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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : B61L 3/12, 27/00 — A1

(11) International Publication Number: WO 96/09199

(43) International Publication Date: 28 March 1996 (28.03.96)

(21) International Application Number: PCT/DK95/00382

(22) International Filing Date: 25 September 1995 (25.09.95)

(30) Priority Data:
1095/94 23 September 1994 (23.09.94) DK

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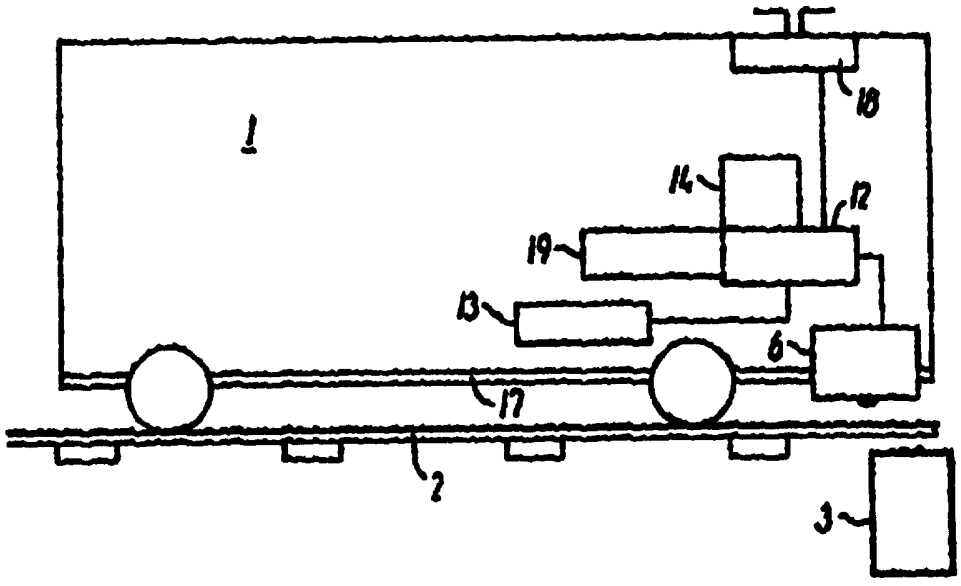
(81) Designated States: AM, AT, AU, BB, BG, BR, BY, CA, CH, CN, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IS, JP, KE, KG, KP, KR, KZ, LK, LR, LT, LU, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TT, UA, UG, US, UZ, VN, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG), ARIPO patent (KE, MW, SD, SZ, UG).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: A TRAFFIC CONTROL SYSTEM, USE OF IT, AND A METHOD OF CONTROLLING THE MOVEMENT OF A MOBILE UNIT



(57) Abstract

A traffic control system for mobile units comprises a plurality of stationary, passive units having electronic store capacity and transmit and receive facilities. The store of the passive units contains an information code which is unique to the unit and is related to the position of the unit concerned. A mobile unit has a computer with associated store capacity and transmit and receive facilities. When interrogated by a mobile unit, the stationary units supply their information code, enabling the mobile unit to calculate its position. The store of the stationary units, in addition to the information codes of said units, contains stored traffic messages which are supplied together with the information code upon interrogation from the mobile unit. The movement from the mobile unit can be adjusted according to the traffic information received.

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A traffic control system, use of it, and a method of controlling the movement of a mobile unit

The invention concerns a traffic control system of the type defined in the introductory portion of claim 1, and the use of such a system in connection with train traffic. The invention moreover concerns a use and a method of controlling the movement of a mobile unit, said method being of the type defined in the introductory portion of claim 11.

The work on increasing the train speeds has created a need for ensuring reliable train control systems.

EP-A-145 464 discloses a train control system wherein transponders, applying a coded response to an inquiry, are located along the track. A train receives information on the code of the next transponder from a control centre, and the train reports when this code has been detected. If the transponder is not detected, the train is brought to a standstill.

