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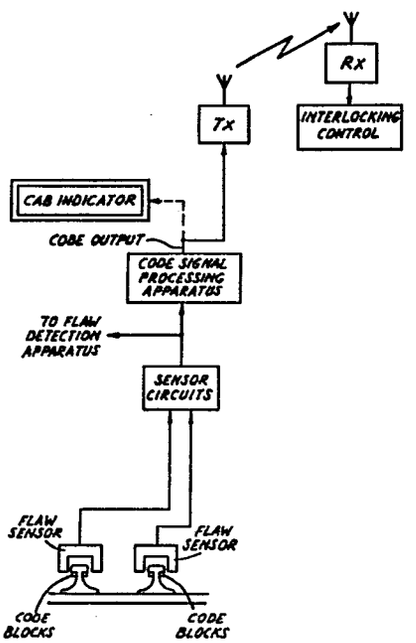
(54) System for locating a railway vehicle.

(57) A flaw detector for checking and continuously proving the integrity of railway tracks rails is given a second role to additionally sense markers attached to the rail webs. These markers, for example welded metal blocks, are arranged to reproduce a code word in the flaw sensor outputs representing the location of the vehicle. The code word is then transmitted, together with another code word representing the vehicle's identity, to a central traffic control office via a radio communication channel. The described arrangement may directly replace conventional track circuit apparatus.



System for locating a railway vehicle

The invention relates to a system for locating a railway vehicle.

The invention seeks to provide a system for determining the location of a railway vehicle along a track notionally divided into track sections. The proposed system uses lower cost apparatus and dispenses with, as far as is possible, active trackside equipment which is vulnerable to vandalism and requires periodic maintenance.

Railway operators have been exploring ways of increasing efficiency of track maintenance for some time in order to cope with the demands of greater usage of track and increased, at least for passenger services, operating speeds. Arising from this ultra-sonic flaw equipment capable of operating at normal traffic schedule speeds has been developed so that the integrity of track rails may be checked without interruptions to services. Flaws, cracks and the like are detected at an early stage and marked, for example by a blob of paint on the track near a flaw and can be dealt with as needed before rail breakages occur.

It is proposed that the present invention shall use existing flaw detection equipment to detect markers installed on the rails, and that the markers fulfil the same functions as track circuits and track signalling equipment, in addition to the normal function of the equipment to check the integrity of track rails.

According to the invention there is provided a system

for locating a railway vehicle equipped with apparatus for detecting flaws, cracks or the like in the running rails comprising sensing means capable of detecting flaws in the track rails, markers associated with the track rails at intervals and which are adapted to produce in a flaw sensor signal output a predetermined response consisting of a code word representive of its location and means connected with the flaw sensor output to provide an indication of the location of the railway vehicle as represented by said code word.

Preferably the invention utilizes flaw detection apparatus provided initially for track rail inspection purposes. Apparatus embodying the invention therefore has a dual role, although as the track inspection functions are no concern of the present invention no corresponding detailed description will be given.

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

Fig. 1 shows at (a) a sectioned view through a rail provided with a metal block set, and at (b) a side view thereof, and

Fig. 2 shows a block diagram of the location system.

In the particular embodiment of the invention to be described metal blocks of several sizes are attached to a running rail immediately below the underside of the head and adjacent the vertical web, as shown in Fig. 1. The size and/or position of the blocks is chosen to provide a useful code when sensed by a passing railway vehicle. For example, the drawing shows blocks of two

different lengths, either long or short, and which are placed as shown in the side view to represent a bar code 1001. The blocks are mounted on at least one side of the rail, blocks may be mounted adjacent both faces of the central vertical web, and these sets of blocks may convey different information.

A railway vehicle is provided with sensing means appropriate to the method of detection to be employed, and in a position which will enable the blocks to be sensed. The sensing means may be connected to provide an input to train borne equipment adapted to make use of the information provided. For example, the invention may be used to communicate to a train a code identifying a particular location such as a point a predetermined distance ahead of a station platform.

