Automatic identity systems proposed

Continuing our coverage of the Paris cybernetics conference, abstracts presented this month discuss various automatic car or train identification systems. (For previous coverage see RS&C, Feb., page 22; Mar., page 38; April, page 26; and May, page 13).

H. Fricke, an engineering professor from Germany discussed a variation of cab signaling that could also provide train identification.

From the point of view of communications techniques, the changeover from fixed signals to cab signals offers the possibility of providing continuous information on the spacing of the leading train and the trailing train. As the minimum spacing must always be observed, it is the task of the signals to supply whatever data is required, at any given moment, concerning the spacing of the leading train. As we know, it is possible to have limited signal transmission in the sharply delimited area available breadthwise in a tractive unit within a frequency zone ranging from 10 to 100 kc by means of a twin conductor laid between the rails. A coil, which is to be considered as the vehicle antenna, is connected to the twin conductor by inductive coupling.

In terms of communications procedure, this means that continuous communication must exist between the leading train and the trailing train. For the sake of convenience, these signals are not transmitted directly from vehicle to vehicle but are conveyed by interposition to a relay station called a "track set". This track set, by exchanging signals with all vehicles traveling along the track, provides a permanent picture of vehicle distribution on the track and thus disposes of all data concerning the location of all vehicles at all times. It can therefore be used for supervising train running. With the installation of storage units, the track set carries out further essential functions for supervising the data transmission system. Moreover, the track set has the task of compensating the damping which occurs by the coupling of vehicles corresponding to one another.

The concept of the selector system is based on the fact that only one vehicle can be located at one point on the track, i.e. the vehicle is identified simultaneously with the data provided as to its location. It is then no longer necessary, for selective signal transmission, to provide the various vehicles with different designations, such as frequencies or codes. This is an advantage which is of considerable value when there are several vehicles traveling in given succession on the same track.

In order to obtain continuous indications as to movements on the track by means of the selector system, all the vehicles located in the sections to be controlled are instructed to indicate their location constantly. To this end the complete track is interrogated from the track set.

In one example of selector systems, the track on which the vehicles are to be identified is divided into numerous, small sections and the location of the vehicle, and hence the vehicle itself, is indicated by the number of sections passed through. All vehicles have vehicle counters and uniformally record the number of sections passed through, starting with nil, from the moment they enter the track.

The division of the track into numbered sections is done in a particularly simple form by intersecting the twin conductor laid between the rails at the end of each section and, in this way, the nature of transmission to the vehicle is modified at the above mentioned characteristic points. When the vehicle passes over the intersecting point, not only is there a zero flow of induced voltage but a phase displacement of 180° occurs in the receiver coil which is moved horizontally along the track.

VEHICLE POSITION COUNTERS

The vehicle position counters are interrogated periodically from the track set by a series of digit impulses, the number of which is indicated by the number of sections, which are recorded by the vehicle on a digit impulse counter. If the position counter and the digit impulse counter in the vehicle coincide, the vehicle issues a response signal which is conveyed to the track set along the rail. This signal, which in the simplest case is a single impulse, not only informs the track set that there is a vehicle on the track but also indicates the location of the vehicle by the moment at which it occurs. For instance, a vehicle which is located in section 8 can only emit this indicator impulse exactly when it receives the 8th digit impulse from the track set. As the information is provided by the moment of the transmission, channel requirement. band width and receiver outlay are low.

If the trailing vehicle operates another counter at the same time as it sends out the response impulses and if this counter computes all the digit impulses which are sent out till the response signal is received from the leading train, then the number of these digit impulses is identical to the vehicle spacing, measured in terms of spacings between intersecting points. This number can be indicated in a cab signal.

It is of particular value from the operations point of view to have digital indication, not of the real, measured spacing with respect to the leading vehicle, but only of the permitted minimum spacing. The tractive unit driver is then aware at all times of his distance from a critical point and also obtains direct information as to spacing modifications. He thus has a continuous picture of the effects of his operations and can read orders at the very moment he must carry them out.

If instructions are to be given as to speed on the track, a leading train is simulated in the track set. The trailing train regulates its spacing in accordance with the behaviour of the leading train. From the point of view of communications techniques, the decisive advantage of this system is that it is no longer necessary to transmit the speed instructions given in accordance with track or operating conditions—speed restrictions on the main track, schedule data—in the form of speed orders to the vehicle and the data content can therefore be substantially reduced. The speed instructions are given by the phantom train in the track set and the train on the track regulates its course by adjusting its spacing with respect to the phantom train. What is achieved by this is that, with the simultaneous occurrence of track data and signal data, extensive priority coupling is eliminated. With the help of a phantom other tasks can also be carried out such as protecting switches, level-crossings, m/w work, etc.

