A RAILWAY VEHICLE MONITORING ARRANGEMENT

The present invention relates to a railway vehicle monitoring arrangement.

Track circuits have been used for many years as a method of detecting trains. Each track circuit is responsible for monitoring the status of an associated section of track and supplies information about its status (train present/absent) to a signalling system. One of the weakest links in this detection is the ability or otherwise of a train to shunt the track circuit, leading to the possibility of trains becoming "lost" in the railway system. Current track circuits do not perform any "plausibility" checking of their outputs and for this reason trains can seem to "appear" and "disappear".

Figure 1 illustrates the above point. The top line is a schematic representation of a length of track. The length of track is monitored by three track circuits A, B and C. The second line is a timeline, showing the sequence of events as a train drives from A to C. The box shows the output from each of the track circuits, track circuit A's output being represented by the top line in the box, B's the next and C's the bottom. The presence of a line in the box indicates that a particular track circuit is reporting that a train is present, the absence of the line showing the opposite (no train is present). Train detection is lost while in B, which could be caused by rail contamination such as leaves on the line or rust. The track circuit reports this, potentially allowing the dangerous situation of another train entering the same section of track.

According to the present invention, there is provided a railway vehicle monitoring arrangement including a plurality of adjacent railway vehicle detection means, each of the detection means providing an indication of the presence or absence of a railway vehicle in an associated section of a railway track, there being communication means whereby each of said detection means can communicate with the or each adjacent detection means to co-operate in the operation of a railway system.

Each of said detection means may be provided by a track circuit.

The arrangement could be such that, if a railway vehicle is detected by one of said detection means over a period of time without any adjacent detection means detecting it, then an error signal is sent to a diagnostic unit of the arrangement.

The arrangement could be such that, in the case of communications (or other) malfunction or a request from an operator, each of said detection means reverts to a mode in which it operates without communication with the or each adjacent detection means.

The arrangement may be such that, if one of the detection means no longer provides an indication of the presence of a vehicle in the associated track section and an adjacent detection means does not provide an indication of the presence of a railway vehicle in its associated track section, said one of the detection means is held in a locked condition representative of the presence of a vehicle in its associated track section.

The arrangement could be such that the exit detection means of the arrangement is configured to use the vehicle detected output from the next (not communicating) detection means to release it from a locked condition, thus preventing it from becoming permanently locked. This indication could be taken from a relay drive or similar, and could also be used to inhibit the spurious generation of an unexpected vehicle by the first detection means in the arrangement.

The arrangement could be such that the direction of working is configured in the detection means and locking is only permitted to be passed in this direction. This would facilitate what is called "close-up". This frequently occurs in metro systems and is where vehicles do not leave a one vehicle detection system gap between each other but follow more closely.

The arrangement could be such that, in the case of the failure of a one of said detection means, the or each adjacent detection means communicates directly to allow vehicle detection information to continue to be shared.

The present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 illustrates a problem with known track circuit arrangements;
Figure 2 is a block diagram of an example of a track circuit arrangement according to the present invention; and
Figure 3 is a flow chart illustrating in simplified terms the operation of the arrangement of Figure 2.

Referring to Figure 2, reference numeral 1 designates a length of railway track divided into sections, each section being monitored by a respective one of adjacent track circuits S1, S2 and S3, each track circuit having a means for detecting the presence of a train in the section of track it is monitoring.

In each track circuit, there is a functional block (2A, 2B or 2C) which produces an output to a respective locking logic block (3A, 3B or 3C) of the track circuit indicating whether a train is or is not detected in the respective track section. The logic block can only change the output into a safer state (train detected) and it cannot force the track circuit to signal that no train is detected. Each track circuit has an output (4A, 4B or 4C) from its logic block 3A, 3B or 3C to a signalling system of the railway system concerned. Also, in each track circuit there is an error log functional block (5A, 5B or 5C) receiving an output from the respective locking logic block 3A, 3B or 3C and between the locking logic block of each track circuit and the or each adjacent track circuit there is a two-way communication link - namely link 6 between locking logic blocks 3A and 3B and link 7 between locking logic blocks 3B and 3C.

Each track circuit S1, S2 or S3 is capable of communication with the adjacent track circuit or track circuits to share information regarding train detection. This information is used to reduce the chance of trains not being detected. If a track

circuit loses detection of a train, it checks with the track circuit or track circuits that are monitoring the route(s) leaving the track section for which the track circuit is responsible, and then alters its output if certain conditions are not fulfilled..

To provide protection against trains being "lost" due to detection failure, each track circuit S1, S2 or S3 uses the concept of "locking". While locked, a track circuit will maintain occupied status even if a train is no longer detected. The "lock" travels with the train and is passed from one track circuit to the next in a similar manner to a token. A track circuit will only lock in the occupied state. A track circuit unlocks itself when it has been determined that the train has moved into an adjacent track section and the lock has been passed to that section. If a train is no longer detected by a track circuit and no track circuit adjacent to it has detected a train entering the track section which it monitors, there is the possibility that the train has not left the first track section but detection has been lost for some other reason (which could be caused by a rusty or leaf-contaminated track for example), in which case the lock forces the track circuit to continue reporting occupied status to the signalling system.