GB-A-2 219 833 discloses a traffic information system for use in bus traffic. A transmitter is provided at each bus stop, transmitting a code to a bus when interrogated, whereby the position of the bus may be determined. This information may be used e.g. in traffic control centres for putting on more buses if necessary.

US 5 129 605 discloses a system wherein a plurality of different position determination systems are used for determining the exact position of a train. The whole is controlled by a control centre which coordinates the information.

Furthermore, a safety system called automatic train control (ATC) has been developed for the purpose of improving train safety. This system protects against a number of human errors on the part of the train drivers, one of the basics of the system being that the train is provided with a computer which receives traffic information, such as stop signals and speed limits, from a plurality of transmitters along the track. Thus, the computer may bring the train to a standstill irrespective of what the train driver does when the train arrives at a stop signal. The signals and the transmitters are controlled from a central signalling post.

The object of the invention is to provide a system making it possible to control a mobile unit, such as a train, which can take place without interference from a traffic control centre as long as the flow of traffic is smooth.

This object is achieved in that the traffic control system is provided with the constructive features defined in the characterizing portion of claim 1. The use of stationary, passive units arranged along a track obviates the need for running cables along the track. Thus, it is easy to encapsulate the stationary units so as to avoid ingress of water. The system is thus extremely insensitive to wind and weather. The stationary units apply a unique code to an interrogation, and the computer of a mobile unit can determine its position, the positions of the stationary units, following mounting, being determined exactly and stored electronically. The mobile unit can hereby determine its position on the basis of the unique code by an electronic look-up table. The mobile unit simultaneously receives traffic information, such as speed limits and data concerning the last-passed train on the point concerned of the section. It is hereby possible to control the speed pilot of the train by data obtained directly

from the stationary unit. As mentioned, the traffic information may also include information concerning the last-passed train, it being hereby possible to estimate the distance to the preceding train and to determine the distance to it. The movement of the train or the mobile unit may thus be adjusted according to this information. This train control may be made additionally safe in that the trains automatically transmit the message to a central control unit, if they no longer keep an expected time-table, so that subsequent trains can calculate more safely whether the section ahead is unoccupied by combining data obtained from the stationary units with data concerning anomaly for a train ahead.

Expediently, as stated in claim 2, the stationary units are tags which transmit and receive at low frequencies, preferably at 27 MHz. The tags may hereby be buried and thus concealed and protected against wind and weather.

Since the stationary units are constructed as stated in claim 3, it is possible to produce a very inexpensive and practically maintenance-free traffic control system, because the circuits are powered by the electromagnetic energy released by the mobile units through their interrogation signal.

As stated in claim 4, the mobile units may store traffic information in the stationary units, and these traffic messages may consist of the interrogation time of the mobile unit and identity information concerning the mobile unit, as stated in claim 5. These data are communicated to the next unit and are then erased, since they are no longer of interest. As stated in claim 6, the traffic messages may comprise speed limits and information on local conditions, and this information may be a warning of work along the track, etc.

As stated in claim 7, the calculated position information may be displayed on a display, the information being represented either by numerical values or as a graphic indication on a map.

As stated in claim 8, the control unit of the mobile unit calculates the distance to the last-passed mobile unit - optionally in time - which takes place on the basis of the received traffic messages from the stationary units and optionally from a traffic control centre if the last-passed unit does not keep a predetermined timetable.

Storage of driving-technical information expediently takes place as stated in claim 9, while more permanent traffic messages are stored after the completion of a successful recognition procedure, i.e. a mobile unit is to validate that it is entitled to store the type of messages concerned, and such a procedure is usually called a handshaking procedure. Corresponding procedures are performed when such permanent traffic messages are erased.

