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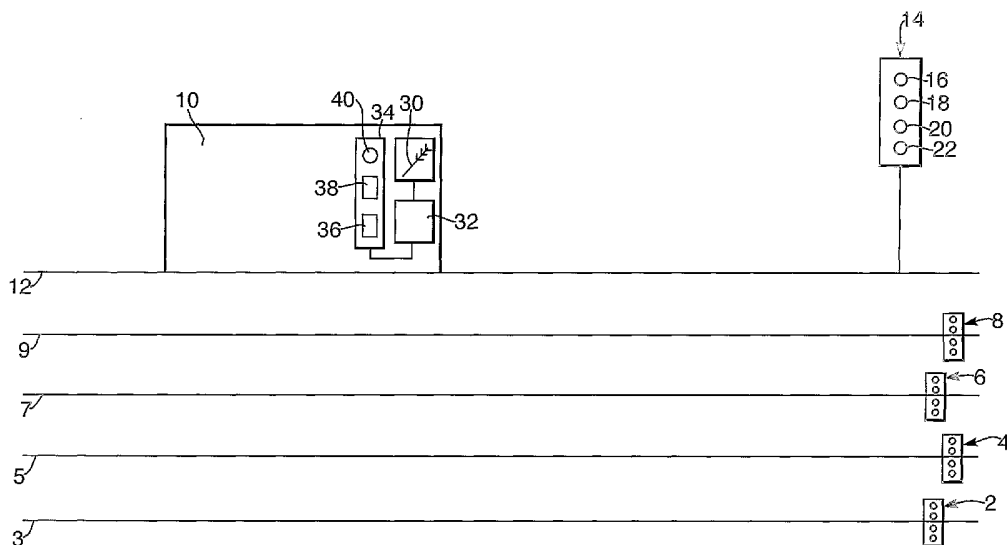
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(54) Title: **SIGNALLING SYSTEM, COMPONENTS THEREOF AND A SIGNALLING METHOD**



(57) Abstract: A signalling system comprising a signal member (14) mounting a visible light emitter unit for providing a visual indication of a condition of the signal to a vehicle (10) travelling along a path. The visible light emitter unit may comprise bulbs (16, 18, 20, 22). An emitter for emitting a non- visible instruction signal comprising information on the condition of the signal is also provided and is mounted integrally with the visible light emitter unit. A receiver (30) is provided on the vehicle (10) for receiving the instruction signal or a signal derived from the instruction signal.

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SIGNALLING SYSTEM, COMPONENTS THEREOF AND A SIGNALLING METHOD

The present invention relates to signalling systems, components thereof and
5 a signalling method, particularly but not exclusively for use on rail
networks.

Signalling systems are used as elements of safety systems on rail networks.
They provide advance warning to the driver of the train that another train,
10 or other obstacle, is on the track ahead of the signal. This allows a train
driver to reduce the speed of the train or to bring the train to a halt if
required. Accidents may occur when a driver mistakenly reads the
condition of a signal, for example due to glare from the sun causing lights
to appear on when they are not. Railway signals in the UK usually comprise
15 a number of bulbs including red, usually yellow, and green bulbs which
may appear on due to the glare of the sun when they are not. In the case
where a train is travelling along one of a plurality of parallel running
tracks, it may be difficult for a driver to determine which one of a plurality
of closely spaced signals in the distance are relevant to their own said one
20 track, especially under conditions of low visibility and/or near a bend in the
track, and/or when there are many signals at the same place in the railway,
for example near stations, or at multi-signal gantries.

Existing railway signalling systems split up a railway line into blocks. At
25 the beginning of each block a signal member is provided for each line. The
signal member currently often used in the UK has a plurality of lights,
namely red, green, yellow and double yellow. The red condition signifies
the presence of a train within the block ahead. Therefore the red light is an
instruction for a driver of a train approaching the signal to slow down and
30 stop before the signal. The yellow condition signifies that there is no train
in the block ahead but that the next signal is in the red condition and
therefore there is a train two blocks ahead, and that the driver therefore

needs to slow down to a speed at which he can stop before the red signal if it is still red when he reaches it. Similarly a double yellow signifies that the signal which is two blocks ahead is in the red condition and therefore there is a train three blocks ahead. In the case of yellow or double yellow signals, a driver may be warned in advance of the presence of a train which may be travelling slower than an approaching train or may even be stationary. A green signal in this system indicates that there are at least three blocks of clear line. The driver adjusts his speed in keeping with the maximum track speed for the particular stretch of line he is on and in keeping with the signal aspect of the signal last encountered. This signalling system is known as 4-aspect signalling and is commonly used in the UK. 3-aspect (red, yellow, green) and basic 2-aspect (red, green) signalling is also used in a similar way. Higher aspect signalling is useful on congested lines and for high speed lines especially, when advance warning of traffic or other obstacles in the path of a train is advantageous.

The above system relies upon a driver acknowledging a signal and taking appropriate action (e.g. regulating his speed according to the signal aspect). Many systems have been developed which communicate the condition of a signal about 200 to 450 metres on the approach side of the signal and the systems give an early indication to the driver of the condition of the signal. Some of these systems also directly influence the motion of the train, for example by directly applying the brakes causing the train to slow down if it is approaching a red signal too quickly to be able to stop. These systems include means of communication with circuitry on a train approaching a signal which is mounted at the side of the track. For example the Automatic Warning System (AWS) includes a track mounted, non-contact magnetic inductor placed between rails of a track so that a detector on the train will pass over it and receive an indication of the condition of an approaching signal. The inductor contains magnets which communicate with a detector on the train and which are linked to the approaching signal. An example of such a warning system is given in US 5415369.

