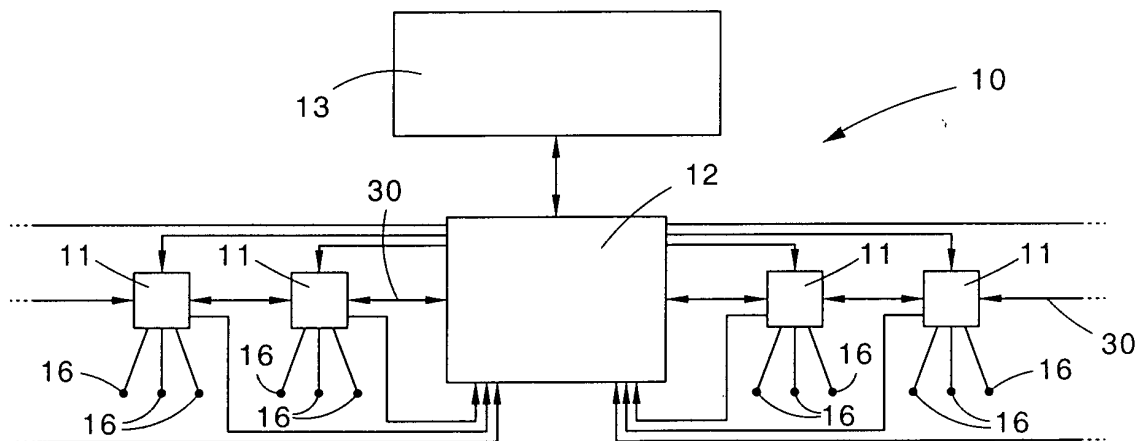


fig. 2

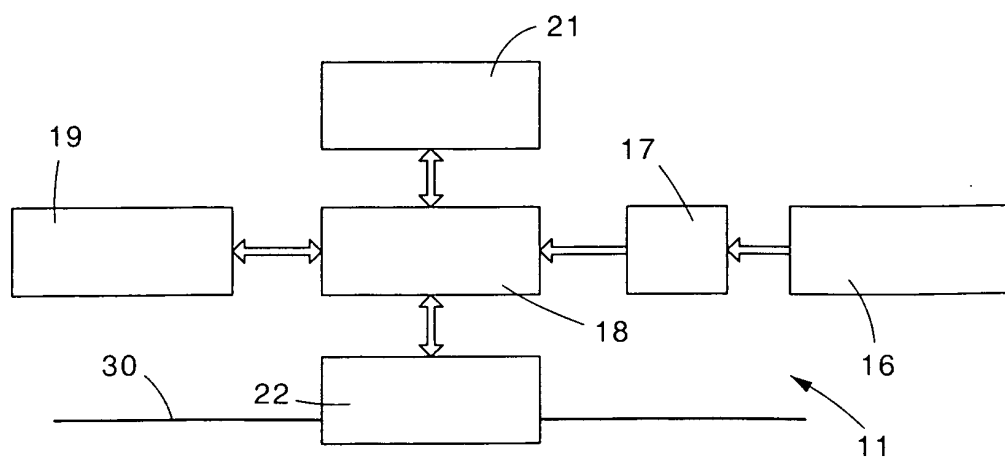


fig. 3

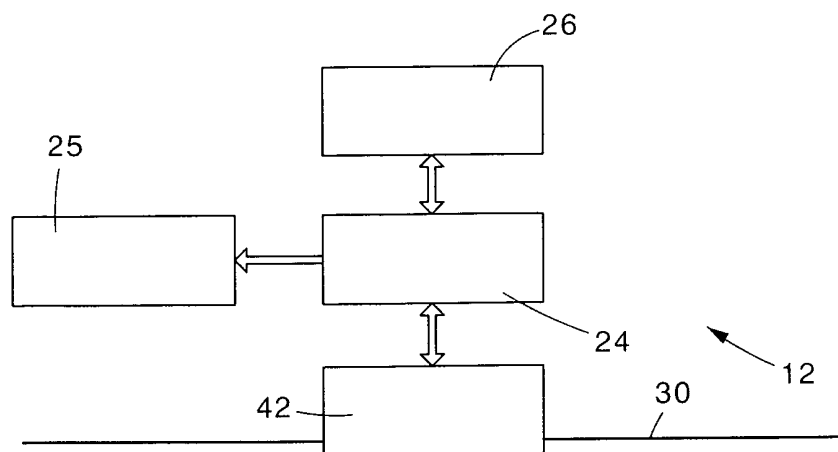


fig. 4

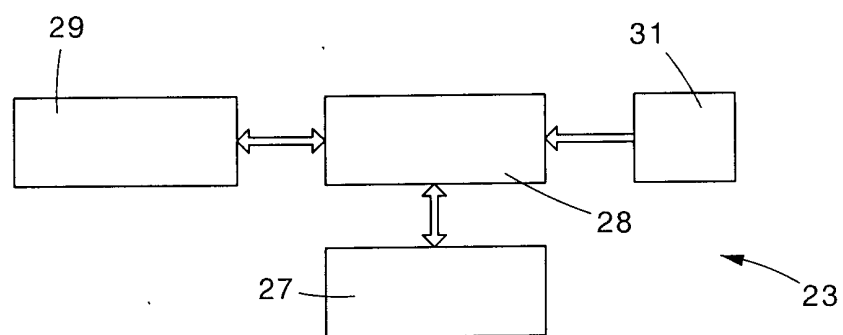


fig. 5

