A track circuit system combined with an automatic control system for rail-mounted vehicles, in which the transmission of information to and the detection of rail-mounted vehicles in the system take place by the exchange of digital messages in the form of telegrams. The telegrams have contents with safety information with, above all, information about track circuit identity but may also have general contents. Separate electronic units (E1, E2) generate two telegrams with the same information contents. These telegrams are compared prior to transmission to a track circuit (2), in which a receiver (B) picks up the telegram. Transmitted and received telegrams are compared for achieving fail-safety. Level indication of the received signal gives information as to whether the track circuit is occupied. An output signal (4) from the system is used as a fail-safe signal for feeding to a traffic control system.
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Track circuit system

TECHNICAL FIELD

The present invention relates to a method and a device for automatic traffic control in connection with trackbound communication. In particular, the method and the device comprise means for detection of rail-mounted vehicles on a track circuit and identification of the track circuit in order to supervise the movement of the rail-mounted vehicle on the circuit in question. Further, the method and the device make possible the transmission of selective information to the supervision units of adjacent track circuits for control of the movement pattern of a leading or trailing rail-mounted vehicle. The device is based on the utilization of digital information transmission between the units included.

BACKGROUND ART

To obtain different forms of automatic traffic control of rail-mounted vehicles, a number of different methods exist at present. Common for all types of control systems is the need for information to the system and for conveyance of the information to the supervised vehicle units. This is solved in a number of different ways. For transmission of traffic information to the vehicles, transmitters, inter alia, are located at certain intervals along the track. See, for example, patent DE 229878. A considerable disadvantage of similar methods is that the vehicles out on the track cannot be continuously provided with up-to-date or changed information.

A solution to the problems which arise when utilizing transmitters and receivers placed along the track for information supervision is to use the track itself as signalling circuit. A switch to a so-called track circuit system has then been made. Track sections are arranged, in
which each track section is electrically insulated from the
other sections. Such a track section is called a track
circuit. This is known technique. Various train block
systems are available on the market, in which, inter alia,
the tracks are utilized as signalling circuit. Using, for
example, rails as conductor of course involves limitations.
For example, it has been very difficult to transmit a
sufficient amount of information in the systems that have
used the rails as transmitting agent for data messages sent
via the rails. In addition, the rails are subjected to
disturbances of various kinds and the difficulties in
creating a fail-safe information transmission are
consequently considerable. It is known to use messages in
digital form modulated as tone frequency signals, thus
reducing the influence of such disturbances, as is described
in, for example, "Die neue Gleisfreimeldung FTG 5917", Josef
Czechowsky, Signal und Draht 74 (1982). The present
invention proposes a different modulating method and a
method of increasing the fail-safety in the transmission of
messages.

SUMMARY OF THE INVENTION

The following describes a system of functions which are
applicable to a system concept which includes a track
circuit system combined with an automatic train control
system for rail-mounted vehicles. Parts of the invention
belong to the state of the art but are applied in a new and
special way.

First of all, standard baseband modulation technique for
telecommunication systems is chosen to modulate a signal for
a track circuit in order to achieve feeding of serial data
by way of the rails. At the same time, the level of the
baseband signal is used to indicate the presence of shunting
vehicle axles on the track circuit. The baseband modulation
that is chosen could be, for example, differential phase
modulation (DPSK = differential phase shift keying).
Baseband modulation provides a possibility of synchronous serial data transmission. The data to be transmitted are collected in information messages in so-called telegrams. These telegrams are divided into blocks or frames in accordance with the high-level data link control (HDLC) technique, according to the standard worked out by CCITT. Thus, a bitoriented protocol is used for the information transmission. It is, of course, also possible to use other synchronous protocols, or even asynchronous transmission and asynchronous protocols. The latter protocols are, however, less biteffective than bitoriented protocols, such as, for example, HDLC.