In conventional railway signals the driver hears different noises inside his train driver cabin depending upon the aspect of the signal. For example, if the track ahead is not clear, a siren may sound in the driver's cabin which
5 the driver is required to acknowledge before turning it off and proceeding.

The installation of track side AWS apparatus is expensive and time consuming. Mounting devices along the railway line, typically between the rails of a track, which may need power lines and/or maintenance, is not
10 something to do lightly. Due to the large number of signals on the rail network in the UK, for example, it is not feasible to provide such track side apparatus at every signal nor even at most signals. Sections of track with the highest risks are fitted with AWS, but well over 50% of the length of railway track is not at present fitted with AWS.

15

A variety of systems for improving road traffic safety are also known. For example, US 2003/0016143 describes an intersection vehicle collision avoidance system. The system comprises traffic lights having an associated RF transmitter unit located adjacent thereto that is arranged to emit an RF
20 signal to oncoming vehicles when the traffic lights are red. A similar system is also described in US 6 262 673. In common with track side AWS equipment, the cost and complexity involved in installing and maintaining such road traffic systems is prohibitive.

25 According to a first aspect of the present invention, there is provided a signalling system comprising a signal member mounting a visible light emitter unit for providing a visual indication of a condition of the signal to a vehicle travelling along a path, an emitter for emitting a non-visible instruction signal comprising information on the condition of the signal and
30 a receiver provided on the vehicle for receiving the instruction signal or a signal derived from the instruction signal, characterised in that the emitter is mounted integrally with the visible light emitter unit.

The non-visible instruction signal emitted by the emitter of the signal member may be received directly by the receiver or it may be modified/retransmitted or otherwise cause a further instruction signal to be emitted by a further emitter, which further instruction signal may be received by the receiver.

The condition of the signal may indicate the presence or otherwise of vehicles or any other obstacles in the path of the vehicle ahead and therefore may provide an instruction to a driver of the vehicle, for example, to stop, proceed, accelerate or decelerate the vehicle along that path. Since the instruction signal is non-visible it will not be confused with glare from the sun reflecting off a light that is not "on".

An advantage of the system of the present invention is that there is no requirement to install additional apparatus alongside the path of the vehicle, for example alongside a railway track, to communicate with a vehicle such as a train.

The visible light emitter unit preferably comprises a light bulb. Thus the system may be installed by simply replacing existing light bulbs on a signal member. The visible light emitter unit preferably comprises at least one, and preferably a plurality of, LEDs. Alternatively the bulb may comprise one or more filaments.

The signalling system preferably comprises a plurality of signal members, each adapted to emit a non-visible instruction signal which may comprise information regarding the identity of the signal member from which it is emitted. A plurality of signal members is preferably provided spaced apart along the path, each adapted to emit a non-visible instruction signal comprising information regarding the location of the signal along the path.

Repeater means may be provided along the path, the repeater means being adapted to repeat an instruction signal from an upcoming signal to the vehicle. In this way it is possible to obtain an advance indication of the condition and/or identity of a signal located along the path of the vehicle.

- 5 This may be useful, for example, in conjunction with high speed vehicles or paths along which many vehicles travel and are therefore congested, where it would be advantageous to know the condition of signals in advance. The repeater means may communicate with the relevant upcoming signal via cable communication means or electromagnetic communication means,
10 such as RF or microwave.

- Tracking means such as GPS position sensor means or track side sensor means may be provided to determine the position of the vehicle along the path. This may be used to determine which signal is coming up next in the
15 path of the vehicle for example and may be used in conjunction with the instruction signal information.

- The emitter may comprise a source signal transmitter. The transmitter may be a radio frequency (RF) transmitter. Alternatively the transmitter may be
20 a microwave transmitter. The instruction signal may originate from the transmitter, which may have its own power source or may use an existing power source associated with the signal member. The emitter may use electromagnetic power incident upon it to cause the non-visible instruction signal to be emitted, possibly using the incident power to power the emitted
25 non-visible signal.

- A microwave or RF transmitter is used preferably to an IR transmitter since glare from solar rays, whether direct or reflected from various surfaces, may interfere with, or be confused as, IR signals by an IR detector.
30 Railways are a neutral environment for metallic objects and there is plenty of opportunity for solar rays to be reflected from shiny reflecting surfaces in the vicinity of a signal, for example, towards a signal member or

receiver. In addition, RF and microwave signals are broader than IR signals which allows them to reach their target destination regardless of the orientation of their transmitter. RF and microwave signalling is more effective in adverse weather conditions, for example, fog and has a longer range than IR signalling.

Alternatively radar means may be provided on the vehicle for transmitting an outgoing signal, the emitter comprising means for reflecting and modulating the outgoing signal to provide the non-visible instruction signal for reception by the radar means. In this case there is no need for the emitter to constantly emit information, resulting in an energy saving, and a reduction in electromagnetic "pollution" in the vicinity. Alternatively the emitter may absorb the outgoing signal and subsequently emit the instruction signal as a result.

15

A further mobile emitter may be provided for a user in the vicinity of the path of the vehicle, the further mobile emitter comprising means for reflecting and modulating the outgoing signal to provide a warning signal for reception by the radar means, the warning signals providing an indication of the presence of the mobile emitter in the vicinity of the vehicle path. Alternatively, the mobile emitter may absorb the outgoing signal and subsequently emit the instruction signal as a result. The mobile emitter may be worn by the user, for example the mobile emitter may be mounted on a badge or a plurality of badges worn at spaced positions on the user's body so that the outgoing signal is not obstructed from reaching at least one badge by the presence of the user's body. Means may also be provided to alert the user that the vehicle is approaching, perhaps in the form of alert means which detects said outgoing signal and provides an audible and/or visual alert to the user.

