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(54) **Communication system for vehicles particularly railway vehicles or the like and stationary units**

System zur Kommunikation zwischen Fahrzeugen, insbesondere Schienenfahrzeugen, und Streckeneinrichtungen

Système de communication entre véhicules, particulièrement ferroviaires, et des postes fixes

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(56) References cited:
EP-A- 0 793 191 WO-A-94/11754
WO-A-97/39934 FR-A- 2 857 644

- **LUNDBERG P: "EUROBALISE TRANSMISSION SYSTEM, A TECHNICAL OVERVIEW" IRSE NEWS, INSTITUTION OF RAILWAY SIGNAL ENGINEERS,, GB, 9 October 2002 (2002-10-09), pages 1-6, XP001246783**

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Description

[0001] Communication system for vehicles, particularly railway vehicles or the like and stationary units, which system provides:

equipment on each railway vehicle which so called on-board equipment is associated to a section transmitting signals interrogating at least one or more operating stationary units each one provided at one of various predetermined locations of the vehicle route and particularly of the railway line and which equipment is associated to a section receiving reply signals of at least one or more operating stationary units that have been interrogated, while operating stationary units are provided with receiving/transmitting means for receiving interrogation signals and for transmitting reply signals.

[0002] Communications between operating stationary units particularly so called balises of railway networks and vehicles, particularly trains, or the like are known, for example from document WO 94/11754 upon which the preamble of claim 1 is based.

[0003] Communications occur between said operating stationary units and on-board equipment or systems placed on vehicles and intended for controlling travel conditions of the vehicle.

[0004] When two vehicles, such as two trains moving along adjacent tracks, pass at a balise, so called cross talk communication can occur (cross talk).

[0005] The present invention is based on the problem of overcoming the above mentioned drawback allowing a communication signal to be univocally correlated to one of the two or more vehicles and thus avoiding the cross-talk phenomenon or the like.

[0006] A further problem in the railway field is to monitor the system or a device in such a way to provide high safety level and to allow vital block actions to be performed guaranteeing the safety condition and management of the traffic.

[0007] The invention solves the above drawbacks by providing a system as defined in claim 1.

[0008] By means of the above characteristics, the on-board equipment is able to check if reply signals received from one or more operating stationary units are the one intended for the vehicle upon which said equipment is provided. Therefore in the case of two trains travelling for example on two adjacent tracks, the communication between a train and a stationary unit is not took for or it does not interfere with the communication between the other train and said operating unit. The fact of frequency encoding by means of a key composed of an identification code univocally associated to a vehicle and the fact of transmitting back the not modified interrogation signal from the operating stationary unit to the vehicle allows the consistency of the train identification code to be checked upon reception by the receiving section associ-

ated to the equipment.

[0009] According to an improvement such check is carried out automatically and according to safety criteria of the two on two type (2oo2). In this case the system according to the present invention provides, in addition to said first section receiving the reply signal transmitted by the operating stationary unit or units, even a second receiving section associated to the equipment which is separated and independent from said first section receiving the reply signal from the operating stationary unit or units and which second receiving section is intended for capturing in the air, directly the interrogation signal transmitted from the transmission section associated to the equipment and which said second receiving section has means for extracting the modulation key and that is the univocal identification code of the vehicle upon which the equipment is placed from the received interrogation signal.

[0010] The fact of extracting the modulation key and that is the univocal identification code of the vehicle upon which the equipment is placed can occur for example by providing the unmodulated carrier coming from means generating it to said second receiving section and basing on such carrier the interrogation signal can be processed for extracting the modulation key and that is the univocal identification code of the vehicle.

[0011] The vehicle identification code obtained by extracting the modulation key of the interrogation signal is transmitted to a comparison unit that can be combined or being part of the equipment.

[0012] The first section receiving the reply signal from on-board stationary unit or units has means independent from the ones of the second receiving section intended for receiving and extracting from the reply signal the component of said reply signal corresponding to the carrier modulated by the DPSK protocol with information to be transmitted to the vehicle and for extracting said information, while the signal corresponding to the carrier modulated by the key corresponding to the univocal identification code of the vehicle and coming from the modulator is provided also to said first receiving section and it is used for separating the retransmitted component of the interrogation signal from the reply signal and so for separating said signal component corresponding to or carrying the information provided by the operating stationary unit.

[0013] Therefore in this case, the consistency of the identification code of the vehicle and particularly of the train occurs twice and independently. The first check is performed by capturing the interrogation signal transmitted from the transmission section and extracting from said signal the code by a specific dedicated receiving section, while the second check is carried out by using the interrogation signal, that is the carrier frequency-modulated by the modulation key corresponding to the univocal identification code of the vehicle from the modulator, that is to say said signal is provided to the receiving section for separating the component corresponding to

the interrogation signal and the component relevant to information transmitted and modulated by DPSK protocol on the carrier from the reply signal of operating stationary unit or units and so for extracting said information.

[0014] According to a specific embodiment, the system according to the invention comprises a first transmission chain, a first receiving chain and a second receiving chain.

[0015] Such principle can be carried out in different ways.

[0016] Further improvements of the system mentioned above are included in the independent claims.

[0017] A particular and advantageous characteristic provides the interrogation signal to be composed of the carrier encoded by FSK modulation (Frequency Shift Keying) using the univocal identification code of the vehicle and particularly of the railway vehicle as the encoding key and so as the modulation key.

[0018] Such code for example comprises information about the type of vehicle and the registration number of such vehicle.

[0019] The invention relates also to a method for the communication between vehicles and particularly railway vehicles or the like and stationary units, wherein each vehicle has an equipment provided with means for communicating with one or more operating stationary units provided with communication means. Such method is defined in claim 8.

[0020] Moreover the invention relates to a terminal for the communication between equipment mounted on a vehicle particularly a railway vehicle and at least an operating stationary unit provided with a communication unit as defined in claim 12.

[0021] Particularly the communication terminal is composed of a receiving antenna and a transmitting antenna to which there are associated circuits forming the first transmission section, the first and the second receiving section and possibly but not necessarily means for checking the consistency between the vehicle identification code extracted from communication and compared with the identification code used for generating the interrogation signal.

[0022] Said means can be manufactured in different ways. Subclaims relate to further improvements of said communication terminal relevant to a preferred and advantageous embodiment.

[0023] As it will be more clear in the following, advantages of the present invention are that cross talk conditions between two travelling trains interrogating a balise are avoided. Thus data provided by the balise for one of the two vehicles are not sent to the other vehicle not expecting said data generating potential dangerous or malfunction situations. Moreover the system allows a communication free from cross talk to be obtained providing a step univocally identifying the receiver of information that is carried out according to high safety criteria (level SIL4) the consistency of the identity of the vehicle to which the communication is addressed, that is the reply

from operating stationary unit. Particularly the consistency of the vehicle identity to which reply from operating unit or units is addressed is verified basing on the consistency between the identification code transmitted with the interrogation signal by the fact of using it as the modulation key, and the identification code received and detected by a specific and independent section receiving and extracting said code.

[0024] Considering the manufacturing point of view, the communication device comprises a simple circuit providing the section generating and transmitting the signal interrogating operating stationary units, the first and the second receiving sections. Such circuit can be made on a common terminal board that can be integrated in a transmitting and receiving antenna device having said electronic circuit in combination near the real antenna. As regards equipment to which information are addressed some slight additions are required such as a central processing unit for executing a software able to compare identification code and able to perform diagnostic actions and having memories required for storing the identification code and the software.

[0025] Further improvements are object of subclaims.

[0026] Characteristics of the invention and advantages deriving therefrom will be more clear from the following description of a non limitative embodiment shown in annexed drawings wherein:

Fig.1 schematically is a system according to the present invention working in a railway traffic control system.

Fig.2 is a block diagram of the on-board unit together with the communication device according to the present invention.

Fig.3 is a block diagram of the communication device according to the present invention and of the arrangement of the three communication sections as well as the diagnostic unit that are integrated on a common board or a common printed circuit.

Figures 4 to 6 separately are the enlarged transmission section, the second receiving section and the first receiving section respectively.

Figure 7 is diagnostic sections.

[0027] With reference to figure 1 it shows a railway traffic control system wherein a communication system according to the present invention is provided. The fact of using it for the communication between trains and operating stationary units is not a limitation, but it is a preferred example for using the system according to the present invention.

[0028] This figure shows two tracks 1, 2 with two trains 3, 4 travelling thereon. Along the railway line, that is along the two parallel tracks, there are provided at least one or more operating stationary units denoted by 5 which are intended for communicating by radio with on-board equipment 53, 54 placed on both vehicles, particularly trains 3 and 4. Each equipment 53 and 54 has a com-

munication section 63 and 64 for transmitting and receiving signals from one or more of said operating stationary units 5 provided with communication units 105 for transmitting and receiving signals. In the railway field operating units are called balises.

[0029] In a particular embodiment such as the one used for railway traffic, communication units of operating stationary units 5 are of the type known as repeater or transponder and reflect the modulated carrier transmitted from communication sections 63, 64 thereto adding information on the reflected signal by a predetermined modulation of said reflected signal.

[0030] Information transmitted from operating units are managed by control means of the railway plant generally denoted by the box 7.

[0031] In order to avoid communication between the two trains and the operating unit denoted by arrows C1 and C2 to interfere one with the other, thus generating error conditions, the invention provides to univocally encode the communication using a frequency modulation called Frequency Shift Keying FSK and using a univocal identification code of the vehicle upon which the communication section and equipment is mounted as the modulation key.

[0032] In this case, the communication unit of each vehicle comprises a transmission section generating a signal interrogating operating stationary units which signal is a carrier modulation by frequency modulation and particularly under FSK mode by using the univocal identification code of the vehicle as the encoding key of the modulation.