Excellent results have been attained in railways for direct current operation when utilizing the above-mentioned technique in the frequency range of up to 2000 Hz, and this despite the relatively great spectral bandwidth required for this kind of transmission.

Transmitting serial data and indicating the presence of vehicle axles within a track circuit by means of the carrier of the signal are known, as previously mentioned, and utilized in other control systems. A novelty in the present supervision or control system is the use of standard transmission technique for, for example, telephony and the like in this application.

The address contents of the HDLC telegrams are the basis for track circuit identification, which is of value for separating disturbance signals from the environment or from the influence of other track circuits. Identification by using serial data may also have been performed by others in the past.

The telegrams may contain safety information which is picked up by antennas on the rail-mounted vehicles, located, for example, in front of the first axle. These telegrams are
evaluated in train-borne equipment for speed supervision. The telegrams for the rail-mounted vehicle may also contain other information of non-safety character. Information may also be conveyed from one track circuit to the next in order to provide a railway line with a block system. This also belongs to the state of the art described, for example, in "Vergleich der Systemmerkmale verschiedener Zugbeeinflussungseinrichtungen", Köth, Eisenbahn Technische Rundschau 20 (1971).

The novel feature is that all the above-mentioned characteristics are combined and applied to one and the same technical system. The HDLC telegrams provide freedom to place information in one or a number of the frames which build up the telegram, which gives great flexibility when modelling a system for information transmission. Information to the system may be mixed in or between the frames in different ways. Unspecified information may be put in one of the frames in a data telegram or be mixed with safety information in several different frames. In the latter case, the unspecified information may be multiplexed in several frames and time-shared with the safety information which is transmitted in repeated frames. This is a process which is also not used elsewhere.

The track circuit system needs a fail-safe level detector, a function which has been mentioned above. This unit will not be further discussed in this description.

Another novelty is the principle of safe detection of data in the track circuit. The generation of the information and the associated and necessary redundancy are achieved in two separate channels, of which one feeds the track circuit with a signal at one end of the track circuit. The signal received at the other end of the track circuit is compared in a fail-safe way with the output signal in a first comparator. The output signal from the first comparator is forwarded, for example to a track relay or some other safety
unit as, for example, a computerized interlocking system. In this way, any influence of disturbance in the track as well as failures in the transmitter units connected to the track are discovered.

The transmission is also continuously checked by a second comparator which compares the information contents in two telegrams generated in two separate units before the information of the transmitting channel is transmitted to the track. This is necessary because when there is a rail-mounted vehicle on the track circuit, no signals reach the receiving unit on the track, which makes the output signal of the first comparator of no interest.

Different temporary disturbances and influences may be filtered out by imparting significance only to repetitive telegrams, where the demand is placed such that at least m out of n telegrams must be unmistakably given the same information content. As a consequence of this, the proposed method may provide the advantage that a smaller amount of redundant information need be fed to the track, since the information of the output signal has been verified by the above-described signal generation and the ensuing comparison. For that reason the telegrams can also be accepted by rail-mounted vehicles which utilize the same filtering technique and which with certainly sense the information as safe. Thus, more information can be transmitted per unit of time. However, the safety information must be made relevant of m out of n telegrams, which, of course, reduces the information flow in the channel. The bit error rate in the digital signals must therefore be fairly low to provide an acceptable system. However, this requirement does not affect the safety.

In the above-mentioned systems, it is required that the transmitter feeds signals towards the rail-mounted vehicle. When changing the direction of traffic, the transmitter/receiver must change places.
BRIEF DESCRIPTION OF THE DRAWING

The accompanying figure shows a schematic view of a proposed linking of units which gives the system the functions aimed at in the description.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A proposed embodiment of the present invention with a method and a device for carrying out the method will be described with reference to the accompanying figure.