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The signalling system may further comprise processing means located on the vehicle to process the received instruction signal and provide a visible

and/or audible indication of the condition of the signal to a driver of the vehicle which may persist until the driver acknowledges its presence, for example by pressing a button or perhaps by causing the vehicle to decelerate or stop.

5

According to a second aspect of the invention there is provided a visible light emitter unit for use with a signalling system including a signal having a plurality of conditions, the visible light emitter unit including an integral emitter for emitting a non-visible instruction signal comprising information on the condition of the signal.

10

The emitter may comprise a RF source signal transmitter. Alternatively the emitter may comprise a microwave source signal transmitter.

15 Alternatively the emitter may comprise a reflector and modulator capable of reflecting and modulating an incoming signal to provide the instruction signal. The emitter may alternatively comprise means for absorbing an incoming signal and subsequently emitting the instruction signal as a result.

20 The visible light emitter unit preferably comprises a bulb which preferably includes a standard screw, bayonet, or push fitting mechanism, thus enabling installation of the light bulb to existing signals and existing signalling systems. The visible light emitter unit is preferably repeatably releasably couplable/decouplable with a power socket, preferably the
25 coupling/decoupling operation not requiring tools (i.e. can be done by hand).

The emitter may be adapted to emit an instruction signal comprising information on the identity of the signed, and/or the location of the signal.

30

The light bulb may comprise at least one, or preferably a plurality of, LEDs. Alternatively the light bulb may contain one or more filaments.

According to a third aspect of the invention there is provided a method of providing an indication, on a vehicle, of the condition of a visual signal located along a path of the vehicle including the steps of emitting an instruction signal containing information regarding the condition of the visual signal from an emitter located at the visual signal, receiving the instruction signal at a receiver located on the vehicle; and processing the instruction signal to provide a visible and/or audible indication of the condition of the visual signal.

Embodiments of the present invention will now be described, by way of example only, with reference to the accompanying drawing in which:

Figure 1 is a schematic representation of a signalling system according to a first embodiment;

Figure 2 shows a light bulb used in the embodiment of Figure 1;

Figure 3 is a sectional view through the light bulb of Figure 2;

Figure 4 shows a schematic sectional view through a signal member used in the embodiment of Figure 1;

Figure 5 is a schematic representation of a signalling system according to a second embodiment;

Figure 6 is a sectional view through a light bulb used in the embodiment of Figure 5; and

Figure 7 is a schematic representation of a RF reflecting and modulating means used in a system according to the invention.

Referring to Figure 1, a signalling system is shown including a train 10 on a track 12 approaching a signal member 14. The track 12 is alongside four other tracks running parallel to it, tracks 3,5,7,9. Each track 3, 5, 7, 9, has corresponding signal members 2,4,6,8. The signal member 14 mounts four
5 light bulbs, a red bulb 16, a first yellow bulb 18, a second yellow bulb 20 and a green bulb 22. The bulbs 16, 18, 20, 22 comprise a plurality of LEDs. LED bulbs are used preferably to filament bulbs since they emit less heat and therefore provide less interference to the working of the present invention as described below. However filament or gas discharge, or other
10 light emitters may be used.

Referring to Figures 2 and 3, the green bulb 22 is shown schematically in section and comprises an array 24 of LEDs 23 and a standard bulb attachment means in the form of plug members 26. The plug members 26
15 allow the bulb 24 to be used as a replacement for an existing standard signal bulb. It will be appreciated that if the standard signal bulb is provided with screw attachment means or bayonet-type attachment means, then the bulb of the present invention may be produced with such attachment means in order to enable it to conveniently replace existing
20 signal bulbs.

The green bulb 24 further comprises an instruction signal transmitter 28, which emits an RF (radio frequency) instruction signal. The instruction signal is only sent when the green bulb 24 is illuminated and therefore
25 "on". The instruction signal which is sent is coded and will be referred to as a "green" instruction signal. The instruction signal is coded to contain two pieces of information: the condition of the signal (i.e. "I am a green signal"), and the identity of the signal (i.e. "I am signal number 126504"). Each bulb 24 has a unique identity code.

30

The red bulb 16 is of a similar construction and its RF transmitter transmits a differently coded "red" instruction signal. Similarly the first yellow bulb

18 sends a "yellow" instruction signal and the second yellow bulb 20 sends a "double yellow" instruction signal. The second yellow bulb 20 is only illuminated in addition to the first yellow bulb 18 and the double yellow signal may be transmitted along with the yellow signal or circuitry may be provided to cancel the yellow signal in the presence of the double yellow signal such that only the double yellow signal is transmitted.

As mentioned, the instruction signal is also coded to contain information on the identity of the signal member 14 so that the instruction signal is not confused with any other instruction signals from any of the signal members 2, 4, 6, 8 at the same location on tracks 3, 5, 7, 9 which run parallel to the line 12. A received signal, received by a receiver antenna 32 of the train, has a code for its condition (red, green, yellow) and a code for its identity. It will be appreciated that it is also possible to code each bulb with just its identity, and for the processor to know that a specifically identified signal/bulb is a red, or a yellow, or a green. The identity code may implicitly give the condition of the signal. However, it is preferred to encode positively in the emitted electromagnetic signal both an element for condition and an element for identity.