[0033] The interrogation signal modulated in this way carries information univocally identifying the vehicle transmitting said signal. The interrogation signal is received by the communication unit of operating stationary units, which communication unit is advantageously composed of a transponder generating a reply signal composed of two components one being the interrogation signal that is simply reflected and the other component being the information modulated on the carrier according to a predetermined protocol and particularly a DPSK protocol.

[0034] In figure 2 the equipment 53, 54 and the communication section 63, 64 as well as the transmitting dipole 73, 74 and the receiving dipole 83, 84 are shown.

[0035] The communication section has the transmission section 10 connected to the transmitting dipole 73, 74 and receiving the identification code for the vehicle from a memory 11 provided inside the equipment 53, 54. The receiving dipole 83, 84 is connected to the input of the double receiving section. Particularly said receiving dipole is connected to a section receiving the reply signal of the operating stationary unit denoted by 12 and to a section receiving the interrogation signal directly received by the transmitting dipole, which second receiving section is denoted by 13.

[0036] The output from the first receiving section 12 provides information that is transmitted to operating units

of the equipment 53, 54 generally denoted by 14. The output from the second receiving section 13 provides the identification code for the vehicle that is transmitted to a consistency comparing and checking unit 15 which compares the code detected by the receiving section 13 with the one stored inside the memory 11.

[0037] If there is no consistency between the identification code of the vehicle stored inside the equipment 53, 54 and the one detected upon reception by the second receiving section 13, that is between the transmitted code and the received one the equipment or a dedicated section rejects received information and so the fact that information transmitted with a reply signal of an operating stationary unit is just the one for the receiving vehicle is guaranteed.

[0038] According to a further advantageous characteristic, the first receiving section 12 intended to extract the signal component relevant to information and so information from the reply signal separates the reply signal component composed of the interrogation signal reflected by the transponder of the operating stationary unit 5 by the fact that it receives (line 16) said component from the transmission section 10 the output from the modulated carrier generator being connected to the input of a mixer of the first receiving section 12, by means of which the reply signal component containing information provided from the operating stationary unit to the vehicle is separated, that is from the balise to the train.

[0039] By means of the above if the reply signal is the one intended for a different train with a different identification code, the first receiving unit 12 could not appropriately extract the reply signal component carrying information and so said information could not be extracted at least in the proper way.

[0040] Similarly the second receiving section 13 extracts the identification code of the train from the interrogation signal directly received from the transmission section 10 by air communication by means of dipoles of transmitting antenna 73, 74 and receiving antenna 83, 84 the output from the unmodulated carrier generator being provided to said section (line 17).

[0041] With reference to figures 3 to 7, there is shown in details an example of a communication device, that is an antenna or an antenna subsystem according to the present invention.

[0042] The antenna is one of the subsystems inside a train. It is composed of a mechanical housing, containing the defrosting device, inner electronics made of only one printed circuit, whose architecture is shown in figure 3. The inner board shown in figure 3 is composed of a microwave front-end generating a radiofrequency carrier at FM modulated-frequency of 5.810 GHz or 5.750 GHz, and it carries out a down conversion at frequency of 10,7 MHz (IF1) or 13 MHz (IF2).

[0043] In order to carry out such operation, the RF carrier is frequency-modulated by the antenna by a univocal code transmitted by the receiver, that is the equipment 53, 54; such carrier, that is FM modulated, is transmitted from

the transmission section TX to the transponder of an operating stationary unit, so called balise, which replays by overlapping information of the balise to the received interrogation signal. Such reply signal, containing the interrogation signal as a FM modulation code and information of the balise under DPSK modulation, reaches the first receiving section Rx, and on the base of the code received from the equipment 53, 54 that is from the memory 11 thereof, the demodulation section demodulates the received signal obtaining information of the balise 5 and the identification code.

[0044] From the general flow diagram it is possible to note the following signal paths:

- CODE - ANTENNA TX chain corresponding to transmission section 10
- ANTENNA RX - DETECTED SIGNAL chain corresponding to the second receiving section 13
- ANTENNA RX - IF OUT chain corresponding to the first receiving section 12
- Diagnostic and control

[0045] In figure 3 boxes show transmission and receiving sections 10, 12, 13 of figure 2. As regards the two receiving sections a branch in common to the two sections or chains is denoted by 18. While diagnostic section is denoted by box 21.

[0046] Figure 4 shows the transmission section 10 and so the signal path defined as CODE-ANTENNA TX chain.

[0047] The code transmitted to the antenna from memory 11 of equipment 53, 54 (Receiver) is converted into a sinusoidal oscillation by VCO 110, particularly: a generated frequency of 350 KHZ corresponds to the low logic level and 500 KHZ correspond to the high logic level.

[0048] Signal from VCO 110 is transmitted to a IQ vectorial modulator 210 together with the carrier frequency obtained by the dielectric resonator oscillator (DRO) 310. Therefore the output from the modulator 210 is a frequency-modulated oscillation at 5.810 GHz or 5.750 GHz and, being appropriately amplified by an amplifier 410 and filtered of spurious components by a band-pass filter 510, is transmitted to the antenna dipole TX 73, 74 and to mixer 2 210 of the first receiving section 12 (figure 6).

[0049] The coupler RF 610 allows power spread out from antenna dipole TX 73, 74 to be detected and a POWER OUT signal to be generated and allows also a signal relevant to the possible power reflected back because of damages to the antenna or because of obstacles placed near it to be generated with signal is denoted by ANTENNA ROS in figure 4.

[0050] Appropriately processed ANTENNA ROS and POWER OUT signals at outputs 710, 810 are transmitted to the microcontroller 20 of the diagnostic section as in figure 7.

[0051] Moreover the transmission section 10 has an

output 910 where the carrier frequency signal is present provided by the dielectric resonator oscillator (DRO) 310 and an output 1010 of the modulator 210 at which output 1010 a frequency modulated oscillation at 5.810 GHz or 5.750 GHz is present, that is the frequency-modulated carrier transmitted from the transmitting antenna dipole 73, 74.

[0052] Figure 5 shows a constructive example of the chain: ANTENNA RX - DETECTED CODE, that is the second receiving section.

[0053] This section of the antenna subsystem functions for "extracting" the identification code from the signal received from the antenna dipole RX 83, 84 and for transmitting it to the checking section 15 of equipment 53, 54 (receiver) which transmits it to CPU board after having bit re-synchronized it.

[0054] The signal received by the antenna dipole RX 83, 84 is made of:

- a) a FM modulated carrier that is the signal transmitted in air by the transmitting antenna dipole 73, 74
- b) a FM modulated carrier + DPSK composed of reply signal of operating stationary unit 5.

the "a" contribution is the signal transmitted from the transmission section (CODE - ANTENNA DIPOLE RX chain) and directly captured by the antenna dipole RX (83, 84), while "b" contribution is the reply signal received by a transponder of an operating stationary unit that has been interrogated by equipment (RECEIVER) by transmitting an interrogation signal generated and transmitted from the transmission section 10.

[0055] The ANTENNA RX - DETECTED CODE chain, that is the second receiving section 13, has to detect the code transmitted "in the air" by the antenna dipole TX 73, 74. The captured signal is transmitted to the mixer 1 130 together with the unmodulated oscillation generated by DRO taken from the output 910 of the transmission section 10.

[0056] The output from mixer 1 130 passes through a lowpass filter 230 attenuating all signals having a frequency higher than 500 KHz. Therefore only two tones at 500 and 350 KHz still remain, that, once converted into voltage by the converter 330 are sent to a threshold comparator 430 providing a signal having low or high logic state depending on the fact if its input is higher or lower than the set threshold respectively. Thus it is possible to "associate" the high logic state to the 500 KHz signal and the low logic state to the 350 KHz signal. The detected code is transmitted to equipment 53, 54 that is to the consistency checking section 15.

[0057] Figure 6 shows in details an example for making the first receiving section aiming at extracting information.

[0058] As already described above, 2 contributions arrive to antenna dipole RX 83, 84:

- a) FM modulated carrier

b) FM modulated carrier + DPSK modulated information

the "b" contribution is the reply signal of operating stationary units and generated by transponder when it is interrogated upon transmission of the interrogation signal.

[0059] ANTENNA DIPOLE RX - IF OUT chain converts the received signal at IF OUT frequency making possible the access to information in the following way: the signal received by the transponder of operating stationary unit reaches mixer 2 120 together with oscillation RF FM modulated by the code and provided by the output 1010 of the transmission section 10. The output from mixer 2 120, that is appropriately amplified by the amplifier 320 and filtered by filters 420 and 520, is composed only of a signal at a predetermined frequency that can be comprehended, interpreted and used by equipment for performing functions controlling the train travel or other functions such as merely displaying information.

[0060] With reference to figure 7, it shows schematically the diagnostic and control section.

[0061] Values of signals:

ANTENNA ROS
POWER OUT
SUPPLY DIAGNOSTIC
BOARD TEMPERATURE
HEATER TEMPERATURE

are sampled and stored in the microcontroller 20 which, once interrogated by equipment 53, 54 (Receiver) by a connection RS485, will reply transmitting values required for performing controls of functionalities and for generating warnings and/or for performing emergency actions.

