

POSITIVE ROUTE IDENTIFICATION

The present invention relates to an arrangement for positively identifying the route taken by a railway vehicle. The invention is particularly useful in driverless trains although this is not its only application.

If a train may be switched on to alternate routes, or directed on to alternative paths on the same route e.g. into a passing loop, and be required to pull up to one of several station platforms, it is important that the train control equipment should know the exact position of the train in order to calculate or select an appropriate braking or driving profile. For example: on the approach to a station with several platforms, to any one of which the train may be switched, each platform may require a different braking profile for the train to stop at that platform. In such a situation, an embodiment of the invention has for one of its objects to provide the necessary cues to the train so that the control equipment will select the correct braking profile.

According to the present invention there is provided an arrangement for positive route identification by which a railway vehicle is able to positively identify its route, wherein, at a predetermined distance from an initial point, each path of a permanent way is defined by at least one signal or marking means, and a railway vehicle constrained to travel on said permanent way has: means for sensing each such signal or marking means to produce a sensed signal; means for measuring distance travelled from said initial point; means in which is stored information describing each path in terms of the signals or marking means and their distances from said point; and means for comparing a sensed signal at a measured distance with said stored information whereby to identify the path

over which the vehicle is travelling.

Preferably the signals or marking means comprise track circuit signals, the frequencies of which are arranged in predetermined sequences, and at a
5 predetermined distance from said initial point, the track circuit signal of each alternative path has a different characteristic frequency.

The invention and how it may be carried into practice will now be described, by way of example only,
10 with reference to the accompanying drawings, in which:

Fig. 1 shows a diagram of a station approach having three alternative routes leading to separate platforms; and

15 Fig. 2 shows a block diagram of an automatic train operating system employing this invention.

Referring to Fig. 1, the arrangement of track circuit frequencies F is shown in part of a track layout approaching a station or depot. The two tracks
20 between stations are labelled conventionally "UP line" and "DOWN line" with the normal direction of traffic on each shown by the accompanying arrow. The two tracks are interconnected with three platform approach tracks labelled A, B and C.

25 The system employs a total of seven track circuit carrier frequencies which are allocated as shown in Fig. 1. On the "DOWN line" leading to A, a train travelling in the direction of the corresponding arrow will encounter a repeated sequence of frequencies
30 F2, F5, F7. On the "UP line" leading to B a train travelling in the direction indicated by the corresponding arrow will encounter a repeated sequence of frequencies F1, F3, F6. On the track leading to C, the first mentioned sequence of F2, F5, F7 will
35 be repeated.

The interconnecting sections of track are identified with a track circuit carrier frequency F4. This frequency

is reserved for connecting sections of track, cross-overs etc. so that it is only detected by a train during the course of changing from one track to another.

5 A train at position S on track A has just entered a track section having the characteristic frequency F7. When the train has travelled a distance x along track A, without diversion, it will be passing through the next track section, having characteristic frequency
10 F2. After a distance $2x$ from position S along track A, it is within a section identified by frequency F5, and after distance $3x$ it will again occupy a section identified by frequency F7.

Assuming that at point P1 the train is diverted,
15 then at the end of distance x it will occupy a section identified by characteristic frequency F4. At point P2 the train may be either switched on to track B or switched on to a further interconnecting section taking it towards point P3 on track C. If it is
20 diverted on to track B, then after a distance $2x$ the train is within a track section identified by the characteristic frequency F6, and after a distance $3x$ it occupies a section having characteristic frequency F3.

However, if at point P2 the train is diverted
25 towards track C after travelling a distance $2x$, it still occupies a track section identified by characteristic frequency F4, and after travelling a distance $3x$ is then within a section identified by frequency F2.

Consider, therefore, a train equipped with
30 means for sensing the track circuit frequency of track sections over which it passes. In the first alternative it senses the frequency sequence F2, F5, F7, F2 etc. and receives no other frequency. In the second alternative it senses the frequencies F2, F5, F7,
35 F4, F6, F3, F1, and in the third alternative it senses the sequence F2, F5, F7, F4, F4, F2, F5. Thus, means capable of discriminating between these frequency

sequences is able to determine whether the train, having travelled a distance $3x$ from point S, is then on track A, track B or track C.

Referring now to Fig. 2, this shows a block diagram of an automatic train operating (A.T.O.) system employing an embodiment of the invention. The track circuit signals are carried by track running rails indicated at 20. The train is equipped with sensing coils 21 positioned close to the track rails and inductively coupled with the rails in order to provide an output at 22 connected to automatic train protection (A.T.P.) equipment 23 on the train.