20

Referring to Figure 4, the signal member 14 is shown schematically with communication means in the form of cables 15, 17, 19, 21 leading to the bulbs 16, 18, 20, 22 respectively. The cables 15, 17, 19, 21 power the bulbs and also provide the coding of the instruction signal emitted from each bulb. As discussed above, the instruction signal provides identification of the condition of the bulb and the specific signal member from which the instruction signal is being emitted i.e. if the green bulb 22 is illuminated on the signal 14, the instruction signal comprises information indicating "The signal 14 is green". Each signal member may be provided with unique identification number such that a signal should not be confused with a signal further along the relevant track or any other signal on the entire network. Bulb holders 25, 27, 29, 31 are provided to link the cables 15, 17,

19, 21 to the bulbs 16, 18, 20, 22 as illustrated in Figure 4. In an alternative embodiment existing bulbs may be used in conjunction with bulb holders which include an instruction signal emitter.

5 A receiver, in the form of an antenna 30 provided on the train 10, receives the instruction signal from whichever bulb is "on" and processor means 32 processes the signal to extract the information on the condition (known as the "aspect") and unique identity of the signal. Alternatively an indication may be provided that an instruction signal is being received which is
10 relevant to one of the other lines 3, 5, 7, 9. Once the information has been processed, an indication is provided to the driver of the train 10, of the condition and identity of the signal 14, for example via a dashboard 34 on the dashboard of the train. The dashboard 34 includes a visual display 36 and an audible alarm 38 capable of producing different sounds depending
15 upon the condition of the signal 14.

At this stage if the condition of the signal 14 is anything other than green, the driver is required to acknowledge the condition of the signal by pressing a button 40, which is also provided on the dashboard 34. If the
20 button 40 is not pressed, means may be provided to apply the brakes of the train 10 and slow the train and/or bring the train to a halt. The driver may be allowed a predetermined time limit in which to acknowledge the condition of the signal 14, or alternatively an automatic brake application may be provided until the condition of the signal 14 is acknowledged.

25 Referring to Figure 5, a second embodiment of the present invention is shown installed on a train 10' and signal 14' on a track 12'. Different red 50, first yellow 52, second yellow 54 and green 56 bulbs are mounted on the signal 14'. Figure 6 shows the green bulb 56. Similarly to the first
30 embodiment the bulb 56 includes an array 58 of LEDs 59 and a standard bulb attachment means in the form of plug members 60. In addition the bulb 56 includes a reflector and modulator 62 which is capable of

modulating and reflecting RF signals. The reflector and modulator 62 is provided within the casing of the bulb 56.

5 The train 10' includes a radar unit 64. The radar unit 64 has a signal generator and emitter and can transmit an outgoing signal in the direction of the signal member 14', the outgoing signal being reflected and modulated, for example as described below, according to which bulb 50, 52, 54, 56 is illuminated at that time. Once modulated and reflected, the outgoing signal becomes the instruction signal and is capable of being
10 received by an antenna 66 on the radar unit 64. Processor means 68 provided on the train 10' processes the information from the instruction signal relating to condition and identity of the signal 14'. Similarly to the first embodiment, the processor means 68 communicates with a dashboard unit 69 which provides a driver of the train 10' with audible and visible
15 alerts regarding the condition of the signal 14'.

Referring to Figure 5, a worker 70 in the vicinity of the line 12' wears a badge 72 containing a reflector 74. In a similar manner to the reflector and modulator 62 on the bulb 56, the reflector 74 is able to reflect and modulate
20 the outgoing signal from the radar unit 64 to provide a warning signal for reception by the antenna 66 of the radar unit 64. The warning signal provides an indication of the presence of the user in the vicinity of the line 12' and when information from the warning signal is processed through the processor 68, a different audible and/or visible alert may be provided on
25 the dashboard for the driver to the alert relating to the condition of the signal 14' so that the driver may distinguish between the two alerts. In addition the worker 70 may receive a warning in the form of an audible or visible warning upon detection of said outgoing signal via the reflector 74. The warning should indicate to the worker 70 that the train 10' is
30 approaching.

The signalling system may be used in conjunction with the GPS (Global Positioning System) which may assist in determining exactly which signals are in the path of the train 10'. Figure 5 shows a repeater unit 80 next to the signal 14' and this repeater unit 80 may be used to receive and retransmit information from other signals along the line 12' to the train 10'. If GPS means is used to identify an upcoming signal member, there may be no need to provide coding to determine the identity of a signal member in the instruction signal. This embodiment may be especially useful where there are not a plurality of signal members at any one location.

10

A further embodiment of the present invention may comprise repeater means in the form of an RF emitter for emitting the instruction signal. The repeater means is positioned at the track side, probably several hundred metres, prior to a signal member with which it is in communication. The repeater means could communicate with the signal member by cable communication or electromagnetic wave communication for example and emit an instruction signal relating to the condition and/or identity of the signal to a passing train. Beneficially, the repeater means is able to detect the presence of a passing train and only emit the instruction signal when the train is passing in order to save energy. The repeater means communicates with the train by emitting a non-visible instruction signal which is detected by a receiver means, on the passing train, of a construction as previously described. The instruction signal may include information only on the identity of an upcoming relevant signal on the track.

25

The repeater means may have its own power supply but is preferably, at least partly, powered by magnetic induction means from the train's power supply. In this way the repeater means receives a low power communication signal from the signal member at all times but only transmits the instruction signal when it senses a passing train.

30

The previously described modulation and reflection of RF signals within a bulb or on a worker's badge mounted reflector 74 may be achieved by any convenient known method. For example, Figure 7 illustrates a simple circuit capable of modulating a RF signal.