Claims

1. Communication system for vehicles, particularly railway vehicles (3, 4) or the like and stationary units (5), which system provides:

equipment (53, 54) on each railway vehicle which so called on-board equipment is associated to a section (10) transmitting signals interrogating at least one or more operating stationary units (5) each one provided at one of various predetermined locations of the vehicle route and particularly of the railway line and which equipment (53, 54) is associated to a section (12) receiving reply signals of at least one or more operating stationary units (5) that have been interrogated, while operating stationary units (5) are provided with receiving/transmitting means (105) for receiving interrogation signals and for transmitting reply signals, wherein

the transmission section (10) of the equipment (53, 54) on a vehicle (3, 4) produces an interrogation signal composed of a carrier wave that is frequency modulated according to a modulation key corresponding to a univocal identification code of the railway vehicle (3, 4) or the like that is different and unique for each vehicle, while receiving/transmitting means (105) of operating stationary units (5) receive said interrogation signal and retransmit it to the receiving section (12) associated to the on-board equipment (53, 54) adding the signal contribution containing the reply information of the corresponding operating stationary unit (5) as a carrier modulation with said reply information to the signal received and frequency modulated with the vehicle identification code,

characterized in that

the system provides, in addition to said first section (12) receiving the reply signal transmitted by the operating stationary unit or units (5), even a second receiving section (13) associated to the equipment (53, 54) which is separated and independent from said first section (12) receiving the reply signal from the operating stationary unit or units (5) and which second receiving section (13) is intended for capturing in the air, directly the interrogation signal transmitted from the transmission section (10) associated to the equipment and which said second receiving section (13) has means (130, 230, 330, 430) for extracting the modulation key and that is the univocal identification code of the vehicle (3, 4) upon which the equipment (53, 54) is placed from the received interrogation signal.

2. System according to claim 1, **characterized in that** the signal contribution containing reply information of the corresponding operating stationary unit (5) is in the form of a carrier modulated with said reply information according to a modulation protocol of the DPSK type.
3. System according to claim 1 or 2, **characterized in that** said extraction of the modulation key and that is of the univocal identification code of the vehicle (3, 4) upon which the equipment (53, 54) is placed occurs by providing the unmodulated carrier (910) from means (310) generating it to said second receiving section (13) and basing on such carrier the interrogation signal can be processed for extracting the modulation key and that is the univocal identification code of the vehicle (3, 4).
4. System according to one or more of preceding claims, **characterized in that** the vehicle identification code obtained by extracting the modulation key of the interrogation signal is transmitted to a com-

parison unit (15) that can be combined or being part of the equipment (53, 54).

5. System according to one or more of the preceding claims 1 to 4, **characterized in that** the first section (12) receiving the reply signal from stationary unit or units (5) has means (120, 420, 320, 520) independent from the ones of the second receiving section (13) intended to receive and extract from the reply signal the component of said reply signal corresponding to the carrier modulated by the DPSK protocol with information to be transmitted to the vehicle (3, 4) and for extracting said information, while the signal (1010) corresponding to the carrier modulated with the key corresponding to the univocal identification code of the vehicle (3, 4) and coming from the modulator (210) is provided also to said first receiving section (12) and it is used for separating the component re-transmitted of the interrogation signal from the reply signal and so for separating said signal component corresponding or carrying information provided by the operating stationary unit (5), so the consistency between the transmitted vehicle identification code and the received one is checked twice and independently.
6. System according to one or more of the preceding claims, **characterized in that** it comprises a first transmission chain (10), a first receiving chain (12) and a second receiving chain (13), the transmission chain being intended for generating a signal (73, 74) interrogating an operating stationary unit (5), which signal is composed of the carrier encoded by FSK modulation (Frequency Shift Keying) using the univocal identification code of the vehicle (3, 4) and particularly of the railway vehicle as the encoding key and so as the modulation key, while a chain (13) receiving the interrogation signal transmitted in the air is provided for extracting the vehicle identification code by demodulating action the signal of the unmodulated carrier (910) being directly provided to said chain (13) from the output of a generator (310) of said carrier and while a chain (12) receiving and extracting information from a reply signal composed of a reflected component of the interrogation signal and a component of the signal modulated with the information is provided, which chain (12) extracts information by using the interrogation signal, that is the modulated carrier (1010) from the modulator (210) of the chain (10) generating the interrogation signal.
7. System according to one or more of the preceding claims, **characterized in that** it comprises a section (15) for checking the consistency of the vehicle identification code used as the modulation key of the interrogation signal between the transmitted code and the code received and extracted by the second re-

ceiving section (13).

8. Method for the communication between vehicles (3, 4) particularly railway vehicles or the like and stationary units (5), wherein each vehicle (3, 4) has equipment (63, 64) provided with means (63, 64) for communicating with one or more operating stationary units (5) provided with communication means (105), which method, in order to univocally identify that information received from an operating stationary unit (5) is relevant to the vehicle (3, 4), if two or more vehicles are contemporaneously travelling, provides the following steps:
- upon transmission, by equipment (53, 54) mounted on said vehicle (3, 4), generating a signal interrogating one or more operating stationary units (5) consisting in encoding a carrier by a frequency modulation using a encoding or modulation key corresponding to a univocal identification code of the vehicle (3, 4);
 - upon reception by said equipment (53, 54), receiving a reply signal of operating stationary unit or units (5) and receiving the interrogation signal and separately demodulating the reply signal for extracting useful information and demodulating the received interrogation signal for extracting the modulation key and so the univocal identification code of the vehicle;
 - checking the consistency between the identification code identified at step b) and the identification code of the vehicle used for modulating the interrogation signal,
- characterized in that** it provides to directly receive the transmitted interrogation signal and to extract the univocal identification code of the vehicle by extracting the modulation key from the transmitted interrogation signal captured in the air.
9. Method according to claim 8, **characterized in that** operating stationary units (5) generate a reply signal composed of a component corresponding to the interrogation signal reflected back and a component composed of a carrier modulated by information.
10. Method according to claim 9, **characterized in that** information is extracted from the reply signal using the interrogation signal, or the carrier frequency-modulated by the encoding key being the univocal identification code of the vehicle (3, 4), which is mixed with the reply signal for extracting the reply signal component carrying information, information being extracted from said component.
11. Method according to claim 9 or 10, **characterized in that** the univocal identification code of the vehicle (3, 4) corresponding to the encoding key of the fre-

quency-modulation of the carrier and being the interrogation signal is extracted by using a signal (910) corresponding to said unmodulated carrier and mixing said signal with the received interrogation signal.

12. Terminal (63, 64) for the communication between equipment (53, 53) mounted on a vehicle (3, 4) particularly a railway vehicle and at least an operating stationary unit (5) provided with a communication unit (105); which communication unit (63, 64) of equipment (53, 54) mounted on the vehicle (3, 4) comprises a section (10) for generating and transmitting a signal interrogating operating stationary unit or units (5) from equipment (53, 54), that is from the vehicle (3, 4) to said operating stationary unit (5), which interrogation signal is obtained by means of modulation using a univocal identification code of the vehicle as the modulation key; a first section (12) receiving a reply signal from the operating stationary unit or units (5) provided with means (120, 420, 320, 520) for extracting/demodulating information required by equipment (53, 54) to operating stationary unit or units (5) and transmitted to equipment (53, 54) therefrom, **characterized in that** it comprises a second receiving section (13) separated from the first one and provided with its own means (130, 230, 330, 430) for extracting/demodulating the univocal identification code of the vehicle (3, 4) from the interrogation signal transmitted from the generation and transmission section (10); means (15) for checking the consistency between the vehicle identification code obtained by the second receiving section (13) and the vehicle identification code used for generating the interrogation signal.
13. Communication terminal (63, 64) according to claim 12, **characterized in that** it is provided in combination with at least an operating stationary unit (5) to which the interrogation signal is transmitted and which operating stationary unit (5) generates a reply signal composed of a component corresponding to the interrogation signal and a component corresponding to a signal modulated by information required by equipment (53, 54).
14. Communication terminal (63, 64) according to claims 12 and 13, **characterized in that** it comprises at least a transmission antenna dipole (73, 74) and at least a receiving antenna dipole (83, 84), the transmission antenna dipole (73, 74) being connected to the output of a transmission section (10) comprising an input for a univocal identification code of the vehicle (3, 4), means (110) for converting said univocal identification code of the vehicle (3, 4) into a sinusoidal oscillating signal and means (210) for modu-

lating a carrier wave with said oscillating, sinusoidal signal, the output of said modulation means (210) provides the carrier frequency-modulated by a FSK modulation to the transmission antenna dipole (73, 74) and which encoding key is composed of the univocal identification code of the vehicle (3, 4).

15. Communication terminal (63, 64) according to one or more of the preceding claims 12 to 14, **characterized in that** the receiving antenna dipole (83, 84) is connected to a first receiving section (12), which receiving section (12) processes the reply signal of an operating stationary unit (5) for extracting information transmitted from such unit (5) to vehicle equipment (53, 54) whose interrogation signal has been transmitted to said operating stationary unit (5), and which first receiving section (12) comprises a mixer (120) to which the reply signal and the signal (1010) relevant to the frequency-modulated carrier coming from the modulator (210) of the transmission section (10) is provided, and the output of said mixer (120) is filtered (420) for extracting information from said reply signal, the reply signal received by said first receiving section (12) and transmitted from the operating stationary unit (5) being composed of a component corresponding to the interrogation signal transmitted to said operating stationary unit (5) from the transmission section (10) of the communication terminal (63, 64) and of a signal component to which information is associated by modulation.
16. Communication terminal (63, 64) according to one or more of preceding claims 12 to 15, **characterized in that** the receiving antenna dipole (83, 84) is connected also to a second receiving section (13), which receiving section (13) is intended for directly receiving the interrogation signal transmitted from the antenna dipole (73, 74) of the transmission section and which interrogation signal is provided to a mixer (130) together with the signal (910) corresponding to the output of the carrier generator (310) of the transmission section (10), while the mixer (130) output is connected to a low-pass filter (230) whose output is connected to a voltage converter (330), whose output supplies a threshold comparator (430) for reconstructing the encoding key of the carrier modulation and so the univocal identification code of the vehicle (3, 4).
17. Communication terminal (63, 64) according to one or more of the preceding claims 12 to 16, **characterized in that** the identification code of the vehicle (3, 4) is transmitted to a comparison section (15) for checking the consistency between the code extracted from the interrogation signal by the second receiving section (13) and the univocal identification code used for modulating the carrier of the interrogation signal.