A first encoder E1 produces telegrams to be sent to a track circuit. Each such telegram contains, in the general case, three different parts comprising a to c, in which

a) is safety information for the receiver of the track circuit, i.e. information which is unique for each track circuit,

b) is fail-safe safety information for the rail-mounted vehicle with contents such as, for example, allowed speed over the track circuit,

c) is safety information to the rail-mounted vehicle, for example an indication as to the destination, stopping points for the vehicle, order for freewheeling, or some information for the operator.

The a-part of a telegram is always the same in a track circuit, whereas the b- and c-parts may be changed from time to time depending on the traffic situation and the like.

In a second encoder E2, the same data messages as in the first encoder E1 are produced but not necessarily in the same format.
The telegrams which are built up in the two encoders E1 and E2 are controlled by external control signals, which carry the information which is to be conveyed via the track circuit system. These control signals are symbolized in the figure by the arrows at 1.

The signal with messages in the form of telegrams from the first encoder E1 is forwarded to a combined code generator-transmitter G as well as to a second comparator C2. The combined code generator-transmitter G is connected to an amplifier A and transmits to this the telegrams which have been produced by the first encoder E1 for the track circuit.

A track circuit is a section of a railway line, in which such a section is electrically delimited from adjacent sections by, for example, an electrical insulation 3 between the track circuits.

The amplifier A converts the signal voltage from the code generator-transmitter G to a level and shape adapted for transmission to the track circuit. This amplifier A is provided with an adjustment device which makes possible adaptation of the voltage level to the length of the track circuit connected. The signals from the amplifier A are fed to the track circuit with one pole to each rail 2 and are preferably connected at the end point of the track circuit.

The signal voltage which is fed via the track is picked up at the other end point of the track circuit by a receiver B with an interface for reception from the track circuit. The receiver B comprises screening circuits which filter out the desired signal from electrical interference, if any, in the track.

The received signal is forwarded to a fail-safe level or threshold detector TD, which in a reliable manner measures the amplitude of the signal voltage in the track to determine whether the signal voltage level lies above or
below a certain value, which indicates a free track circuit or a track circuit occupied by a vehicle.

From the level detector TD the signal is forwarded in the reception channel to a decoder D, where the code message is again quantified.

As mentioned above, both encoders E1, E2 produce data codes with the same telegram contents. The signals from the two encoders E1, E2 are brought to the second comparator C2 where the code messages are compared in a fail-safe manner. If there is no correspondence between the two separate signals, the transmission from the code generator G is cut.

Also the signal received from the track circuit is compared with the transmitted signal in a fail-safe manner, among other things to avoid that a signal from adjacent track circuits can be received in case of a fault in insulating joints 3. Such a comparison is made at least of the a-part in the telegram and is carried out in a first comparator C1, where the signal transmitted to the track circuit is fetched from the data encoder E2 and the signal received from the track circuit is fetched from the decoder D. If the contents of the two channels in the a-part of the telegram are equivalent, a fail-safe output signal 4 is generated from the first comparator C1. This output signal 4 indicates a track circuit free from vehicles. This output signal 4 from the track circuit system is utilized for controlling different devices in the signal system of which the track circuit forms a part.

A rail-mounted vehicle adapted to the track circuit system has a receiver with an antenna near the rail in front of the first axle in the direction of travel. Since the signals in the track have different polarities in the two rails, the vehicle may suitably be equipped with two antennas, which pick up the same signal but with opposite polarity. When these signals are added, a more powerful input signal is
received by the receiver while at the same time disturbing
signals from the two antennas cancel each other.

The rail-mounted vehicle according to the above is provided,
in principle, with the same type of data communication
receiver as the track circuit system and thereby senses
telegrams received from the track circuit as failsafe; thus,
the rail-mounted vehicle can be supervised by the system.
CLAIMS

1. A track circuit system combined with an automatic control system for rail-mounted vehicles, characterized in that the transmission of information to rail-mounted vehicles and the detection of rail-mounted vehicles on a track circuit take place by the exchange of digital messages between electronic units,

separate electronic units generate at least two messages with the same information to the track circuit, which messages in order to achieve fail-safety are compared in an electronic unit prior to transmission to the track circuit,

a message transmitted to the track circuit is picked up by a receiver connected at some other location within the track circuit,

a message transmitted to the track circuit and a message received from the track circuit are compared in a fail-safe manner in an electronic unit, which generates a fail-safe output signal (4) with information about the traffic situation within the track circuit, an output signal (4) which is used for controlling the traffic control equipment,

rail-mounted vehicles located within the track circuit may continuously decode the information sent to the track circuit.