The traffic control system defined in claims 1-10 may be used in connection with a large number of mobile units, and these follow a more or less predetermined route. This may e.g. be taxiing of aircraft in airports, where the pilot himself can taxi the aircraft to a gate, and the control tower does not have to interfere as long as there is no other aircraft along the route concerned. The system can be used in connection with public bus traffic, since a computer incorporated in a bus can transmit information to a traffic control centre if the bus does not keep the timetable. The traffic control centre can then display the expected changed arrivals at subsequent bus stops. The passengers will hereby be kept currently informed of the expected arrival of the next bus. However, the system finds particular application within traffic control sys-

tems in connection with railway traffic as stated in claim 11. Here, the train driver can drive the train without interference from the traffic control center as long as the established timetable is kept. The train drivers are no longer referred to visual signals along the track, but can drive the train on the basis of their knowledge of the position of the train and the knowledge of the position of the last-passed train. This opens up the prospect of introducing driver-less trains, where the computer of the train controls its movements. The invention also concerns a method which is distinguished by the subject-matter defined in claim 12.

The invention will be explained more fully below in connection with a preferred embodiment and with reference to the drawing, in which:

fig. 1 schematically shows the control system of the invention in connection with a train;

fig. 2 shows in plan view how the control system of the train communicates with a stationary unit through an inductive coupling by means of frame aerial;

fig. 3 schematically illustrates the communication between the computer of the locomotive and a stationary unit and a traffic control centre;

fig. 4 schematically shows the structure of a stationary unit;

fig. 5 shows how the information may be protocolized with an interrogation and a subsequent reply in a traffic control system according to the invention; and

fig. 6 shows how the interrogation may be designed, when simultaneously storing data of a more permanent nature.

The traffic control system of the invention is shown in fig. 1 and is implemented in the shown embodiment in a train 1 travelling on rails 2. Stationary units 3 or tags are provided along the track, said tags preferably operating at 27 MHz, so that they lend themselves to being buried, e.g. along a track, without interfering with the transmission and reception conditions of these tags. The stationary units 3, which are shown in greater detail in fig. 4, all contain a predetermined identification code. These stationary units are provided along the track at a predetermined distance of e.g. 100 meters or 500 meters, and the positions of the stationary units are subsequently determined very precisely, and the position of the unit is stored together with the information code as a table in an electronic store. These electronic tables are subsequently copied in the computers of all mobile units, which can subsequently determine their own positions exactly by a table look-up when they detect a stationary unit. The mobile unit 1 communicates with the stationary unit 3 through a frame aerial 17, which is connected to a computer 12 through a transmitter/receiver 16. This electromagnetic signal is received by a frame aerial 4 on the stationary unit, which will be explained in connection with fig. 4. In reply to an interrogation the stationary unit transmits its identification code as well as stored traffic messages by means of which the computer 12 can calculate its own position and ensure that there are no other trains or mobile units immediately ahead on the rails. If the stationary unit 3 contains information concerning speed limits, such information may be used via the computer 12 for controlling the maximum speed of a traffic pilot 13. Further, the computer 12 can calculate the distance to the last-passed mobile unit, which can be shown

on a display 14 together with various relevant items of information, such as the actual speed of the train, the time and the previously calculated position; the latter may be shown either in an alphanumeric representation or as a graphic representation on a map or a map segment. The train driver may also communicate with the computer 12 through a driver interface 19 in the form of a keyboard. The computer is moreover connected to a unit 11 from which driving-technical data are obtained. It is thus here that the computer receives information on the actual speed of the train. The computer 12 is finally connected to a unit 13 from which it receives information on driving-technical initiatives, i.e. activation of brakes, activation of throttle control, etc. It is noted that two-way communication is involved, so that the computer 12 receives information on driving-technical initiatives, but can also take over the control from the train driver, if, owing to the received information, the computer detects a situation where such interference is required.

Simultaneously, the computer 12 is in radio communication with a traffic control centre 15, which takes place via a transmitter/receiver 18 with associated aerial. The computer 12 currently receives relevant information via this radio connection, and this information comprises time adjustments, the passage points of time of the system being currently stored in the stationary units, so that a certain precision is required with respect to the points of time. The information also comprises current information on other trains, if these do not keep the predetermined timetables, and the amount of deviation involved for these trains timewise. Trains are identified by means of predetermined identification codes. The centre simultaneously transmits current interrogations to which the computer merely replies OK as long as the timetable is kept. In case of deviations from the timetable beyond permitted

tolerances, the computer of the train communicates the amount of these deviations, which is determined by means of the position determination compared with predetermined timetables stored in the store of the computer.