It must be noted, from the point of view of construction, that by using semi-conductor construction parts and annular core storage units, performance and space requirements are so low that the apparatus can easily be installed in the vehicle. The direct current flow required for the data processing amounts to a few milli-watts and, for data transmission, 20-50 watts are required in the track set and 10-15 watts in the vehicle.

Factors to be considered regarding automatic car identification were discussed by W. M. Keller, vice-president research, AAR.

In the selection of hardware or physical equipment for automatic car identification, the environment in which it must function covers almost all the weather conditions known. Fog, rain, sleet, snow, high ambients up to 130°F, and low temperatures down to 50° below zero are encountered. For this reason we in the United States specified a temperature requirement of from −65°F to +150°F as the temperature band in which the device must properly perform.

A number of activating media for the system that will result in the most advantageous operation in all of the weather and atmospheric conditions is available. Some of these media are:

- Microwaves
- Infrared Waves
- Visible Light Waves
- Radio Waves
- Gamma Waves
- Magnetic Fields
- Inductive Current

Considering that the freight car does not have a self-contained source of electric current, any system used must be activated by an external or wayside source or power. The power used must be capable of penetrating any shielding or barrier produced by atmospheric conditions. There is a double path this energy from the wayside source must take. The energy must be transmitted to the passing car and a suitable signal returned to the wayside device.

In the evaluation of these details on power transmission there is the problem of converting the received energy at the car into reflected signals that can be conveniently received and translated into car numbers by the wayside black box or facility. It is obvious that it is cumbersome to utilize gamma rays to be converted to light by sodium iodide when a light source could be used. The complications of this process, however, has some justification in the fact that gamma rays are not restrained by such elements such as fog, snow or other barriers that would stop light rays.

Any system must be reliable and accurate. In the guide lines set for the development of these systems the maximum rate of error established is one error in 250,000 readings. Since nine characters (3 letters and 6 digits) are to be read, this rather exacting requirement has led to a discussion as to whether the redundancy required is not in excess of the economic value of the accuracy.

NO LABEL MAINTENANCE

The labels or devices on the cars must be of such design that they will not require any maintenance. The labels must be easily applied and placed at some standard location with respect to height above top of rail and lateral distance from the gage side of rail. Since freight cars are of many shapes and dimensions, it has appeared that the most logical way to establish a location for the devices is on the truck. The variation in truck frame heights is much smaller than other parts of the car conveniently accessible for this application. While there is less total movement in the truck frame than the car body, there is a certain movement involved in the truck frame caused both by the deflection of the rails and the changes in truck part dimensions resulting from wheel, journal and bearing assembly wear. For this reason tolerances for scanner operation were set on the maximum variations of truck frame movement and these tolerances are 4½" lateral and 2¼" vertical.

Certain reflected waves which have a focal point may be affected by these tolerances. Therefore, the study of either increasing the depth of focus or increasing the area of pickup has presented a problem to designers using certain types of components.

The economic study poses a problem of estimating the cost of some undeveloped device that will be used to solve a problem about which only certain facts are available. The starting point for any economic estimate such as this has to be based upon certain assumptions. There was sufficient knowledge of some prototype devices to allow a reasonable estimate on the sum that a device might cost that could be used to determine if such a system would be justified. This maximum cost was established at $5,000 for the read-out and energy input wayside installation and $5.00 per car for the label. It should be emphasized that this was not a price but merely a basis for estimating economics.

In the use of any new equipment the experience obtained in its early stages frequently points the way to better handling of the entire problem. It is expected that the use of this means of reading car numbers will prove to be no exception in this general rule. As the system is broadened in use there will no doubt be methods in which its use will prove to be extended into areas beyond what are now considered to be the limits of the use of lists of car numbers. To develop such uses the AAR has a special committee working on this one item only. This committee is in the Operations and Maintenance Department of the AAR and the AAR Research Department is working on the tools that will be needed to provide the data necessary to make the system operable in an efficient manner.

FOUR ACI SYSTEMS

An evaluation of four ACI systems was presented by Joseph J. Schmidt, assistant director of research, Denver & Rio Grande Western.

Specifications for performance and for operation of an automatic car iden-

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CYBERNETICS SYMPOSIUM

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tification system were developed by the American railroads. Manufacturers and research organizations were invited to submit proposals, in accordance with these specifications. Four systems were then finally judged adequate for testing under railroad service conditions.

System A features a scanning radio frequency which is triggered by the passage of a freight car. A pre-tuned coil antenna mounted under the freight car responds to a certain frequency. The transmitter-receiver located between the rails recognizes the frequency to which the car-mounted coil is tuned.