18. Communication terminal (63, 64) according to one or more of the preceding claims 12 to 17, **characterized in that** it constitutes an antenna subsystem comprising transmission (73, 74) and receiving (83, 84) antenna dipoles and circuits composing the transmission section (10), the first (12) and second (13) receiving section and possibly means (15) for checking the consistency between the identification code of the vehicle (3, 4) extracted from the communication and compared with the identification code used for generating the interrogation signal.

Patentansprüche

1. Kommunikationssystem für Fahrzeuge, insbesondere Schienenfahrzeuge (3, 4) oder dergleichen, und stationäre Einheiten (5), wobei dieses System umfasst:

eine Ausrüstung (53, 54) an jedem Schienenfahrzeug, wobei diese sogenannte Bordausrüstung mit einem Abschnitt (10) verbunden ist, der Signale sendet, um mindestens eine oder mehrere stationäre Betriebseinheiten (5) abzufragen, die jede an einer von mehreren vorbestimmten Stellen der Fahrzeugstrecke und insbesondere der Eisenbahnlinie vorgesehen sind, und wobei diese Ausrüstung (53, 54) mit einem Abschnitt (12) verbunden ist, der Antwortsignale von mindestens einer oder mehreren stationären Betriebseinheit(en) (5) empfängt, die abgefragt wurden, während die stationären Betriebseinheiten (5) mit Empfangs-/Sendemitteln (105) zum Empfangen von Abfragesignalen und zum Senden von Antwortsignalen versehen sind, wobei

der Sendeabschnitt (10) der Ausrüstung (53, 54) an einem Fahrzeug (3, 4) ein Abfragesignal erzeugt, bestehend aus einer Trägerwelle, die einem Modulationsschlüssel entsprechend moduliert wird, der einem eindeutigen Identifikationscode des Schienenfahrzeugs (3, 4) oder dergleichen entspricht, der für jedes Fahrzeug anders und einmalig ist,

während die Empfangs-/Sendemittel (105) der stationären Betriebseinheiten (5) dieses Abfragesignal empfangen und es zum zur Bordausrüstung (53, 54) gehörigen Empfangsabschnitt (12) zurücksenden, indem sie den Signalbeitrag, der die Antwortinformation der entsprechenden stationären Betriebseinheit (5) als Trägermodulation mit dieser Antwortinformation enthält, zum empfangenen und mit dem Fahrzeugidentifikationscode frequenzmodulierten Signal addieren,

dadurch gekennzeichnet, dass das System zusätzlich zum ersten Abschnitt

(12), der das von der oder den stationären Betriebseinheit (en) (5) gesendete Antwortsignal empfängt, auch einen zur Ausrüstung (53, 54) gehörigen zweiten Empfangsabschnitt (13) umfasst, der vom ersten Abschnitt (12) getrennt und unabhängig ist und das Antwortsignal von den stationären Betriebseinheit(en) (5) empfängt, und wobei dieser zweite Empfangsabschnitt (13) dazu bestimmt ist, das vom zur Ausrüstung gehörigen Sendeabschnitt (10) gesendete Abfragesignal direkt per Funk aufzufangen, und dieser zweite Empfangsabschnitt (13) Mittel (130, 230, 330, 430) aufweist, um den Modulationsschlüssel, das heißt, den eindeutigen Identifikationscode des Fahrzeugs (3, 4), an dem die Ausrüstung (53, 54) montiert ist, aus dem empfangenen Abfragesignal zu extrahieren.

2. System nach Anspruch 1, **dadurch gekennzeichnet, dass** der Signalbeitrag, der die Antwortinformation der entsprechenden stationären Betriebseinheit (5) enthält, in der Form eines Trägers vorliegt, der einem Modulationsprotokoll vom DPSK-Typ entsprechend mit dieser Antwortinformation moduliert wurde.

3. System nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** diese Extraktion des Modulationsschlüssels, das heißt, des eindeutigen Identifikationscodes des Fahrzeugs (3, 4), an dem die Ausrüstung (53, 54) angeordnet ist, erfolgt, indem der unmodulierte Träger (910) von Mitteln (310) zu seiner Erzeugung dem zweiten Empfangsabschnitt (13) zugeführt wird und das Abfragesignal auf der Basis dieses Trägers verarbeitet werden kann, um den Modulationsschlüssel, das heißt, den eindeutigen Identifikationscode des Fahrzeugs (3, 4) zu extrahieren.

4. System nach einem oder mehreren der vorherigen Ansprüche, **dadurch gekennzeichnet, dass** der Fahrzeugidentifikationscode, der durch Extrahieren des Modulationsschlüssels des Abfragesignals erhalten wird, an eine Vergleichseinheit (15) gesendet wird, die mit der Ausrüstung (53, 54) kombiniert oder Bestandteil davon sein kann.

5. System nach einem oder mehreren der vorherigen Ansprüche 1 bis 4, **dadurch gekennzeichnet, dass** der erste Abschnitt (12), der das Antwortsignal von der oder den stationären Einheit(en) (5) empfängt, Mittel (120, 420, 320, 520) aufweist, die von denen des zweiten Empfangsabschnitts (13) unabhängig sind und dazu bestimmt sind, das Antwortsignal zu empfangen und daraus die Komponente des Antwortsignals zu extrahieren, die dem Träger entspricht, der durch das DPSK-Protokoll mit der an das Fahrzeug (3, 4) zu sendenden Information moduliert wurde, während das Signal (1010), das dem Träger

- entspricht, der mit dem Schlüssel moduliert wurde, der dem eindeutigen Identifikationscode des Fahrzeugs (3, 4) entspricht und vom Modulator (210) kommt, auch dem ersten Empfangsabschnitt (12) zugeführt wird und benutzt wird, um die zurückgesendete Komponente des Abfragesignals vom Antwortsignal zu trennen, und somit, um diese Signal-
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komponente, die der von der stationären Betriebseinheit (5) bereitgestellten Information entspricht oder diese trägt, zu trennen, wodurch die Übereinstimmung zwischen dem gesendeten Fahrzeugidentifikationscode und dem empfangenen zweifach und unabhängig kontrolliert wird.
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6. System nach einem oder mehreren der vorherigen Ansprüche, **dadurch gekennzeichnet, dass** es eine erste Sendekette (10), eine erste Empfangskette (12) und eine zweite Empfangskette (13) umfasst, wobei die Sendekette dazu bestimmt ist, ein Signal (73, 74) zur Abfrage einer stationären Betriebseinheit (5) zu erzeugen, wobei dieses Signal aus dem Träger besteht, der durch FSK (Frequency Shift Keying)-Modulation mit dem eindeutigen Identifikationscode des Fahrzeugs (3, 4) und insbesondere des Schienenfahrzeugs als Kodierschlüssel und demnach als Modulationsschlüssel codiert wurde, während eine Kette (13), die das per Funk übertragene Abfragesignal empfängt, vorgesehen ist, um den Fahrzeugidentifikationscode durch einen Demodulationsvorgang zu extrahieren, wobei das Signal des unmodulierten Trägers (910) dieser Kette (13) vom Ausgang eines Generators (310) dieses Trägers direkt zugeführt wird, und während eine Kette (12) vorgesehen ist, die die Information von einem Antwortsignal, bestehend aus einer reflektierten Komponente des Abfragesignals und einer Komponente des mit der Information modulierten Signals, empfängt und extrahiert, wobei diese Kette (12) die Information extrahiert, indem sie das Abfragesignal verwendet, das heißt, den modulierten Träger (1010) vom Modulator (210) der Kette (10), die das Abfragesignal erzeugt.
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7. System nach einem oder mehreren der vorherigen Ansprüche, **dadurch gekennzeichnet, dass** es einen Abschnitt (15) zur Prüfung der Übereinstimmung zwischen dem Fahrzeugidentifikationscodes umfasst, der im gesendeten Code und im empfangenen Code, der vom zweiten Empfangsabschnitt (13) extrahiert wird, als Modulationsschlüssel des Abfragesignals verwendet wird.
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8. Kommunikationsverfahren die zwischen Fahrzeugen (3, 4), insbesondere Schienenfahrzeugen oder dergleichen und stationären Einheiten (5), wobei jedes Fahrzeug (3, 4) eine Ausrüstung (53, 54) aufweist, die mit Mitteln (63, 64) zur Kommunikation mit einer oder mehreren stationären Betriebseinheit(en)
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- (5) versehen ist, die mit Kommunikationsmitteln (105) versehen sind, wobei dieses Verfahren, um eindeutig zu erkennen, dass die von einer stationären Betriebseinheit (5) empfangene Information für das Fahrzeug (3, 4) relevant ist, wenn zwei oder mehr Fahrzeuge gleichzeitig vorbeifahren, die folgenden Schritte umfasst:
- a) beim Senden, durch die die an das Fahrzeug (3, 4) montierte Ausrüstung (53, 54), das Erzeugen eines Signals, um eine oder mehrere stationäre Betriebseinheit(en) (5) abzufragen, umfassend das Codieren einer Trägers durch eine Frequenzmodulation mit einem Kodier- oder Modulationsschlüssel, der einem eindeutigen Identifikationscode des Fahrzeugs (3, 4) entspricht;
- b) beim Empfang durch diese Ausrüstung (53, 54), das Empfangen eines Antwortsignals der stationären Betriebseinheit(en) (5) und das Empfangen des Abfragesignals und das separate Demodulieren des Antwortsignals, um die Nutzinformation zu extrahieren, und das Demodulieren des empfangenen Abfragesignals, um den Modulationsschlüssel und somit den eindeutigen Identifikationscode des Fahrzeugs zu extrahieren;
- c) das Prüfen der Übereinstimmung zwischen dem Identifikationscode, der in Schritt b) erkannt wurde, und dem Identifikationscode des Fahrzeugs, der zur Modulation des Abfragesignals verwendet wurde,
- dadurch gekennzeichnet, dass** es den direkten Empfang des gesendeten Abfragesignals und die Extraktion des eindeutigen Identifikationscodes des Fahrzeugs vorsieht, indem es den Modulationsschlüssel aus dem gesendeten Abfragesignal extrahiert, das per Funk aufgefangen wird.
9. Verfahren nach Anspruch 8, **dadurch gekennzeichnet, dass** die stationären Betriebseinheiten (5) ein Antwortsignal erzeugen, das zusammengesetzt ist aus einer Komponente, die dem zurückgesendeten Abfragesignal entspricht, und einer Komponente, die aus einem durch Information modulierten Träger besteht.
10. Verfahren nach Anspruch 9, **dadurch gekennzeichnet, dass** die Information anhand des Abfragesignals oder des Trägers, der mit dem Kodierschlüssel, welcher der eindeutige Identifikationscode des Fahrzeugs (3, 4) ist, frequenzmoduliert wird, aus dem Antwortsignal extrahiert wird, indem er mit dem Antwortsignal gemischt wird, um die informationstragende Komponente des Antwortsignals zu extrahieren, wobei diese Information aus dieser Komponente extrahiert wird.

