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(71) Applicant(s)
Frederic Jean-Pierre Demole
2 Old Brompton Road, LONDON, SW7 3DQ,
United Kingdom

(72) Inventor(s)
Frederic Jean-Pierre Demole

(74) Agent and/or Address for Service
John Gordon
10-12 Priest Bridge, LONDON, United Kingdom

(54) Abstract Title
**Centralised rail control system**

(57) The centralised rail control network relies on a national central control centre based on a large high performance computer that directly sends instructions to carriages and periodically receives speed and geographical location data from carriages. The same computer also directly controls all junctions on the network and is linked to a database on which network data is stored.

This makes it possible for the computer to give reduced speed or stop instructions to each individual carriage so that trains can travel on the network safely.

The system provides significantly more safety, and cost-effectiveness than traditional regional man-operated networks and is ideally suited to large developing countries where a substantial increase in efficiency and safety is needed.

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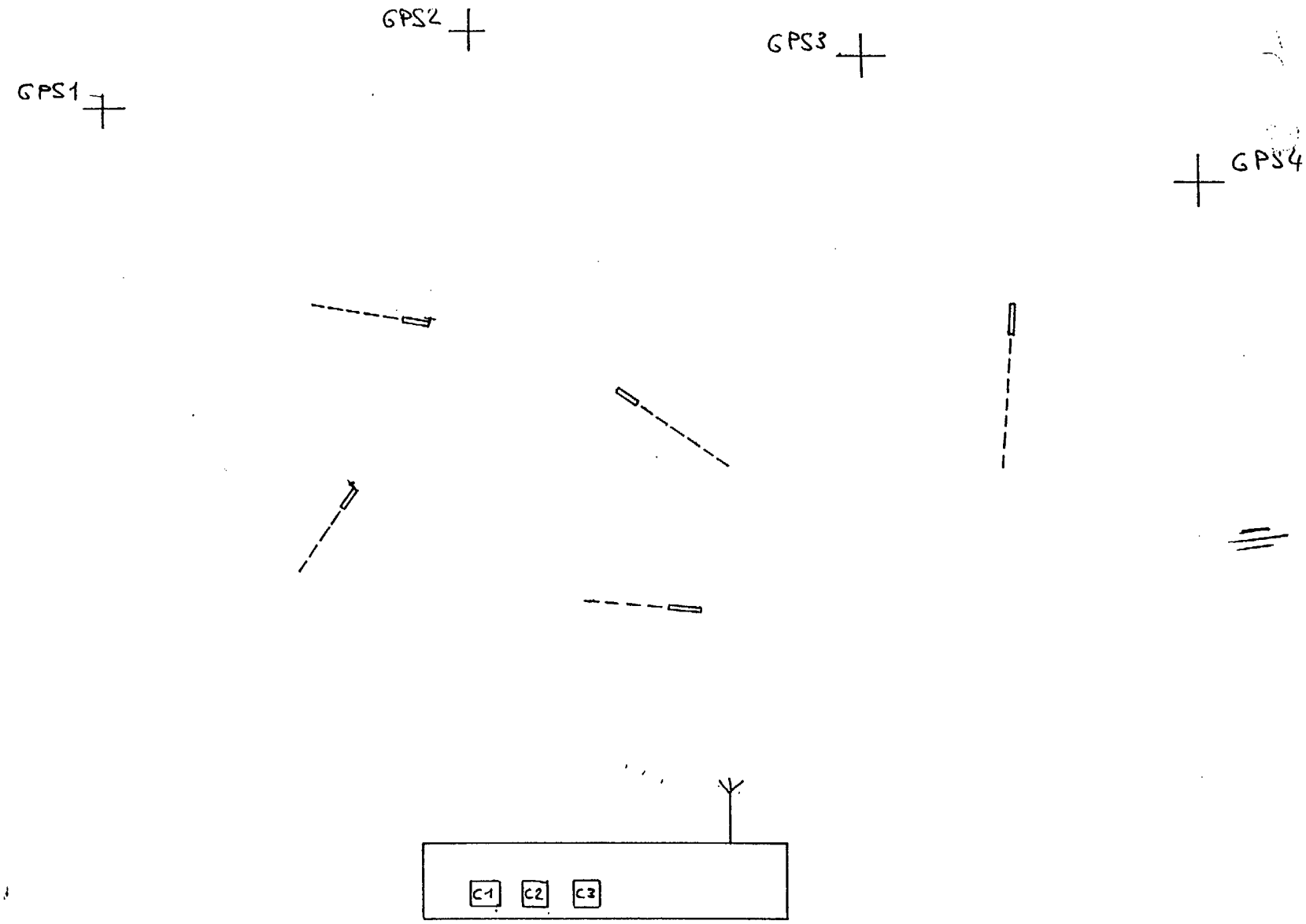
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# CENTRALISED RAIL CONTROL NETWORK

## I. General design :

The centralised rail control network relies on a national central control centre based on a large high performance computer that sends and receives periodically data directly to and from each carriage running on the network and can directly control all junctions on the network.