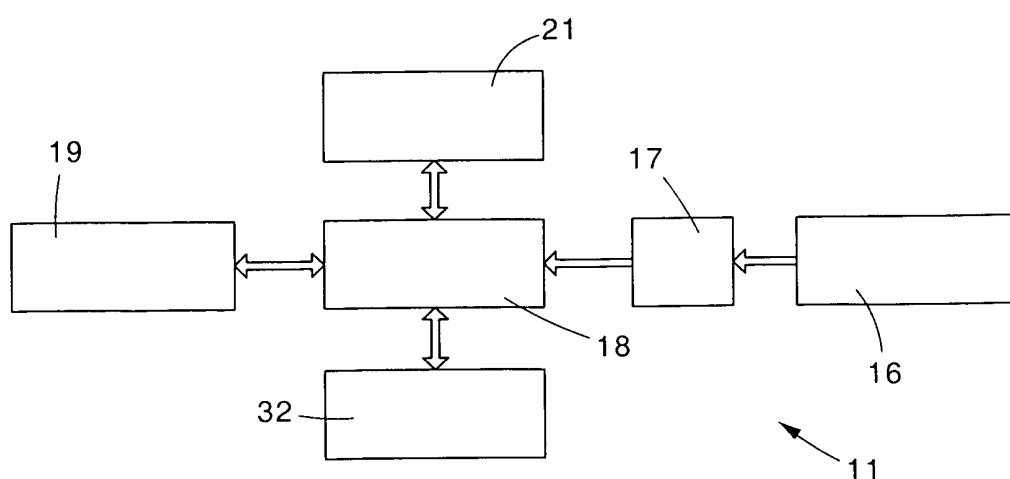


fig. 6

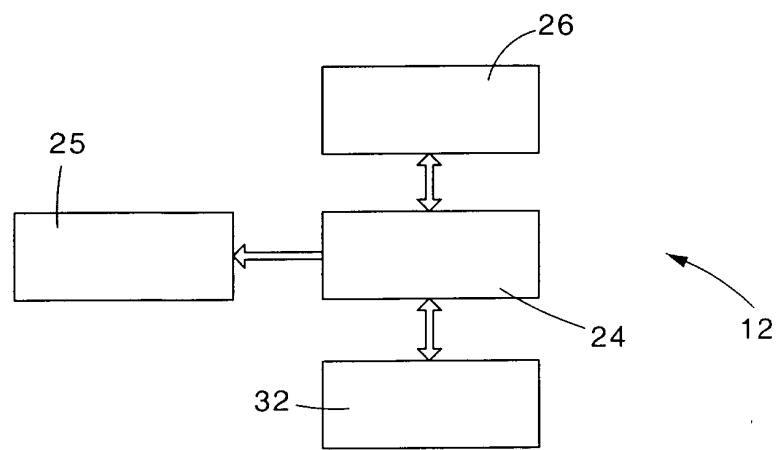


fig. 7

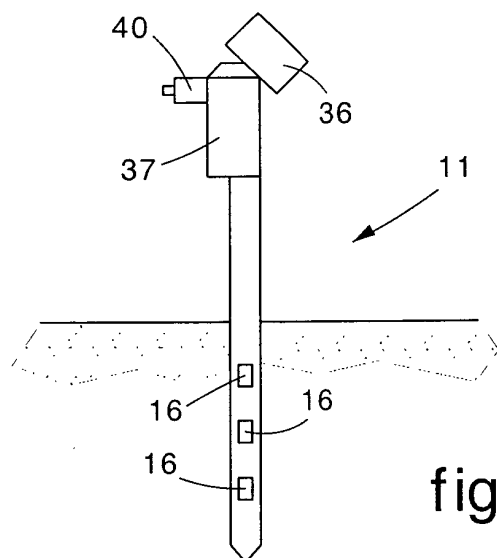


fig. 8

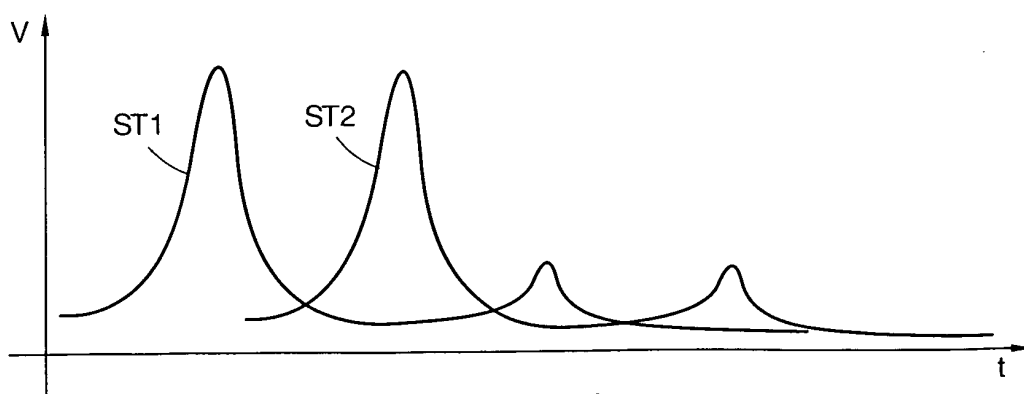


fig. 9