11. Verfahren nach Anspruch 9 oder 10, **dadurch gekennzeichnet, dass** der eindeutige Identifikationscode des Fahrzeugs (3, 4), der dem Kodierschlüssel der Frequenzmodulation des Trägers entspricht und das Abfragesignal ist, unter Verwendung eines Signals (910) extrahiert wird, das diesem unmodulierten Träger entspricht, und dieses Signal mit dem empfangenen Abfragesignal gemischt wird.
12. Endgerät (63, 64) für die Kommunikation zwischen einer an ein Fahrzeug (3, 4), insbesondere ein Schienenfahrzeug montierten Ausrüstung (53, 54) und mindestens einer stationären Betriebseinheit (5), die mit einer Kommunikationseinheit (105) versehen ist;
- wobei diese Kommunikationseinheit (63, 64) der an das Fahrzeug (3, 4) montierten Ausrüstung (53, 54) umfasst
- einen Abschnitt (10) zum Erzeugen und Senden eines Signals zur Abfrage der stationären Betriebseinheit(en) (5) von der Ausrüstung (53, 54) aus, das heißt, vom Fahrzeug (3, 4) zur stationären Betriebseinheit (5), wobei dieses Abfragesignal durch Modulation mit einem eindeutigen Identifikationscode des Fahrzeugs als Modulationsschlüssel erhalten wird;
- einen ersten Abschnitt (12), der ein Antwortsignal von der oder den stationären Betriebseinheit(en) empfängt, die mit Mitteln (120, 420, 320, 520) zum Extrahieren/Demodulieren der von der Ausrüstung (53, 54) benötigten Information versehen ist, die zu den stationären Betriebseinheit(en) (5) und von dort zur Ausrüstung (53, 54) gesendet wird,
- dadurch gekennzeichnet, dass** es umfasst einen zweiten Empfangsabschnitt (13), der vom ersten getrennt ist und mit seinen eigenen Mitteln (130, 230, 330, 430) versehen ist, um den eindeutigen Identifikationscode des Fahrzeugs (3, 4) aus dem vom Erzeugungs- und Sendebereich (10) gesendeten Abfragesignal zu extrahieren/ demodulieren;
- Mittel (15), um die Übereinstimmung zwischen dem Fahrzeugidentifikationscode, der vom zweiten Empfangsabschnitt (13) erhalten wird, und dem Fahrzeugidentifikationscode, der zur Erzeugung des Abfragesignals verwendet wird, zu prüfen.
13. Kommunikationsendgerät (63, 64) nach Anspruch 12, **dadurch gekennzeichnet, dass** es in Verbindung mit mindestens einer stationären Betriebseinheit (5) vorgesehen ist, zu der das Abfragesignal gesendet wird, und wobei diese stationäre Betriebseinheit (5) ein Antwortsignal erzeugt, welches zusammengesetzt ist aus einer Komponente, die dem Abfragesignal entspricht, und einer Komponente, die einem Signal entspricht, das durch die von der Ausrüstung (53, 54) benötigte Information moduliert wird.
14. Kommunikationsendgerät (63, 64) nach Anspruch 12 und 13, **dadurch gekennzeichnet, dass** es mindestens einen Sendeantennendipol (73, 74) und mindestens einen Empfangsantennendipol (83, 84) umfasst, wobei der Sendeantennendipol (73, 74) mit dem Ausgang eines Sendebereichs (10) verbunden ist, umfassend einen Eingang für einen eindeutigen Identifikationscode des Fahrzeugs (3, 4), Mittel (110), um diesen eindeutigen Identifikationscode des Fahrzeugs (3, 4) in ein sinusförmiges oszillierendes Signal umzuwandeln, und Mittel (210), um eine Trägerwelle mit diesem oszillierenden sinusförmigen Signal zu modulieren, wobei der Ausgang dieses Modulationsmittels (210) den durch eine FSK-Modulation frequenzmodulierten Träger dem Sendeantennendipol (73, 74) zugeführt wird und dieser Kodierschlüssel aus dem eindeutigen Identifikationscode des Fahrzeugs (3, 4) besteht.
15. Kommunikationsendgerät (63, 64) nach einem oder mehreren der vorherigen Ansprüche 12 bis 14, **dadurch gekennzeichnet, dass** der Empfangsantennendipol (83, 84) mit einem ersten Empfangsabschnitt (12) verbunden ist, wobei dieser Empfangsabschnitt (12) das Antwortsignal einer stationären Betriebseinheit (5) verarbeitet, um die Information zu extrahieren, die von dieser Einheit (5) an die Fahrzeugausrüstung (53, 54) gesendet wurde, deren Abfragesignal an die stationäre Betriebseinheit (5) gesendet worden ist, und wobei dieser erste Empfangsabschnitt (12) einen Mischer (120) umfasst, welchem das Antwortsignal und das aus dem Modulator (210) des Sendebereichs (10) kommende Signal (1010), das für den frequenzmodulierten Träger relevant ist, zugeführt werden, und die Ausgabe dieses Mixers (120) wird gefiltert (420), um die Information aus diesem Antwortsignal zu extrahieren, wobei das Antwortsignal, das vom ersten Empfangsabschnitt (12) empfangen und von der stationären Betriebseinheit (5) gesendet wurde, zusammengesetzt ist aus einer Komponente, die dem Abfragesignal entspricht, das vom Sendebereich (10) des Kommunikationsendgeräts (63, 64) zur stationären Betriebseinheit (5) gesendet wurde, und einer Signalkomponente, die durch Modulation mit Information versehen wurde.
16. Kommunikationsendgerät (63, 64) nach einem oder mehreren der vorherigen Ansprüche 12 bis 15, **dadurch gekennzeichnet, dass** der Empfangsantennendipol (83, 84) auch mit einem zweiten Empfangsabschnitt (13) verbunden ist, wobei dieser Empfangsabschnitt (13) dazu bestimmt ist, das vom Antennendipol (73, 74) des Sendebereichs gesendete Abfragesignal direkt zu empfangen, und dieses

Abfragesignal zusammen mit dem Signal (910), das der Ausgabe des Trägergenerators (310) des Sendeabschnitts (10) entspricht, einem Mischer (130) zugeführt wird, während der Ausgang des Mixers (130) mit einem Tiefpassfilter (230) verbunden ist, dessen Ausgang mit einem Spannungswandler (330) verbunden ist, dessen Ausgang einen Schwellenwertkomparator (440) zur Wiederherstellung des Kodierschlüssels der Trägermodulation und somit des eindeutigen Identifikationscodes des Fahrzeugs (3, 4) versorgt.

17. Kommunikationsendgerät (63, 64) nach einem oder mehreren der vorherigen Ansprüche 12 bis 16, **dadurch gekennzeichnet, dass** der Identifikationscode des Fahrzeugs (3, 4) an einen Vergleichsabschnitt (15) geleitet wird, um die Übereinstimmung zwischen dem Code, der vom zweiten Empfangsabschnitt (13) aus dem Abfragesignal extrahiert wurde, und dem eindeutigen Identifikationscode, der zur Modulation des Trägers des Abfragesignals verwendet wurde, zu prüfen.
18. Kommunikationsendgerät (63, 64) nach einem oder mehreren der vorherigen Ansprüche 12 bis 17, **dadurch gekennzeichnet, dass** es ein Antennensubsystem mit Sende- (73, 74) und Empfangsantennendipolen und Schaltungen (83, 84) bildet, umfassend den Sendeabschnitt (10), den ersten (12) und zweiten (13) Empfangsabschnitt und möglicherweise die Mittel (15) zur Prüfung der Übereinstimmung zwischen dem Identifikationscode des Fahrzeugs (3, 4), der aus der Kommunikation extrahiert wird mit dem Identifikationscode, der zur Erzeugung des Abfragesignals verwendet wurde.