The invention may utilize several alternative phenomena, of which the following are some examples: conductive metal blocks may be used in conjunction with eddy current flaw sensors, radio-active blocks in conjunction with corresponding radiation sensors, blocks of radar absorbent material with cooperating means for sensing reflected energy, and light reflective surfaces cooperating with a mobile laser source and light sensor. Further possibilities include specially formed blocks having internal cavities designed to resonate at a microwave frequency and which cooperate with a microwave transmitter and receiver on a vehicle, or blocks drilled or formed with holes arranged to modulate a jet of compressed air which is sensed by an acoustic detector on a vehicle. In another arrangement mechanical contact sensing is employed, in which case the rail mounted blocks may be formed with specially shaped ramp formations. Such an

arrangement is probably only useful at relatively low speeds.

The information to be conveyed by or derived from sensing of the blocks is as follows: the size and/or spacing of blocks may represent an encoded location identity which will indicate to a vehicle its position, the time span of the message, i.e. elapsed time between the first and last block as sensed by a vehicle may be used to calculate vehicle speed, several sets of members may be arranged in a predetermined sequence to provide a more sophisticated progressive time or speed check, and the blocks may be used to trigger a further operation such as initiating radio communication with a remote traffic control office which can provide more detailed information. The invention may also be used to convey fixed data concerning conditions on the line or route ahead, for example, to indicate a maximum speed limit, distance to given point, say a platform end, and so on.

In the particular embodiment illustrated diagrammatically in Fig. 2 the invention is used in conjunction with a radio signalling system for the control of a railway train. The train communicates with a central traffic control room from time to time by means of a secure radio system.

Referring to Fig. 2, the train carries a flaw sensors conveniently positioned close to the rail heads, one sensor for each rail. These sensors do not need to be positioned ahead of the first axle and may be located anywhere that is convenient. Known flaw sensors are suspended beneath a special coach which is attached to a train in addition to normal passenger service

coaches. In the embodiment the flaw sensors rely upon the principle of eddy current induction in the conductive material of the track rails. Sensing coils are mounted in close proximity to, and therefore are inductively coupled with, the track rails so that the impedance of the coils is significantly affected by the physical and metallurgical properties of the rails. A discontinuity in a rail, such as is caused by a crack or a cavity, will cause a momentary change in the sensor coil impedance as the sensor passes over the crack etc.

The sensor coils are connected in resonant sensor circuits in such a way that these transient impedance changes influence the frequency and amplitude of a sensor circuit output. Conveniently this output is analysed by flaw detection, signal processing circuits which seek out the evidence of impedance changes caused by cracks etc. In a dual purpose system as presently proposed the impedance changes brought about by the coded blocks are immediately apparent in the output, when compared with the changes due to a small crack for example, and take the form of a well-defined and predetermined corresponding code word signal.

These code word signals are divided out of the main flaw sensor circuit output by, for example, a threshold discriminating circuit the output of which is connected with code signal processing apparatus. This apparatus may be as simple, in one form of the invention, as a squaring circuit, but in more sophisticated version, also includes code verification circuits in which a received code word is checked against stored valid code words in order to check the validity of the sensed code word. The signals from the two sensor coils are also

correlated in a fail-safe manner so that spurious signals are disregarded and only valid codes in both signals in combination are processed.

The processing apparatus output is connected to a radio communication transmitter which, upon receiving a code word signal, is energised to transmit the signal to a receiver in a central traffic control office where the signal indicating the location of the railway vehicle is connected to railway control signal interlocking means. The signal may also be connected to a train describer display for a visual indication of the vehicle's location.

The transmitted signal containing the location code signal forms part of a message which also contains further information such as the vehicle's identity, other information for example train speed may be included. Train speed can be independently calculated from the sensed signals if the coded block sequences are of predetermined length so that sensed message length is directly proportional to train speed over a coded block set.

When the sensing equipment detects the markers the train indicates its location at prearranged points, the radio is energised to transmit a signal of the event to the control office which then responds with further signalling commands, operating commands, or other information. The system may require the intervention of a human operater, i.e. the driver, or may be completely automatic; in the former case failure to make some response to an indication arising from the passage of a member set of blocks may result in the actuation of an automatic train protection system.