If a train is detected in a track section without having been detected in any adjacent track circuit(s) (an "unexpected train"), there are several possible explanations. The most common of these is that a momentary disturbance causes the track circuit to erroneously detect a train, which sort of event should not cause locking. Other possibilities are that maintenance workers have caused a track circuit to operate for their protection. Depending on the application, it may be desirable to lock a track circuit in such a case, so a "time-out" is provided to enable self-locking.

In the event of a failure of track circuit S2, the adjacent track circuits S1 and S3 could be configured to communicate with each other and carry out the lock transfer and other information sharing directly, instead of the usual two stages via S2 (S1 to S2

and then S2 to S3). This could enable the railway system to continue in protected operation with relatively little reduction in performance.

The knowledge of the status of surrounding track sections can also be used to provide an error-checking role. If a train is detected over a period of time without any of the surrounding track circuits having detected the train, then an error can be passed to a diagnostic unit. An error such as this could indicate a failed track circuit, or debris on the track or flooding for example.

In the above example with reference to Figure 2, the outputs "train detected" and "locked" are indicated by logic "true" and "train not detected" and "unlocked" by logic "false".

The flow chart of Figure 3 shows how the information available from a track circuit is used to determine the correct output, the key to Figure 3 being set out in the following table.

State/Test	Explanation
Occupied	Track circuit sending status "occupied" to signalling system.
Unoccupied	Track circuit sending status "unoccupied" to signalling system.
Train Detected	A train is currently being detected as present in the monitored track section.
Lock	It is appropriate to lock.
Unlock	It is appropriate to unlock.
Locked	In the locked state, the status sent to the signalling system is "occupied" regardless of whether a train is detected or not.
Unlocked	In the unlocked state, the status sent to the signalling system is a direct reflection of the input from the track.

With reference to Figure 3, the calculations performed to determine the status of the track are performed cyclically, the cycles being referred to below.

Lock

A track circuit should enter into the locked condition if track circuit has requested (from an adjacent track circuit) and has been given permission to lock (by an adjacent track circuit) and is detecting a train. It should also lock if a self-locking timer has expired.

Expressed as a logic equation:

SelfLockTimerExpired OR (Request lock 2 cycles ago AND Lock permission last cycle AND Detecting a train)

A track circuit should request permission to lock when it is detecting a train and it is not currently locked and the train is not indicated as unexpected - this is to prevent locks being generated for brief disturbances or similar.

Expressed as a logic equation:

Detecting AND NOT(Locked) AND NOT(Unexpected)

A train is considered to be unexpected if either a new train is detected or the train was unexpected last cycle and it is still detected. Additionally at least one of the following must also be true:

it is not locked

or no adjacent track circuit is detecting a train

or no adjacent track circuit is locked

or it has not stopped detecting a train recently (configurable timeout)

or an adjacent track circuit has not stopped detecting a train recently (configurable timeout)

Expressed as a logic equation:

((Detecting AND NOT (Detecting last cycle)) OR (Unexpected last cycle AND Detecting)) AND NOT (Adjacent locked OR Locked OR Adjacent detecting OR Train left adjacent timer>0 OR Train left timer>0)

Unlock

A track circuit should exit the locked condition if an adjacent track circuit is locked and is detecting a train.

Expressed as a logic equation:

Adjacent locked AND Adjacent detecting a train

A track circuit should be held in the locked condition if the requirements to exit the locked condition are not satisfied.

The structure of each of track circuits S1, S2 and S3 could be realised in practice by an appropriately programmed computer whose software realises the above-described functions or a dedicated piece of hardware such as a programmable logic device (PLD) which has been designed to perform the above-described functions.

The above-described arrangement has the advantage over known track circuit arrangements in that instead of there being "train detection lost" periods as shown in Figure 1, in such periods "train detection" is maintained.

CLAIMS

1. A railway vehicle monitoring arrangement including a plurality of adjacent railway vehicle detection means, each of the detection means providing an indication of the presence or absence of a railway vehicle in an associated section of a railway track, there being communication means whereby each of said detection means can communicate with the or each adjacent detection means to co-operate in the operation of a railway system.

2. An arrangement according to claim 1, wherein each of said detection means is provided by a track circuit.

3. An arrangement according to claim 1 or 2, wherein if a railway vehicle is detected by one of said detection means over a period of time without any adjacent detection means detecting it, then an error signal is sent to a diagnostic unit of the arrangement.

4. An arrangement according to any preceding claim, wherein in the case of communications (or other) malfunction or a request from an operator, each of said detection means reverts to a mode in which it operates without communication with the or each adjacent detection means.

5. A railway vehicle monitoring arrangement according to any preceding claim, wherein if one of the detection means no longer provides an indication of the presence of a vehicle in the associated track section and an adjacent detection means does not provide an indication of the presence of a railway vehicle in its associated track section, said one of the detection means is held in a



locked condition representative of the presence of a vehicle in its associated track section.

6. An arrangement according to claim 5, wherein the exit detection means of the arrangement is configured to use the vehicle detected output from the next (not communicating) detection means to release it from a locked condition, thus preventing it from becoming permanently locked.

7. An arrangement according to claim 5 or 6, wherein the direction of working is configured in the detection means and locking is only permitted to be passed in this direction.

8. An arrangement according to any preceding claim, wherein in the case of the failure of a one of said detection means, the or each adjacent detection means communicates directly to allow vehicle detection information to continue to be shared.