System B utilizes a carefully focused microwave beam aimed at a special plaque attached to the side frame of the freight car truck. This plaque has embossed on it a series of dipole antennae which reflected the incident radio frequency energy.

System C uses an aimed infra-red spectrum beam which is reflected in a prescribed manner by a retro-reflective material which is affixed to a plaque on the side of the freight car truck. The arrangement of the reflective material is dependent on the coding system used. Provisions are made for parity checking.

System D beams visible light at various colored pieces of retro-reflective material which is attached by means of special adhesive to the side of the freight car. The returned colored beam of light is directed to appropriate photocells by means of an optical system and a group of filters and dichroic mirrors.

A nation-wide data processing system is proposed, using as its basis for operation, the automatic car identification system coupled with such ancillary devices as reporting station designation, date-time group, train designation, and variable per diem charge applicable to the freight car. The system contemplates inserting all pertinent data from the originating railroad "waybill" and keying the car identification to this data. All this data is stored in a large scale memory section of a centralized computer. The freight commodity, the applicable freight rate, the routing of the shipment, and the division of revenue among the several railroads participating in the car movement are furnished from a storage file section of the computer. As the freight car progresses toward its destination, its present location is continually corrected in the computer by means of transmissions from the various automatic car identification points that it passes. A message editing and routing computer operating over the combined transmission network linking together all the railroad operating terminals abstracts pertinent data from the original "waybill" and from the accounting computer and transmits the necessary traffic movement information to each terminal that the car is approaching. On delivery of the car to destination, the corrected net revenue due to each participant is inserted into the appropriate railroad file. Monthly, cross-billing charges are prepared and revenue is distributed according to the computer record.

In a similar manner, per diem charges are corrected daily at the arbitrarily agreed hour and, monthly, net settlements would take place through the national per diem bureau.

Freight car inventory for the entire continent would be automatic, accurate, and current. Distribution of cars to fulfill shipment requirements would be made expeditiously and efficiently. At the same time, standardized freight car repairs and predetermined charges for such repairs would be handled in a small section of the computing facility. Again inter-railroad settlement would be on a monthly net difference basis through a central agency.

An automatic by-product of this system would be the greatly improved and accurate freight traffic information required by the shipper and the consignee.

The Paris Transport Authority intends to put into service on one of its major subway routes, an automatic headway control system and centralized traffic control facilities. Mr. Tiercin, of the PTA, said that a feature of the headway control will be platform indicators to tell motormen the "time to be lost" or "time to be made up" so as to adhere to the schedule and provide even loading patterns. If these times are greater than 20 sec, the indication is replaced by a signal preventing a train's departure or a "long delay."

Moreover a full telephone system will enable any necessary messages to be exchanged, namely with train crews, when the trains are stationary.

The main components will be:

(1) A telecontrol system for transmission of information and orders between the line and the central control point.

(2) At the central control point will be a time registering system, a programming machine, a computer, a visual control panel (CTC machine with trains identified by number on the panel and repeating aspects or data of platform indicators), and vari-

ous programmed machines.

(3) Various control devices operated from either the central control point or on the line, and operating more especially the electric switch machines and the traction current supply switch gear.

(4) In each station there will be two platform indicators (one for each direction) and other control facilities pertinent to the station and for inter-station application.

(5) A telephone system.

Over 40 automatic retarder classification yards have been constructed on U.S. railroads since 1952. The annual return on their investment varies from 5 to 80%, reported A. L. Essman, chief signal engineer, Burlington Lines.

Tangible economic factors to be considered include:

(1) The return on the investment may run anywhere between 5% and 80%. Some railroads require a minimum return of 25% before the project would receive consideration. While on the other hand some railroads would conclude the expenditure justifies if it enhanced the "ability to compete".

(2) Reduction in locomotive and crew hours at all locations which would be affected by the availability of the new yard. In some instances, a railroad includes capital investment in locomotives as a savings.

(3) Retirement of trackage in other yards and the savings of maintenance occasioned by such retirement.

(4) Availability of land for other purposes.

(5) Savings in car per diem charges resulting from shorter terminal delay.

(6) Reduction in total car requirements because of greater car usage resulting from reduced terminal time.

(7) Reduction in overtime because of more efficient use of locomotives and crews.

(8) Increased productivity of yardmasters, car inspectors and clerical personnel.

(9) Increased tonnage handled per train and consequent overall reduction in through freight train miles.

(10) Reduction in initial and final terminal allowances to road train and engine crews.

Intangible factors include:

(1) Reduction in personal injuries sustained by yard personnel.

(2) Reduction in lading and car damage because of better regulated and fewer handlings.

(3) Faster and better service to shippers.

(4) Reduction of yard cleaning expense because of fewer impacts.

(5) Increase in efficiency due to substitution of automation for human judgment. RS&C