Fig. 4 shows the stationary unit 3 which, as mentioned before, comprises a frame aerial 4 or coil, which communicates with the control unit 7 or CPU of the stationary unit via a transmitter/receiver interface. The control unit 7 is powered from the transmitter/receiver interface, which takes place by means of a rectifier circuit 6 that rectifies the radio signal and supplies a DC voltage to the control unit 7 over its associated stores. The control unit 7 has a PROM 9 in which the program sequences necessary for the function are stored together with the unique identification code of the control unit. The stationary unit moreover has a RAM in which traffic messages are stored. Traffic messages in the form of passage points of time or interrogation points of time and train information are overwritten on previous, corresponding information, while traffic messages of a more permanent nature, such as speed limits and the like, are stored in separate store sections in the RAM 8.

The communication between a mobile unit 1 and a stationary unit 3 may take place e.g. as shown in fig. 5. The mobile unit first gives a password 20 which partly ensures that the unit is allowed to store data in the RAM of the stationary unit, partly starts the power supply to the stationary unit. After the password 20, an information code 21 is given, followed by driving-technical information in the form of interrogation point of time and optionally speed. When the stationary unit has received these data, it transmits it unique information code 25 by means of which the mobile unit can determine its position by a table look-up. It subsequently transmits traffic messages

consisting partly of information on the last-passed mobile unit, said information being designated 26, as well as information of a more permanent nature, such as speed limits and warnings of work along the track. The last-mentioned permanent data are designated 27.

Fig. 6 illustrates how data may be composed, if the mobile unit is to be permitted to store data which are of a more permanent nature. The data order is by and large the same as above, the mobile unit supplying a password 20, an identification code 21 followed by driving-technical data 22, and then the mobile units supply another password 23 which, if the stationary unit recognizes it, permits the mobile unit to store information of a more permanent nature, said information being designated 24 and comprising speed limits and the like, as mentioned above. When the stationary unit has recognized these data, it supplies a reply, as shown in connection with fig. 5.

The invention has been explained above in connection with train control systems, but it is clear that a number of advantages can be achieved by implementing a system of the type described above along the roads in major Danish towns, where the knowledge of the exact positions of cars and buses may be used for improving the service to bus passengers, improving the safety of taxi drivers and aiding emergency vehicles by creating green waves through the towns.

The invention may moreover be used in connection with taxiing of aircraft in airports, so that the control towers are relieved of this type of job.

Further, the system opens up the prospect of putting driver-less trains into operation.

Patent Claims:

1. A traffic control system for mobile units (1) and comprising:

- a plurality of stationary, passive units (3) having electronic store capacity (8, 9) and transmit and receive facilities (4, 5), said store containing an information code (25) which is unique to the unit and is related to the position of the unit concerned;

- at least one mobile unit (1) having a computer (12) with associated store capacity and having transmit and receive facilities (16, 17);

- said stationary units (3) when interrogated (20-22) by a mobile unit (1, supplying its information code (25) enabling the mobile unit (1) to calculate its position,

characterized in

- that the stationary units, in addition to their information codes (25), contain stored traffic messages (26, 27) which are supplied together with the information code (25) upon interrogation from the mobile unit (1),

- and that the movement of the mobile unit (1) can be adjusted according to the traffic information (26, 27) received.

2. A traffic control system according to claim 1, characterized in that the passive units (3) are tags which transmit and receive at low frequencies, preferably at 27 MHz.