A.T.P. equipment 23 could be of a form known in the art - see for example British Patent Specifications Nos. 2159311 and 2017991. As is known from the prior art, such A.T.P. equipment performs a fail-safe safety function according to which the train's brakes are applied if, for example, no track circuit signal is detected, or the measured speed of the train exceeds the maximum speed limit indicated by a coded modulation signal carried by the track circuit signal. The A.T.P. equipment 23 provides an output 24, consisting of the characteristic track circuit frequency, which is connected to automatic train operating (A.T.O.) equipment 25 which, among other things, controls the brakes and the drive motors of the train.

A.T.O. systems are well known in the art and it is not proposed to describe here their construction or detailed operation. It is sufficient to know that such a system draws upon several sources of information and compares variable parameters either one with the other, or with fixed stored values, to determine acceleration, deceleration and velocity values.

One of the sources of information for the A.T.O. equipment 25 is a geographical information store generally indicated at 26 in Fig. 2. This comprises an electronic store of information such as track circuit

frequency sequences, location code words, distance between identifiable points, gradient information etc.. This information is indexed in the memory so that it may be read by the A.T.O. equipment sequentially as the train moves along a route.

5 A distance measuring means in the form of a tachometer or odometer 27 is also connected to the A.T.O. equipment 25 to supply a measurement of distance travelled by the train. This distance is used by
10 the A.T.O. equipment 25 to address the geographical information store 26 in order to read from it corresponding information concerning the position of the train and the route being traversed.

The A.T.O. equipment 25 may be set to update
15 its operating information after each distance x travelled by the train (see Fig. 1). If in travelling the distance x from its last information update the train has been diverted from say, track A at point P1 in Fig. 1, the information read from memory
20 26 will indicate the alternative possibilities, for example that the track circuit shall have a frequency of either F4 or F2. The A.T.O. equipment is then able to determine, if the received track signal frequency is F4, that the train has been diverted at point
25 P1 towards P2. After a further distance x , by comparing the then received track circuit frequency, it can further determine if the train has been switched on to track B, when the track circuit frequency will be F6, or if the train has been further switched
30 towards point P3 and track C, when the track circuit signal will have frequency F4. A subsequent check after distance $3x$ will confirm whether the train is travelling on track B and receiving a track circuit signal having a frequency F3, or whether it is on
35 track C and receiving a track circuit signal having a frequency F2.

In one form of the invention, the route detecting equipment is arranged to be operatively responsive to reception of the intermediate section frequencies F4 only, and is not normally stimulated by the normal fixed track circuit frequency sequences.

In normal track layouts, the track circuit signals are carried by the running rails except at cross-overs, intersections, etc. where the track circuit signals are carried by signal conducting loops laid in the track bed. A first loop extends along the normal direction of track and carries the expected straight ahead signal having a carrier frequency in the expected sequence. A second loop is also laid in the track bed extending for a short distance along the straight track, up to the commencement of the cross-over track section, and then following the branching or interconnecting section. If the track points are set to divert a train, then the second branch loop is energised and carries a signal having carrier frequency F4. If the track points are set straight ahead, then the second loop is not energised but the first loop carries a signal having a carrier signal frequency as determined by the sequence on that line.

The commencement of an interconnecting section is accurately marked at a fixed, predetermined point by the commencement of the track section signal loop which, thus, may serve as the reference marker point or initial point.

30

35



CLAIMS

1. An arrangement for positive route
identification by which a railway vehicle is able to
5 positively identify its route, wherein, at a
predetermined distance from an initial point, each
path of a permanent way is defined by at least one
signal or marking means, and a railway vehicle
constrained to travel on said permanent way has:
10 means for sensing each such signal or marking means
to produce a sensed signal; means for measuring
distance travelled from said initial point; means in
which is stored information describing each path
in terms of the signals or marking means and their
15 distances from said point; and means for comparing
a sensed signal at a measured distance with said
stored information whereby to identify the path
over which the vehicle is travelling.

2. An arrangement as claimed in Claim 1, wherein
20 the signals or marking means comprise track circuit
signals, the frequencies of which are arranged in
predetermined sequences, and wherein at a predetermined
distance from said initial point, the track circuit
signal of each alternative path has a different
25 characteristic frequency.

3. An arrangement for positive route identification,
substantially as described with reference to the
accompanying drawings.

30

35