2. A track circuit system according to claim 1, characterized in that the transmission of messages between units in the system takes place in telegrams which are divided into a number of sections, one section containing safe information about the identity of the track circuit, another section containing safe traffic
control information and a third section containing varying unspecified information.

3. A track circuit system according to claims 1 and 2, characterized in that fail-safety upon comparison between messages sent to and received by the track circuit is achieved in a counter in which at least m out of n telegrams shall be identical, at least with respect to sections of the telegrams which are relevant to the safety, in order to verify faultless data communication in the track circuit.

4. A track circuit system according to claims 1 and 2, characterized in that the telegrams to rail-mounted vehicles on the track circuit contain information about travel speed over the track circuit and other information of a safety nature.

5. A track circuit system according to claims 1-4, characterized in that the telegrams are divided into frames and where mixed information is sent separately in one frame or multiplexed in several frames, time-shared with repeated frames containing safety information.

6. A track circuit system according to claims 1-5, characterized in that the telegrams contain information about a free or occupied track circuit, which information may be used in a block system.

7. A device in a track circuit system according to claim 1, characterized in that the device comprises

a first encoder (E1) which produces serial data in the form of telegrams divided into different sections which are significant from the point of view of safety,

a second redundant encoder (E2) which produces data telegrams with the same information contents as the first
encoder (E1) but not necessarily in the same format as the telegrams of the first encoder (E1),

a code generator-transmitter (G) which produces a baseband signal, which is modulates with the signal from the encoder (E1) and the created signal of which is amplified and fed to the track circuit,

a receiving unit (B) with a fail-safe level detector (TD) and a decoder (D),

a fail-safe first comparator (C1) which compares the telegrams received from the track circuit and the telegrams sent to the track circuit,

a fail-safe second comparator (C2) which compares the output signal from the encoders (E1, E2) and breaks the transmission from the code generator (G) to the track circuit if the output signals from the respective encoders (E1, E2) do not match each other.

8. A device in a track circuit system according to claim 7, characterized in that encoders (E1, E2), code generator-transmitter (G), level detector (TD), decoder (D) and comparators (C1, C2) are implemented in a fail-safe computer unit.

9. A device in a track circuit system according to claim 7, characterized in that the signal from the code generator-transmitter (G) to the track circuit and the signal from the track circuit to the receiving unit (G) are connected to each end of a track circuit.
INTERNATIONAL SEARCH REPORT

International Application No PCT/SE 90/00865

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)  
According to International Patent Classification (IPC) or to both National Classification and IPC  
IPC5: B 61 L 1/18, 25/02  

II. FIELDS SEARCHED  
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IPC5 | B 61 L  

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in Fields Searched  
SE, OK, FI, NO classes as above  

III. DOCUMENTS CONSIDERED TO BE RELEVANT  
Category | Citation of Document, with indication, where appropriate, of the relevant passages | Relevant to Claim No.  
---|---|---  
A | US, A, 4498650 (B L SMITH ET AL) 12 February 1985, see abstract | 1-9  
A | EP, A1, 0288564 (K FUTSUHARA) 2 November 1988, see page 4, column 16 - page 5, line 24 | 1-9  

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IV. CERTIFICATION  
Date of the Actual Completion of the International Search  
18th April 1991  
Date of Mailing of this International Search Report  
1991-04-22  
International Searching Authority  
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ANNEX TO THE INTERNATIONAL SEARCH REPORT
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