Revendications

1. Système de communication pour des véhicules, particulièrement des véhicules ferroviaires (3, 4) ou analogue et d'unités stationnaires (5), ledit système réalise:
- un équipement (53, 54) sur chaque véhicule ferroviaire, ledit soi-disant équipement à bord est associé à une section (10) transmettant des signaux interrogeant au moins une ou plusieurs d'unités stationnaires de fonctionnement (5), chacune réalisée à un de divers emplacements prédéterminés de la route du véhicule et particulièrement de la ligne de chemin de fer, et ledit équipement (53, 54) est associé à une section (12) recevant des signaux de réponse d'au moins une ou plusieurs unités stationnaires de fonctionnement (5) qui ont été interrogées, pendant que les unités stationnaires de fonctionnement (5) sont équipées de moyens de réception/

transmission (105) pour recevoir des signaux d'interrogation et pour transmettre des signaux de réponse,

où

la section de transmission (10) de l'équipement (53, 54) sur un véhicule (3, 4) produit un signal d'interrogation constitué d'une onde porteuse qui est modulée en fréquence selon une clé de modulation correspondant à un code d'identification univoque du véhicule ferroviaire (3, 4) ou analogue qui est différent et unique pour chaque véhicule,

pendant que les moyens de réception/transmission (105) d'unités stationnaires de fonctionnement (5) reçoivent ledit signal d'interrogation et le retransmettent à la section de réception (12) associée à l'équipement à bord (53, 54) ajoutant la contribution du signal contenant l'information de réponse de l'unité stationnaire de fonctionnement correspondante (5) comme modulation de porteuse avec ladite information de réponse au signal reçu et modulé en fréquence par le code d'identification du véhicule, **caractérisé en ce que**

le système réalise, en plus de ladite première section (12) recevant le signal de réponse transmis par la ou les unités stationnaires de fonctionnement (5), même une deuxième section de réception (13) associée à l'équipement (53, 54) qui est séparée et indépendante de ladite première section (12) recevant le signal de réponse de la ou des unités stationnaires de fonctionnement (5), et ladite deuxième section de réception (13) est destinée à capturer dans l'air, directement le signal d'interrogation transmis par la section de transmission (10) associée à l'équipement, et ladite deuxième section de réception (13) possède des moyens (130, 230, 330, 430) pour extraire la clé de modulation et qui est le code d'identification univoque du véhicule (3, 4) sur lequel l'équipement (53, 54) est placé par le signal d'interrogation reçu.

2. Système selon la revendication 1, **caractérisé en ce que** la contribution du signal contenant l'information de réponse de l'unité stationnaire de fonctionnement correspondante (5) se présente sous la forme d'une porteuse modulée par ladite information de réponse en accord avec un protocole de modulation du type DPSK.
3. Système selon la revendication 1 ou 2, **caractérisé en ce que** ladite extraction de la clé de modulation et qui est du code d'identification univoque du véhicule (3, 4) sur lequel l'équipement (53, 54) est placé, est produite en fournissant la porteuse non modulée (910) du moyen (310) la produisant à ladite deuxième section de réception (13) et est basée sur une

porteuse telle que le signal d'interrogation peut être traité pour l'extraction de la clé de modulation et qui est le code d'identification univoque du véhicule (3, 4).

4. Système selon une ou plusieurs des revendications précédentes, **caractérisé en ce que** le code d'identification du véhicule obtenu par l'extraction de la clé de modulation du signal d'interrogation est transmis à une unité de comparaison (15) qui peut être combinée avec ou faire partie de l'équipement (53, 54).
5. Système selon une ou plusieurs des revendications 1 à 4, **caractérisé en ce que** la première section (12) recevant le signal de réponse de la ou des unités stationnaires (5) possède des moyens (120, 420, 320, 520) indépendants les uns des autres de la deuxième section de réception (13) destinée à recevoir et extraire du signal de réponse le composant dudit signal de réponse correspondant à la porteuse modulée par le protocole DPSK avec l'information à transmettre au véhicule (3, 4) et pour extraire ladite information, pendant que le signal (1010) correspondant à la porteuse modulée par la clé correspondant au code d'identification univoque du véhicule (3, 4) et provenant du modulateur (210) est fourni également à ladite première section de réception (12), et il est utilisé pour séparer la composante retransmise du signal d'interrogation du signal de réponse et ainsi pour séparer ladite composante de signal correspondant ou portant l'information fournie par l'unité de fonctionnement stationnaire (5), ainsi la cohérence entre le code d'identification de véhicule transmis et celui reçu est vérifiée deux fois et indépendamment.
6. Système selon une ou plusieurs des revendications précédentes, **caractérisé en ce qu'il** comprend une première chaîne de transmission (10), une première chaîne de réception (12) et une deuxième chaîne de réception (13), la chaîne de transmission étant destinée à produire un signal (73, 74) interrogeant une unité de fonctionnement stationnaire (5), ledit signal est constitué de la porteuse codée par modulation FSK (modulation par déplacement de fréquence) en utilisant le code d'identification univoque du véhicule (3, 4) et particulièrement du véhicule ferroviaire comme clé de codage et ainsi comme clé de modulation, pendant qu'une chaîne (13) recevant le signal d'interrogation transmis dans l'air est prévue pour extraire le code d'identification du véhicule par une action de démodulation du signal de la porteuse non modulée (910) fourni directement à ladite chaîne (13) depuis la sortie d'un générateur (310) de ladite porteuse, et pendant qu'une chaîne (12) recevant et extrayant l'information d'un signal de réponse constitué d'une composante réfléchie du signal d'interrogation et d'une composante du signal modulé par

l'information est fournie, ladite chaîne (12) extrait l'information en utilisant le signal d'interrogation, qui est la porteuse modulée (1010) du modulateur (210) de la chaîne (10) en produisant le signal d'interrogation.

7. Système selon l'une ou plusieurs des revendications précédentes, **caractérisé en ce qu'il** comprend une section (15) pour vérifier la cohérence du code d'identification du véhicule utilisé comme clé de modulation du signal d'interrogation entre le code transmis et le code reçu et extrait par la deuxième section de réception (13).
8. Procédé pour la communication entre véhicules (3, 4), en particulier véhicules ferroviaires ou analogue et des unités stationnaires (5), où chaque véhicule (3, 4) possède un équipement (63, 64) muni de moyens (63, 64) pour communiquer avec une ou plusieurs unités de fonctionnement stationnaires (5) munies de moyens de communication (105), ledit procédé, pour identifier d'une manière univoque que l'information reçue d'une unité de fonctionnement stationnaire (5) se rapporte au véhicule (3, 4), si deux véhicules ou plus se déplacent en même temps, réalise les étapes suivantes:
 - a) lors de la transmission, par l'équipement (53, 54) monté sur ledit véhicule (3, 4), produire un signal interrogeant une ou plusieurs unités de fonctionnement stationnaires (5) consistant à coder une porteuse par une modulation de fréquence en utilisant une clé de codage ou de modulation correspondant à un code d'identification univoque du véhicule (3, 4);
 - b) lors de la réception par ledit équipement (53, 54), recevoir un signal de réponse de la ou des unités de fonctionnement stationnaires (5) et recevoir le signal d'interrogation et démoduler séparément le signal de réponse pour l'extraction de l'information utile et la démodulation du signal d'interrogation reçu pour l'extraction de la clé de modulation et ainsi du code d'identification univoque du véhicule;
 - c) vérifier la cohérence entre le code d'identification identifié à l'étape b) et le code d'identification du véhicule utilisé pour la modulation du signal d'interrogation,**caractérisé en ce qu'il** prévoit la réception directe du signal d'interrogation transmis et l'extraction du code d'identification univoque du véhicule en extrayant la clé de modulation du signal d'interrogation transmis capturé dans l'air.
9. Procédé selon la revendication 8, **caractérisé en ce que** les unités de fonctionnement stationnaires (5) produisent un signal de réponse constitué d'une composante correspondant au signal d'interrogation

réfléchi et d'une composante constituée d'une porteuse modulée par l'information.

10. Procédé selon la revendication 9, **caractérisé en ce que** cette information est extraite du signal de réponse en utilisant le signal d'interrogation, ou bien la porteuse modulée en fréquence par la clé de codage étant le code d'identification univoque du véhicule (3, 4), qui est mélangé avec le signal de réponse pour extraire la composante du signal de réponse portant l'information, l'information étant extraite de ladite composante.
11. Procédé selon la revendication 9 ou 10, **caractérisé en ce que** le code d'identification univoque du véhicule (3, 4) correspondant à la clé de codage de la modulation en fréquence de la porteuse et étant le signal d'interrogation est extrait en utilisant un signal (910) correspondant à ladite porteuse non modulée et en mélangeant ledit signal avec le signal d'interrogation reçu.
12. Terminal (63, 64) pour la communication entre un équipement (53, 54) monté sur un véhicule (3, 4), particulièrement un véhicule ferroviaire, et au moins une unité de fonctionnement stationnaire (5) munie d'une unité de communication (105);

ladite unité de communication (63, 64) de l'équipement (53, 54) montée sur le véhicule (3, 4) comprend

une section (10) pour produire et transmettre un signal interrogeant une ou des unités de fonctionnement stationnaires (5) de l'équipement (53, 54), qui est du véhicule (3, 4) à ladite unité de fonctionnement stationnaires (5), ledit signal d'interrogation étant obtenu par une modulation en utilisant un code d'identification univoque du véhicule comme clé de modulation;

une première section (12) recevant un signal de réponse de la ou des unités de fonctionnement stationnaires (5) muni de moyens (120, 420, 320, 520) pour extraire/démoduler l'information requise par l'équipement (53, 54) à ou aux unités de fonctionnement stationnaires (5) et transmise à l'équipement (53, 54) depuis celles-ci, **caractérisé en ce qu'il** comprend:

une deuxième section de réception (13) séparée de la première et munie de ses propres moyens (130, 230, 330, 430) pour extraire/démoduler le code d'identification univoque du véhicule (3, 4) du signal d'interrogation transmis par la section de génération et de transmission (10);

des moyens (15) pour vérifier la cohérence entre le code d'identification du véhicule obtenu par la deuxième section de réception (13) et le code d'identification du véhicule utilisé pour produire le signal d'interrogation.