In an other embodiment the message represented by the blocks of a member set may be changed, for example, by adjusting the mutual position of the blocks, and this may be employed to represent a "signal aspect" replacing a red, amber, green aspect set lights. Thus, when it is desired to communicate a particular signal aspect to a train the mutual positions of the blocks is adjusted accordingly and the signal aspect is automatically sensed by a passing train. Similarly other changing information may be conveyed to the train. The sensing equipment carried by the train vehicle may be interlocked with the automatic braking system in order that, for example, if a "red" signal aspect is sensed indicating that the train shall immediately halt, the emergency braking system may be actuated unless the driver responds by bringing the train to a halt within a predetermined period of time.

The metal blocks which comprise a member set may be attached to the rail in several ways such as by friction welding, by glue, or other suitable method which preferably which does not introduce flaws into the rail. The location of the blocks under the head of the rail adjacent the vertical web insures that they will not interfere with mechanical track maintenance tools, nor that they will impede or be damaged by wheel flanges. The blocks may be separate or joined together by mounting on a communal carrier or base, or may be formed integrally as a monolithic bar.

The apparatus of the present invention can replace conventional track circuit vehicle detection apparatus. The known track circuit receivers are connected to a track occupancy relay which is only "picked-up" when the section is unoccupied. The relay is usually

located in a relay room at some distance from the track section monitored and connected by signal wires. The radio link in the present invention is directly analogous with the wire link. However, the conventional track circuit is an active arrangement and the railway vehicle plays a passive role, merely shunting the track rails. In the invention the coded blocks indicating the location of the track section are passive and the railway vehicle plays an active role in sensing the blocks and relaying the occupancy indication. This means that considerable cost savings may be made since there are only as many expensive active sets of apparatus as there are trains, instead of there being as many as there are track sections, and the maintenance of expensive trackside equipment is eliminated.

There are various possibilities for the placing of code block sets on the rails to convey to the train certain information in addition to that contained in the actual message. Coded block sets are preferably positioned on both rails, opposite to each other. Flaw detection apparatus is provided for each rail and their outputs are correlated for fail-safe detection of the blocks.

The block sets may be staggered or differentially placed between left and right hand rails, for example, so that the vehicle may deduce its direction of travel from the order of detection of the blocks.

The block sets may be selectively placed on one side only of the rails, i.e. inside or outside, and this could be used to indicate to a vehicle that it is being routed towards a platform say if the blocks are inside the rails, or straight-on if the blocks are outside.

The sensor circuits shown in Fig. 2 therefore will contain, to realise the above mentioned variations, comprise two separate sensor coils and connected circuits in respect of each rail, making four separate sensor circuts overall, without taking into account any redundancy arrangements. The code signal processing circuits comprise circuit means for correlating the several signal outputs from the sensor, to provide a consolidated signal output corresponding to vehicle location, or comparing the signals to derive the further additional information.

The output of the signal processing circuits can be connected with a cab indicator display positioned in the driver's view, this connection is shown by a dashed line in Fig. 2. The location of the vehicle is reproduced in this display in sight of the driver as a reminder to him of his vehicle's present location.

CLAIMS

1. A system for locating a railway vehicle equipped with apparatus for detecting flaws, cracks or the like in the running rails comprising sensing means capable of detecting flaws in the track rails, markers associated with the track rails at intervals and which are adapted to produce in a flaw sensor signal output a predetermined response consisting of a code word representive of its location and means connected with the flaw sensor output to provide an indication of the location of the railway vehicle as represented by said code word.

2. A system as claimed in claim 1 wherein the means to provide the indication of the location of the railway vehicle includes radio communication means or the like for transmitting the location code word to a remote receiving station.

3. A system as claimed in claim 2 wherein the radio communication means is automatically energised by sensing of a code word to transmit the same.

4. A system as claimed in any one of Claims 1 to 3 including a cab indicator responsive to a sensed code word to display in the vehicle driving cab an indication of the location.

5. A system as claimed in any one of Claims 1 to 4 wherein the markers comprise means mounted on each of the rails, the flaw sensing means comprises sensing means associated with each of the rails to produce a sensor signal output in respect of each rail and said signal outputs are correlated to

provide a single indication of vehicle location.

6. A system as claimed in claim 5 wherein the markers are differentially or selectively disposed on the rails in order to convey additional information.