3. A traffic control system according to claim 1 or 2, c h a r a c t e r i z e d in that the transmit and receive facilities (4, 5) of the passive, stationary units (3) comprise a passive, inductive coil (4) over which the interrogation signal (20-22) is received and a response signal (25-27), with information code (25) and traffic messages (26-27), is supplied, and that the stationary units (3) comprise an integrated electronic circuit having store capacity in the form of a ROM (9) for the identification code (25) and a RAM (8) for the traffic messages (26-27), and that the electronic circuit is powered with energy collected by the inductive coil.

4. A traffic control system according to claim 1 or 3, c h a r a c t e r i z e d in that the electronic circuits of the stationary units (3) have a control unit adapted to record traffic messages received from a mobile unit (1) and to store these messages in the RAM (8) and to subsequently supply the messages to one or more successively interrogating mobile units (1).

5. A traffic control system according to claims 1-4, c h a r a c t e r i z e d in that traffic messages (21, 22) supplied by a mobile unit (1) to one of the stationary units comprise interrogation point of time and identity information concerning the interrogating unit.

6. A traffic control system according to claims 1-5, c h a r a c t e r i z e d in that the traffic messages (21-24) contain information (24) on speed limits and information on local conditions in general.

7. A traffic control system according to claims 1-6, c h a r a c t e r i z e d in that the mobile units (1) have a control unit (12) which, by a look-up in a catalog stored in the store associated with the computer, deter-

mines the position of the unit in response to the information code (25) received from one of said stationary units (3), and that the control unit (12) has an associated display (14) to display the calculated position.

8. A traffic control system according to claim 7, c h a r a c t e r i z e d in that the control unit is moreover associated with a calculating unit which calculates the distance to the last-passed mobile unit in response to the received traffic messages and messages from a traffic control centre, if the movement of the last-passed unit differs from a predetermined timetable, and that this distance is displayed by the display (14), optionally in the form of a stop order.

9. A traffic control system according to claims 1-8, c h a r a c t e r i z e d in that the control units (7) of the stationary units (3) store traffic messages (21-22) concerning the movement of a mobile unit in a section of the RAM (8) in which the corresponding information on the last-passed mobile unit was stored.

10. A traffic control system according to claims 1-9, c h a r a c t e r i z e d in that the control units (7) of the stationary units (3) store traffic messages (24) of a permanent nature or of longer duration in the ROM (9), and that these messages are stored only after the completion of a successful recognition procedure.

11. Use of a traffic control system according to claims 1-10 in connection with train traffic, said system ensuring that the traffic on a track segment ahead can be monitored directly from the train itself.

12. A method of controlling the movement of a mobile unit (1) and comprising interrogation (20-22) from the mobile

unit to one of a plurality of prearranged stationary, passive units (3), which, in response to the interrogation (20-22), supply an electronically stored, unique information code (25), following which the position of the mobile unit (1) is determined in response to the unique information code (25),

c h a r a c t e r i z e d in

that the mobile unit (1) receives electronically stored traffic information (26-27) together with the unique information code,

and that the movement of the mobile unit (1) is controlled in response to the determined position and the received traffic information (26-27).