### Central control center :

A database linked to the central computer stores all information about the entire national rail network on authorised speed on each track segment, distances between junctions, junctions locations and rail stations locations.

Based on each carriage location and the information on the database, the central computer then forecasts the track segment on which each carriage will be present in the next interval of time and identifies on which of those track segments more than one train will be present.

The central computer then assigns reduced speeds or stop orders to some of the carriages so that all trains are able to run and cross safely on the network.

### Carriages :

On each carriage, an electronic device contains a send/receive system that operates on a global satellite communication network, a global positioning system receiver, a sound-backed display for the driver and a headset and microphone for direct communication with the driver.

Each carriage sends periodically, around every 20 seconds, a signal, via the global satellite communication network to the central computer, containing its own particular communication number, its own location as calculated by the global positioning system and its own speed.

### Junctions :

At each train station, a send/receive system that operates on a global satellite communication network relays commands and position confirmation signals from all junctions assigned to the train station.

Junctions that are too remote to be linked to a train station are equipped with their own send/receive system.

**II. Advantages of the centralised rail control network over traditional man-based regional networks :**

The centralised rail control network is :

a) more efficient because it relies on a single database and operates with low cost communications instead of on a very large number of field-based sensors, optical signals and switches.

b) more cost-effective because it does away with these large numbers of expensive to maintain field-based sensors, optical signals and switches hardware.

c) safer because a central computer system :

- almost completely eliminates the occurrence of those regional man-based control errors that have caused many accidents in the past.

- continually controls if the speed at which the train is running is authorised on the track segment on which the train is running.

- can stop, by transmitting a stopping signal directly to the train's braking system, any train that does exceed the authorised speed, does not comply with its instructions, or on which the driver does not act or react normally or does not communicate verbally normally.

- monitors continually the positions of all junctions and can stop any train running on a track where a junction would change its position for no reason or would not change its position as requested to, or where monitoring of its position is not possible any more.

- makes the driver's task easier since he does not have to look for signals and read them at different speeds, distances and weather conditions but get signals from his on-board sound-backed display.

- allows the driver to concentrate on the tasks for which he is best suited, which are monitoring and controlling of the train's speed, observation of the tracks, reporting of any problem with the network or any unusual events around it, and emergency stop of the train in case of emergency on the train, object on the track or damage to the track.

The centralised rail control network also :

a) increases time to destination performance since trains have much less frequently to stop in order to allow other trains to cross but will instead more often slow down to do so.

b) increases comfort to the passengers since reduced speeds are more comfortable than stops and gos.

c) is beneficial to the rail network in general, because by taking the control tasks and responsibilities from train station personal, it allows these employees to concentrate on train station operation and management as well as customer services.

**III. Remarks :**

**Suitability :**

The centralised rail control network is particularly well suited to large developing countries where the traditional telecommunication network and rail network is not of the same standard as those of developed countries and where parts of the network is very remote and not linked to train stations. In those countries, where safety is a major issue due to the large number of accidents in the past, the rail network can be made safe in the time it takes to equip all carriages and train stations with the electronic systems described above. This time can be conservatively estimated to be around one year.

**Communication :**

It is recommended that each carriage operate its own communication line with its own telecommunication number. In order to make the central computer's task more manageable, it is possible to have the carriages have their periodic signals sent sequentially to the central control center, by using the clock signal sent by the global positioning satellites. Each carriage will then send its signal after another in the same repeated sequence according to its number in the sequence.

**Central computer :**

The central computer is backed-up by one or two other identical computers with identical database and software that form three independent systems. This is necessary so that another computer does exactly the same work done as the first one and will report to the operator any outgoing instruction that differs from the first one for verification.

The third computer is used as spare in case one of the two others malfunction or is unavailable for maintenance, repair or upgrade. In this case the third computer automatically takes over from the malfunctioning computer and reports to the operator.

**Additional level of safety :**

When, in the near future, image recognition system that can detects coming left or right or both from under the carriage become available, such systems can be added to the electronic system on the carriage so as to give an additional degree of safety and check that will back-up the position confirmation signals from the junctions.

In this system configuration, each carriage will also sends the same signal as described above to the central computer when the image recognition system detects a track coming left or right or both from under the carriage. In this case the signal sent also tells the central computer if a track is coming left, right or both left and right from under the carriage. From this additional information, the central computer can identify the particular junction on which the train is going and double check with the position information of the junction itself that the train is actually being directed to the right track.