13. Terminal de communication (63, 64) selon la revendication 12, **caractérisé en ce qu'il** est réalisé en combinaison avec au moins une unité de fonctionnement stationnaire (5) à laquelle le signal d'interrogation est transmis, et ladite unité de fonctionnement stationnaire (5) produit un signal de réponse constitué d'une composante correspondant au signal d'interrogation et d'une composante correspondant à un signal modulé par l'information requise par l'équipement (53, 54).

14. Terminal de communication (63, 64) selon les revendications 12 et 13, **caractérisé en ce qu'il** comprend au moins un dipôle d'antenne de transmission (73, 74) et au moins un dipôle d'antenne de réception (83, 84), le dipôle d'antenne de transmission (73, 64) étant connecté à la sortie d'une section de transmission (10) comprenant une entrée pour un code d'identification univoque du véhicule (3, 4), des moyens (110) pour convertir ledit code d'identification univoque du véhicule (3, 4) en un signal oscillant sinusoïdal et des moyens (210) pour moduler une onde porteuse avec ledit signal sinusoïdal oscillant, la sortie dudit moyen de modulation (210) fournit la porteuse modulée en fréquence par une modulation FSK audit dipôle d'antenne de transmission (73, 74), et ladite clé de codage est constituée du code d'identification univoque du véhicule (3, 4).

15. Terminal de communication (63, 64) selon une ou plusieurs des revendications précédentes 12 à 14, **caractérisé en ce que** ledit dipôle (83, 84) de l'antenne de réception est connecté à une première section de réception (12), ladite section de réception (12) traite un signal de réponse d'une unité de fonctionnement stationnaire (5) pour extraire l'information transmise par une telle unité (5) à l'équipement (53, 54) du véhicule, dont le signal d'interrogation a été transmis à ladite unité de fonctionnement stationnaire (5), et ladite première section de réception (12) comprend un mélangeur (120) auquel le signal de réponse et le signal (1010) se rapportant à la porteuse modulée en fréquence provenant du modulateur (210) de la section de transmission (10) est fourni, et la sortie dudit mélangeur (120) est filtrée (420) pour extraire l'information dudit signal de réponse, le signal de réponse reçu par ladite première section de réception (12) et transmis de l'unité de fonctionnement stationnaire (5) étant constitué d'une composante correspondant au signal d'interrogation transmis à ladite unité de fonctionnement stationnaire (5) depuis la section de transmission (10) du terminal de communication (63, 64) et d'une composante de signal à laquelle l'information est associée par modulation.

16. Terminal de communication (63, 64) selon une ou plusieurs des revendications précédentes 12 à 15,

caractérisé en ce que le dipôle (83, 84) de l'antenne de réception est connecté également à une deuxième section de réception (13), ladite section de réception (13) est destinée à recevoir directement le signal d'interrogation transmis par le dipôle (73, 74) de l'antenne de la section de transmission, et ledit signal d'interrogation est transmis à un mélangeur (130) conjointement avec le signal (910) correspondant à la sortie du générateur de porteuse (310) de la section de transmission (10), alors que la sortie du mélangeur (130) est reliée à un filtre passe-bas (230) dont la sortie est connectée à un convertisseur de tension (330) dont la sortie fournit un comparateur de seuil (430) pour reconstruire la clé de codage de la modulation de la porteuse et ainsi le code d'identification univoque du véhicule (3, 4).

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17. Terminal de communication (63, 64) selon une ou plusieurs des revendications précédentes 12 à 16, **caractérisé en ce que** le code d'identification du véhicule (3, 4) est transmis à une section de comparaison (15) pour vérifier la cohérence entre le code extrait du signal d'interrogation par la deuxième section de réception (13) et le code d'identification univoque utilisé pour moduler la porteuse du signal d'interrogation.

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18. Terminal de communication (63, 64) selon une ou plusieurs des revendications précédentes 12 à 17, **caractérisé en ce qu'**il constitue un sous-système d'antenne comprenant des dipôles d'antenne de transmission (73, 74) et de réception (83, 84) et des circuits formant la section de transmission (10), les première (12) et deuxième (13) sections de réception et éventuellement des moyens (15) pour vérifier la cohérence entre le code d'identification du véhicule (3, 4) extrait de la communication et comparé au code d'identification utilisé pour produire le signal d'interrogation.

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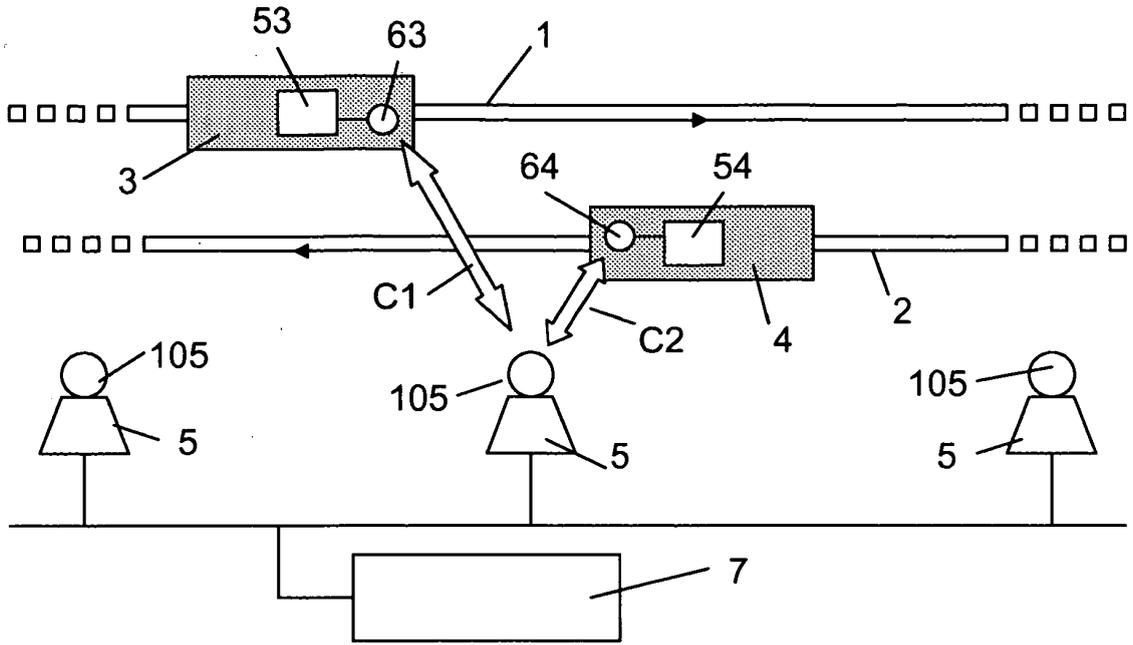