5

A unique coded signal current is generated by a power source 100 and coded pulse generator 102 and flows through a diode 104 connected across a transmission line 106. Transmission line 106 is connected to an antenna 114. The transmission line 106 extends beyond the diode 104 by a dimension corresponding to a quarter wave of an incident RF signal in the transmission line 106 at a predetermined operating frequency. This transmission line 106 terminates in a short circuit. When the diode 104 is driven by pulses of the coded signal current into a conducting state the antenna 114 is presented with a short circuit at the diode 104. When the diode 104 is not conducting the antenna 114 is presented with a short circuited quarter wave line which is effectively an open circuit. These changes in state allow reflection of varying degrees of the RF power incident on the antenna 114 and produce a reflected RF signal which has a version of the code from the coded pulse generator 102 impressed upon it. Thus an outgoing instruction signal which contains information unique to the unique signal current is produced. In the present invention this process may be used to code an instruction signal to provide information relating to the condition and identity of a signal member.

25 Various modifications may be made to the present invention without departing from its scope. For example, transmitters or modulators may be provided within head and tail light bulbs of the trains in order to warn of possible collisions with an approaching train. Signalling systems according to the invention may be used with any vehicle network, for example a road network where the system may be adapted to comprise traffic lights and road vehicles. Any known antennae may be used to detect RF signals, for example dipole or horn antennae.

30

CLAIMS

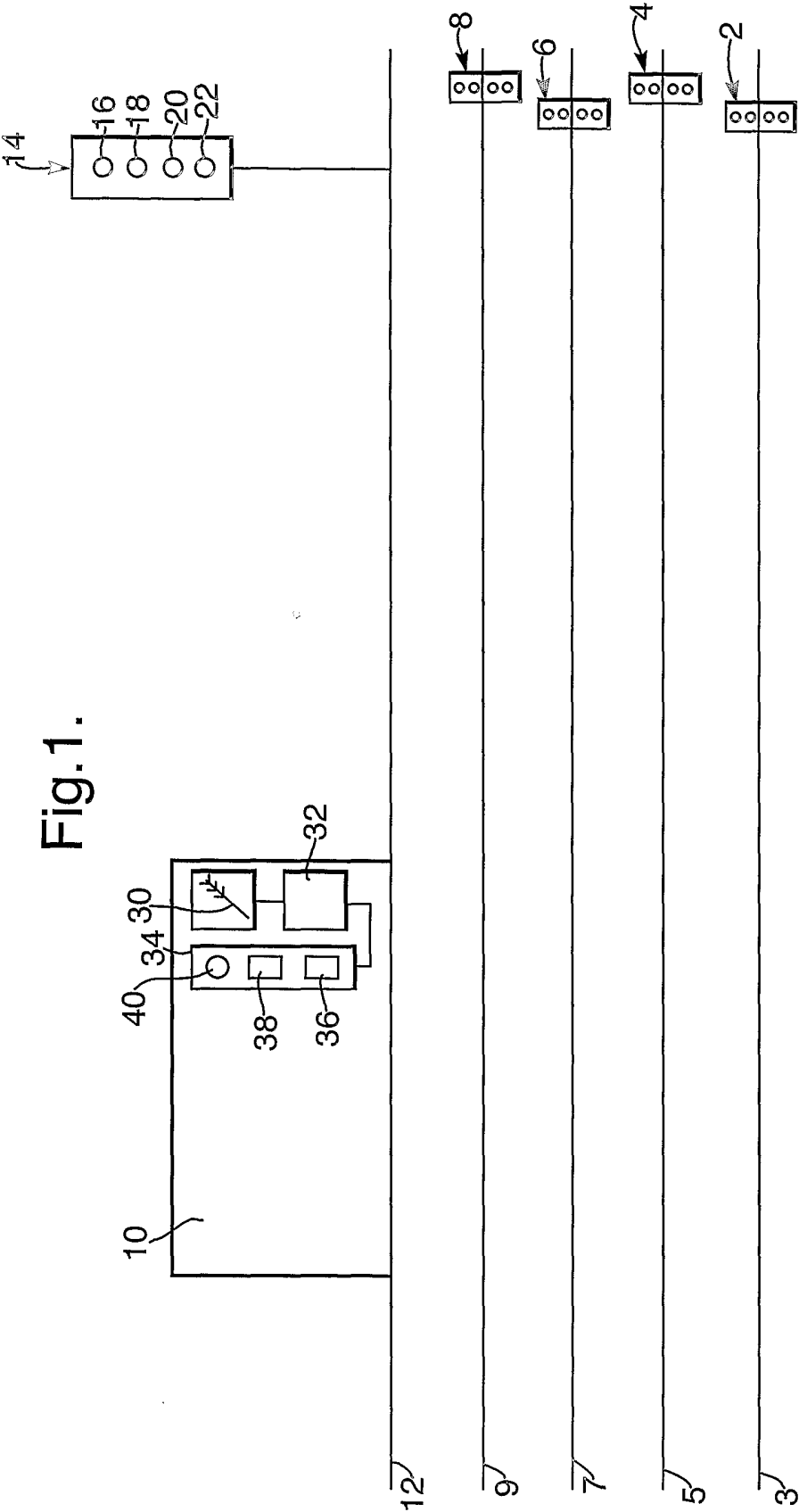
1. A signalling system comprising a signal member mounting a visible light emitter unit for providing a visual indication of a condition of the signal to a vehicle travelling along a path, an emitter for emitting a non-visible instruction signal comprising information on the condition of the signal and a receiver provided on the vehicle for receiving the instruction signal or a signal derived from the instruction signal, characterised in that the emitter is mounted integrally with the visible light emitter unit.
2. A signalling system according to claim 1, in which the signalling system comprises a plurality of signal members, each adapted to emit non-visible instruction signals comprising information regarding both the condition of the signal member and the identity of the signal member from which it is emitted.
3. A signalling system according to any preceding claim, in which the visible light emitter unit comprises a signal bulb unit.
4. A signalling system according to claim 3, in which the signal bulb unit comprises at least one light emitting diode (LED).
5. A signalling system according to claim 4 in which the signal bulb unit comprises a plurality of LEDs.
6. A signalling system according to any preceding claim further comprising a plurality of signal members spaced apart along the path, each adapted to emit a non-visible instruction signal comprising information regarding the location of the signal along the path as well as the condition of the signal.