## CLAIMS

The centralised rail control network can provide almost complete rail control safety at considerably lower installation and operating costs than traditional man-based regional control networks. It makes rail control more efficient and has many other beneficial implications for general train safety issues, performance, comfort and train station operations. It is able to add rapidly great value to rail networks located in developing countries at a cost that is considerably lower than what would be required to achieve the same value by conventional rail control network upgrades.

**AMENDMENTS TO THE CLAIMS HAVE BEEN FILED AS FOLLOWS:**

1 A centralised rail control system, comprising a fixed land-based computer, linked to a transmitter, and a train system, linked to a transmitter, fixed on each train running on the controlled network. The database of the computer stores the geographical co-ordinates of the location of each track segment of the controlled network, the planned route of each train over the next part of the year and the call number of the transmitter linked to each train system. Each train system is able to calculate the geographical co-ordinates of its own geographical location and provides these to the computer system using its transmitter. The computer is programmed so as to be able, by comparing the latest geographical location of each train with data on the database to check that each train follows its planned route.

2 A centralised rail control system as claimed in claim 1 where the computer's database stores the maximum authorised speed of each track segment. The train system receives data from the computer that is communicated to the driver as speed to observe. The computer is programmed so as to be able, based on the geographical location of each train with data on the database to change the speed of the appropriate trains at the appropriate time so that no train will collide with any other train.

3 A centralised rail control system as claimed in claim 1 or claim 2 comprising a junction system, linked to a transmitter, located at the centre of the network of the electrical command cables commanding the junctions in a group of junctions. The computer's database stores, for each junction in the network, the call number of the transmitter of its respective junction system. The computer receives position data about the position setting of each junction from the transmitter linked to each junction system. A junction system receives orders to change the position setting of a particular junction from the computer and is able to activate the electric command system of each single junction in order to set the particular junction in the ordered position setting. The computer is programmed, based on the geographical location of each train with data on the database, so as to be able to check the position setting of the appropriate junction at the appropriate time and to change, if necessary, the position setting of the appropriate junction at the appropriate time so that each train follows its planned route.

3 A centralised rail control system as claimed in claim 1 or claim 3 comprising a number of level crossing systems, located each at a single level crossing present on the rail network, that are each linked to a transmitter and that are able to check that their respective crossing level is safe to be run over by an incoming train. The database of the computer stores the location of each of these level crossings on the network and the call number of each level crossing's transmitter. The computer is programmed, based on the geographical location of each train with data on the

database, so as to recognise when a train is due to run over a particular level crossing. The computer will contact this particular level crossing at the appropriate time and receive information about whether the level crossing is safe to be run over or not. Should the computer not receive information that the level crossing is safe to be run over, the computer will then change the speed of the train so that the train is able to approach the level crossing at low speed and stop before running over the level crossing if necessary

4 A centralised rail control system as claimed in any preceding claim, where the train system also provides its transmitter with the speed at which the train is running.

5 A centralised rail control system as claimed in any preceding claim where the train system is able to bypass the train's driver commands and stop the train by activating the train's brakes if the computer sends a particular signal in case of emergency.

6 A centralised rail control system as claimed in any preceding claim where the computer and each train system are able to exchange voice communication using their transmitters, so that the human operator monitoring the computer is able to communicate verbally with each train's driver.

7 A centralised rail control system as claimed in any preceding claim, where the computer, based on the speed received from each train is able to check that the speed of each train is appropriate and will change the train's speed if not.

8 A centralised rail control system as claimed in any preceding claim where a train system is able to recognise if a track is present on the left hand side of the train and to recognise if a track is present on the right hand side of the train. The train system provides the computer with this information so that the computer is able to check that the train is on the assigned track.

9 A centralised rail control system as described herein with reference to Figures 1-3 of the accompanying drawing

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|---|---|---|---|
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| **Claims searched:** | 1-9 (sent 28.8.99) | **Date of search:** | 18 October 1999 |

# Patents Act 1977
# Search Report under Section 17

**Databases searched:**

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.Q): G4Q (QBBA, QBAA, QBAD, QBU)

Int Cl (Ed.6): B61L

Other:

**Documents considered to be relevant:**

| Category | Identity of document and relevant passage | | Relevant to claims |
|---|---|---|---|
| X | EP 0605848 A1 | (UNION SWITCH & SIGNAL) | 1 at least |
| X | WO 96/06766 A1 | (GE-HARRIS RAILWAY ELECTRONICS) | " |
| X | US 5740046 | (ELESTEDT) | " |
| X | US 5072900 | (MALON) | " |
| X | US 4711418 | (AVER ET AL) | " |

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| X | Document indicating lack of novelty or inventive step | A | Document indicating technological background and/or state of the art. |
| Y | Document indicating lack of inventive step if combined with one or more other documents of same category. | P | Document published on or after the declared priority date but before the filing date of this invention. |
| & | Member of the same patent family | E | Patent document published on or after, but with priority date earlier than, the filing date of this application. |