7. A system substantially as described with reference to the accompanying drawings.

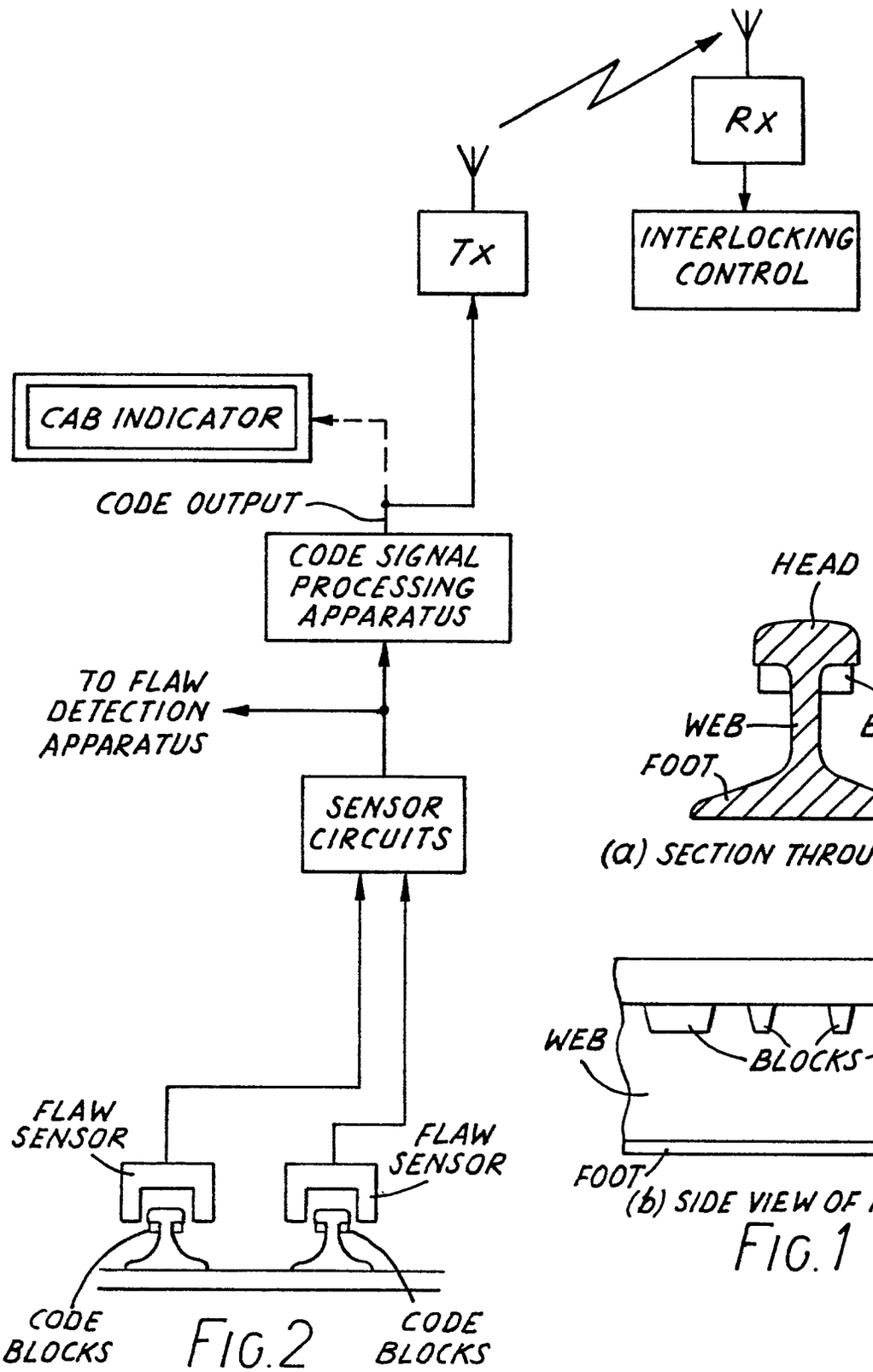


FIG. 2

(a) SECTION THROUGH RAIL

(b) SIDE VIEW OF RAIL

FIG. 1