7. A signalling system according to any preceding claim, in which a repeater means is provided along the path, the repeater means being adapted to repeat an instruction signal from an upcoming signal to the vehicle.
- 5
8. A signalling system according to claim 7, in which the repeater means is adapted to repeat the identity of a forthcoming signal member on the path.
- 10
9. A signalling system according to any preceding claim in which tracking means is provided to determine the position of the vehicle along the path.
10. A signalling system according to any preceding claim, in which the
- 15 emitter comprises a source signal transmitter.
11. A signalling system according to claim 10 in which the source signal transmitter is a RF transmitter.
- 20
12. A signalling system according to any of claims 1 to 9 further comprising radar means provided on the vehicle for transmitting an outgoing signal, the emitter comprising means for reflecting and modulating said outgoing signal to provide the non-visible instruction signal for reception by the radar means.
- 25
13. A signalling system according to any preceding claim, in which a further mobile emitter is provided for a user in the vicinity of the path of the vehicle, the further mobile emitter comprising means for providing an outgoing signal to provide a warning signal for reception by the receiver on
- 30 the vehicle, the warning signal providing an indication of the presence of the mobile emitter in the vicinity of the vehicle path.

14. A signalling system according to any preceding claim, further comprising processor means located on the vehicle to process the received instruction signal and provide a visible and/or audible indication of the condition of the signal to the driver of the vehicle.
- 5
15. A visible light emitter unit for use with a signalling system including a signal having a plurality of conditions, the visible light emitter unit including an integral emitter for emitting a non-visible instruction signal comprising information on the condition of the signal.
- 10
16. A visible light emitter unit according to claim 15, adapted to emit a non-visible instruction signal comprising information on the identity of the signal.
- 15
17. A visible light emitter unit according to claim 15 or claim 16, in which the emitter comprises a RF source signal transmitter.
18. A visible light emitter unit according to any of claims 15 to 17, in which the emitter comprises a reflector and modulator capable of reflecting and modulating an incoming signal to provide the instruction signal.
- 20
19. A visible light emitter unit according to any of claims 15 to 18 adapted to emit a non-visible instruction signal comprising information on the location of the signal.
- 25
20. A visible light emitter unit according to any of claims 15 to 19 further comprising a plurality of LEDs.
21. A method of providing an indication, on a vehicle, of the condition of a visual signal located along a path of the vehicle including the steps of emitting an instruction signal containing information regarding the condition of the visual signal from an emitter located at the visual signal,
- 30

receiving the instruction signal at a receiver located on the vehicle; and processing the instruction signal to provide a visible and/or audible indication of the condition of the visual signal.

- 5 22. A method according to claim 21 in which the instruction signal has encoded within it information identifying the condition of the signal and the identity of the signal.



2/5

Fig.2.