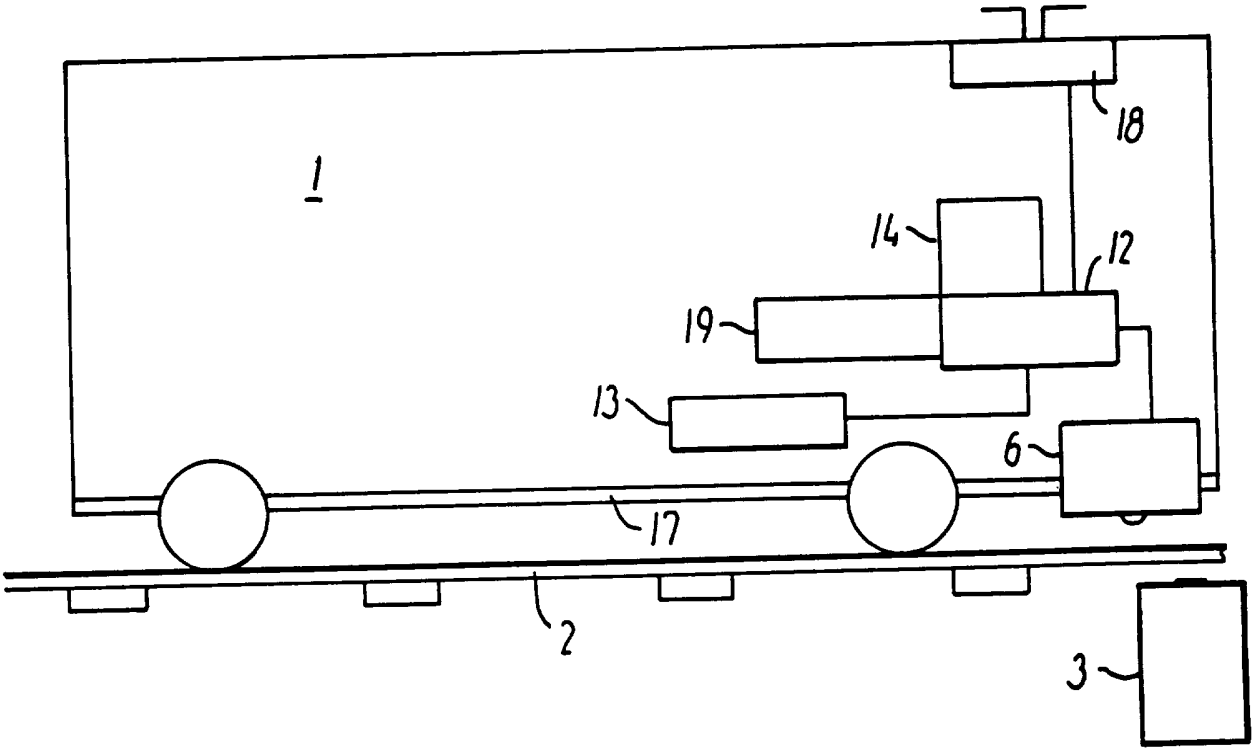

FIG. 1

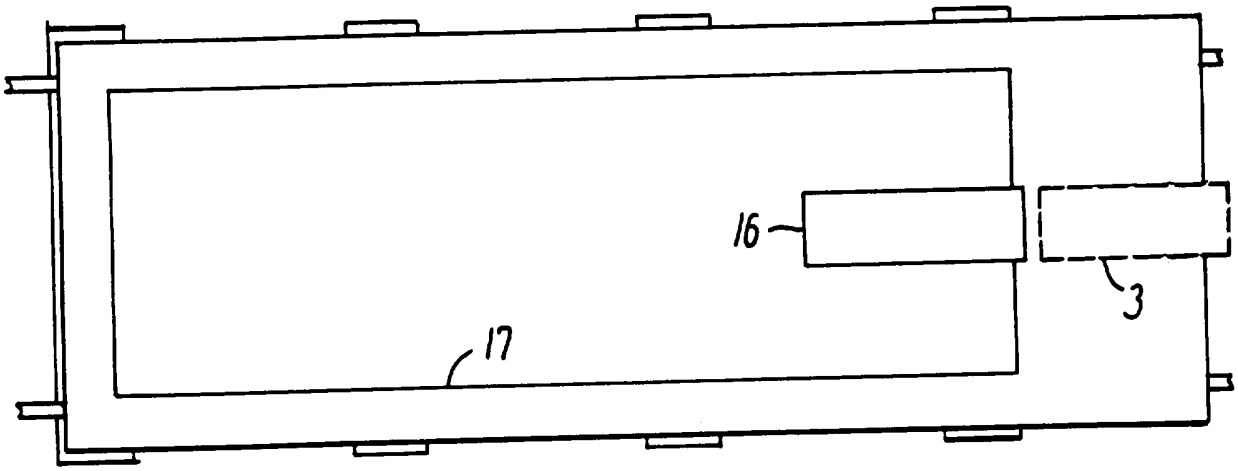

FIG. 2

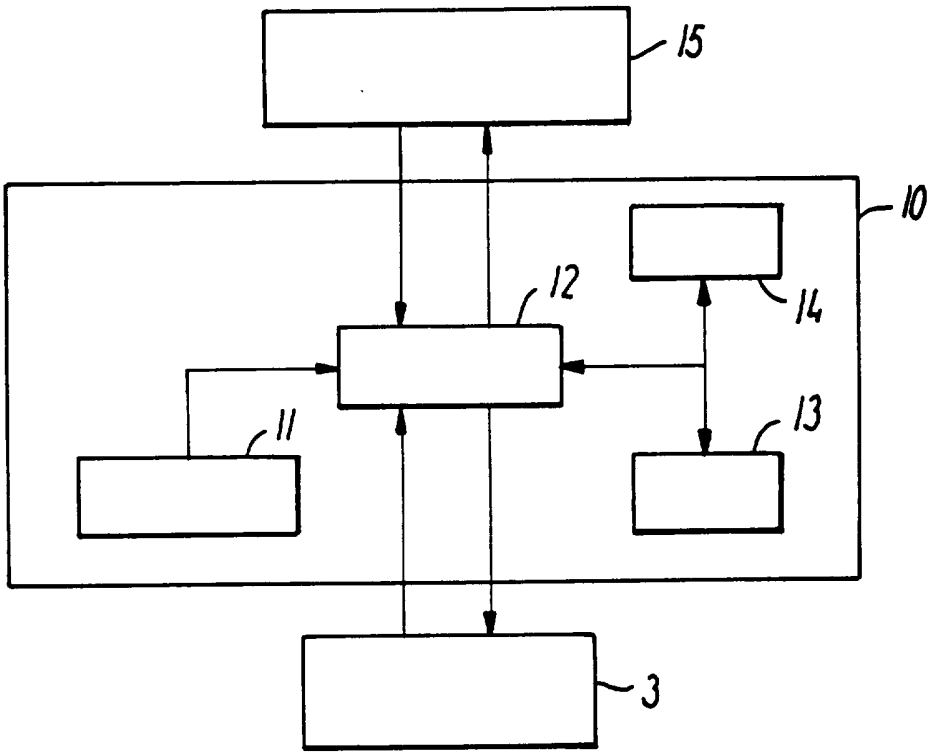

FIG.3

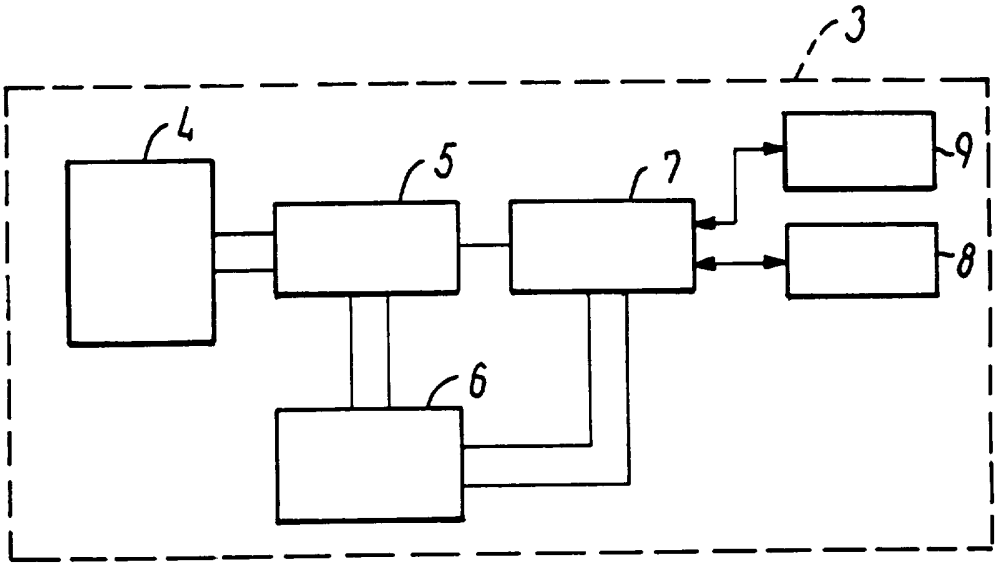

FIG.4

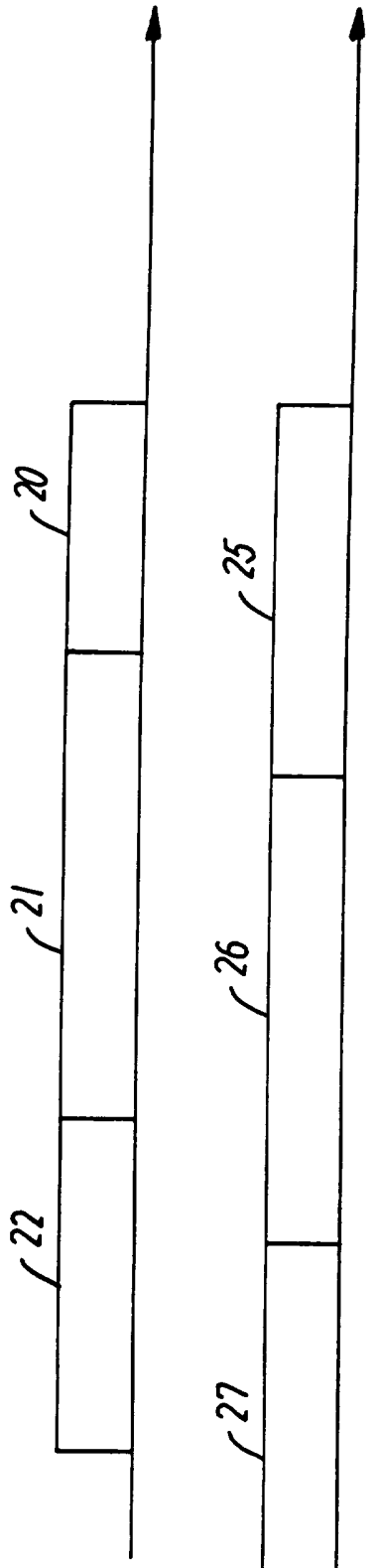

FIG.5

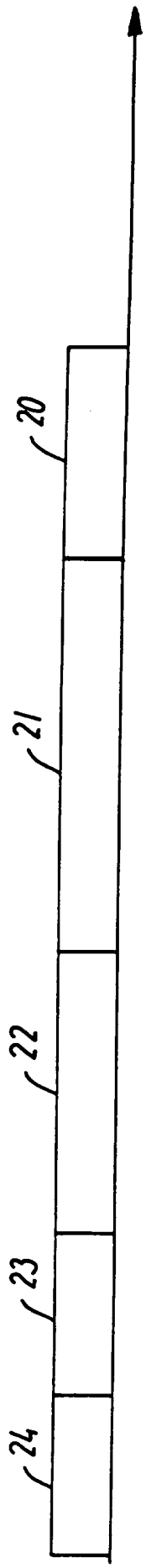

FIG.6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/DK 95/00382

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: B61L 3/12, B61L 27/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: B61L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3940765 A (WILHELM GRAFINGER ET AL), 24 February 1976 (24.02.76), column 1, line 15 - line 26	1,11,12
Y		2
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X	DE 3434268 A1 (LICENTIA PATENT-VERWALTUNGS-GMBH), 20 March 1986 (20.03.86), see the whole document	1,3-12
Y		2
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Y	WO 8900940 A1 (BRITISH RAILWAYS BOARD), 9 February 1989 (09.02.89), page 2, line 14 - page 3, line 1; page 5, line 14 - line 19	2
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[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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29 January 1996	03 -02- 1996
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Håkan Sandh Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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INTERNATIONAL SEARCH REPORT

Information on patent family members

05/01/96

International application No.
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		US-A-	4735383	05/04/88