Fig. 1

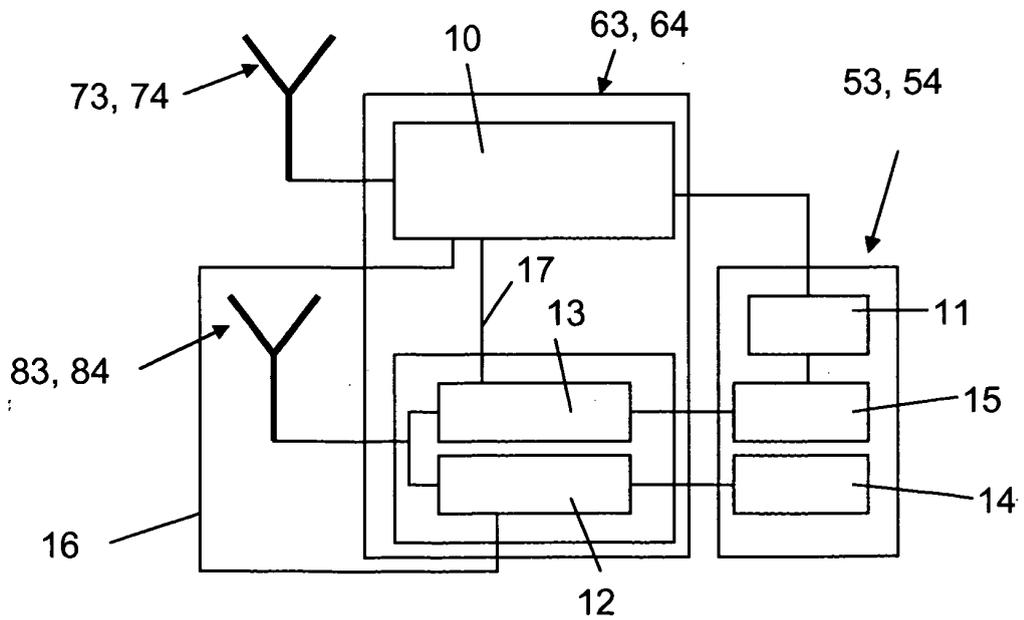


Fig. 2

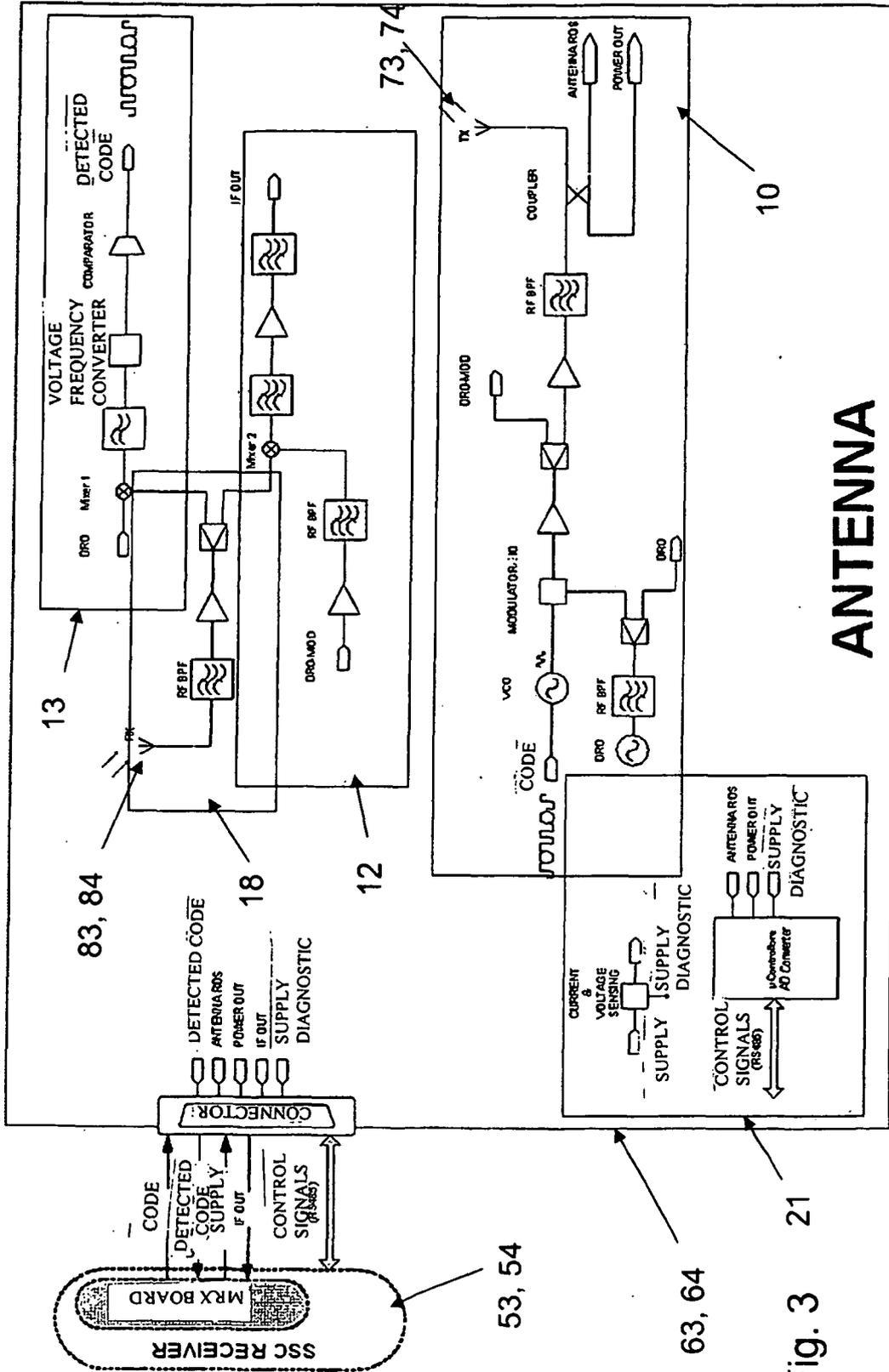


Fig. 3 21

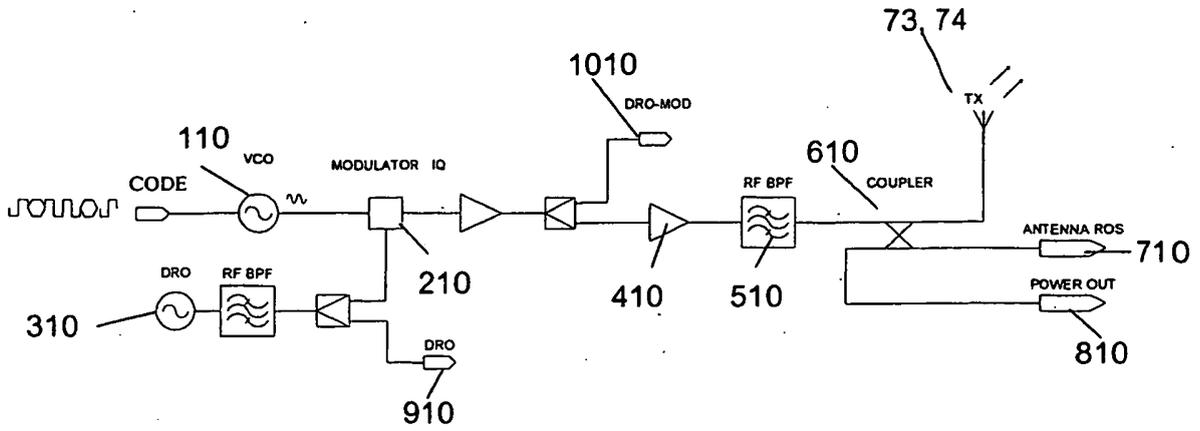


Fig. 4

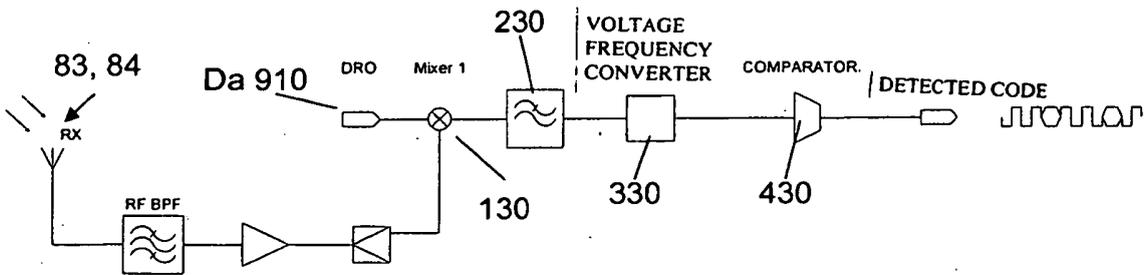


Fig. 5

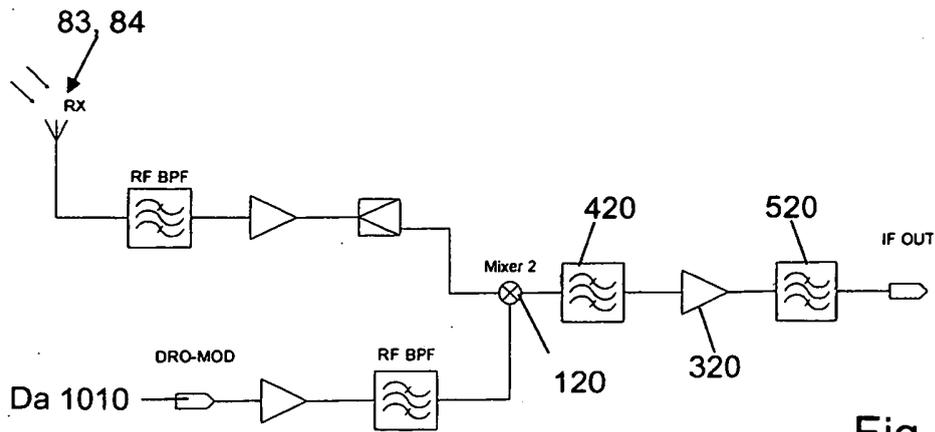


Fig. 6

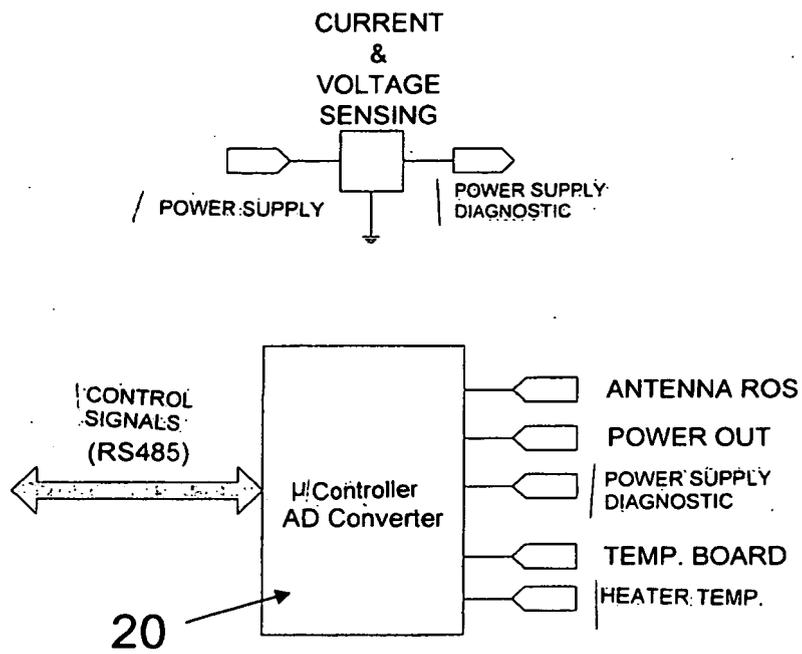


Fig. 7

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 9411754 A [0002]