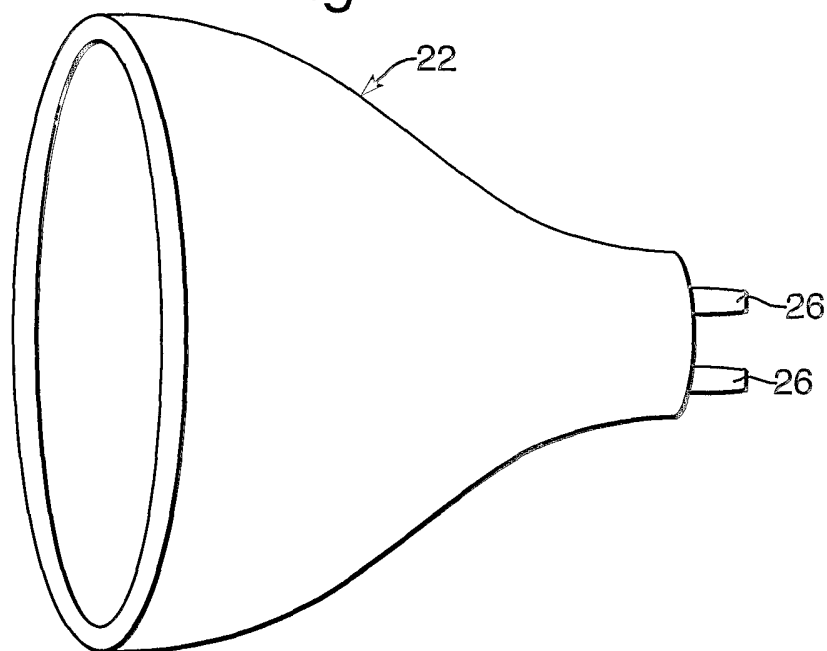
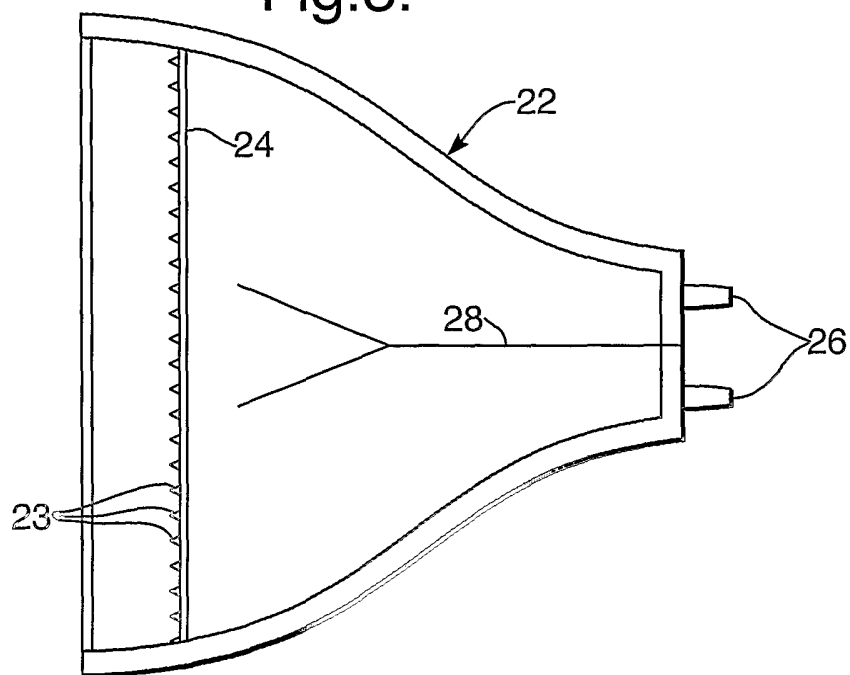
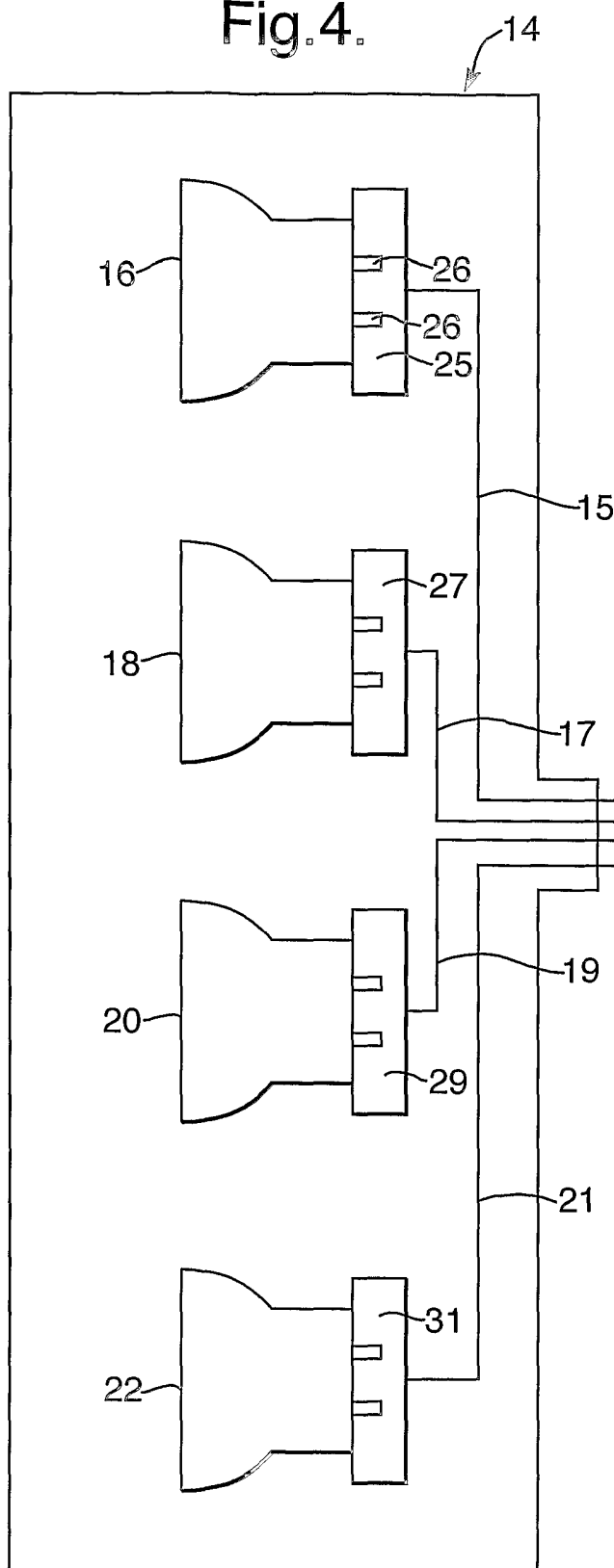


Fig.3.



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Fig. 4.



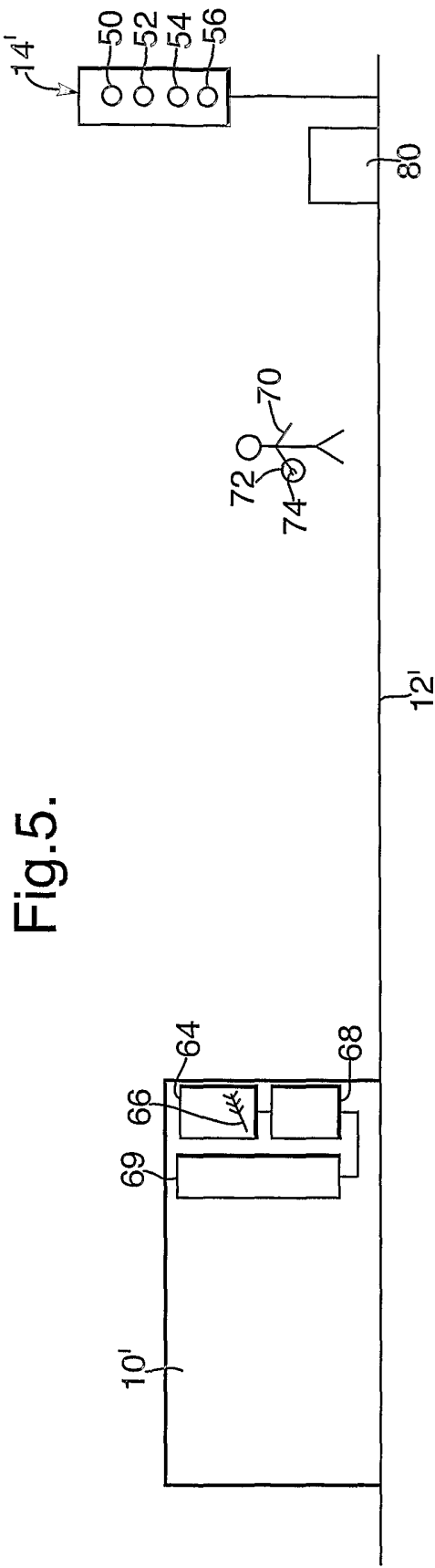


Fig. 5.

Fig. 6.

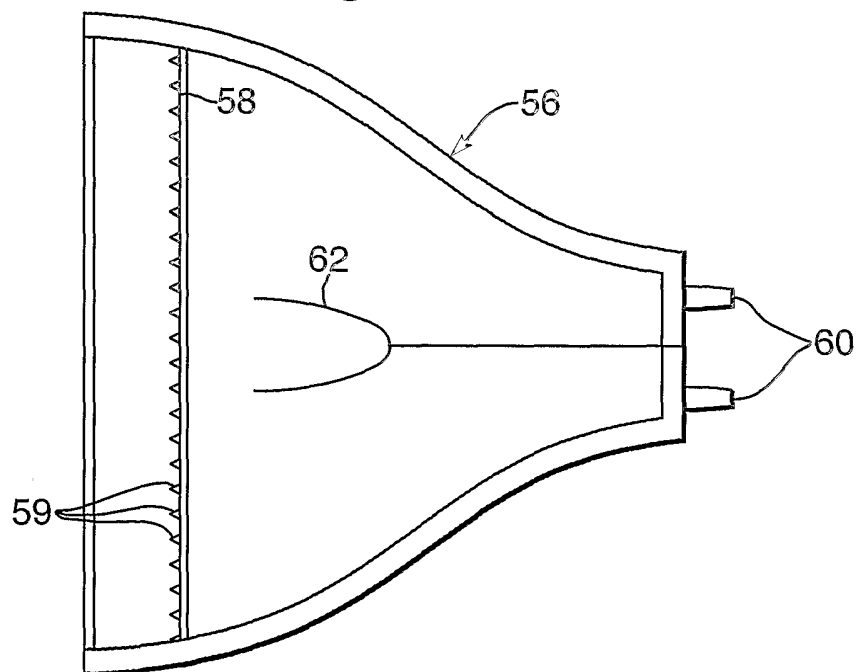
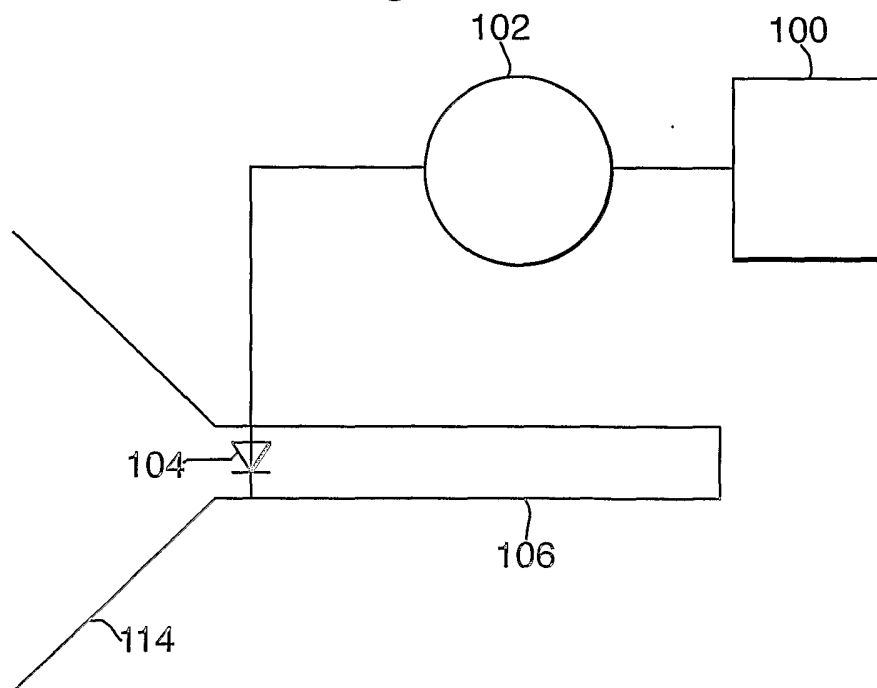


Fig. 7.



INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB2004/000912A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B61L3/12

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)

IPC 7 B61L

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

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

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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☒ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

12 May 2004

Date of mailing of the international search report

21/05/2004

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INTERNATIONAL SEARCH REPORT

International Application No
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
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Information on patent family members

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