Development of local telephone facilities on the Southern Region

SOME METHODS OF PROVIDING AUTOMATIC TELEPHONE SYSTEMS TO STATIONS ALONG LOW-DENSITY RAILWAY LINES

One of the proposals put forward at the time the railway modernisation programme was suggested was the integration of each Region's telephone system and the ultimate provision of fully automatic dialling between any two stations on the British Railways network.

A review of all available telecommunications equipment was made. From this, it became obvious that while the exchanges at the main centres and the trunk facilities could be provided using conventional equipment and practices, the problem of providing fully-automatic intercommunication to a standard comparable to that given to main exchanges would require either the development of new equipment or the modification of existing systems.

To assess the suitability of various methods, the Southern Region of British Railways selected three systems for incorporation into existing exchange schemes. The following is a description of the three methods under test.

Line Connector system

The Line Connector system permits full exchange facilities to be given to 22 extensions and requires only four pairs of wires back to the main exchange. A central point is chosen to serve the 22 extensions and a special "subscribers unit" consisting of two relay sets and a small battery in a sealed container are mounted at this point. For the Southern Region's trial installation it was possible to mount this unit in a signalbox relay room but the equipment is designed to be housed in an outdoor cabinet at any convenient location.

The 22 extensions to be served are wired conventionally back to the subscribers unit of the line connector and terminated on screw-terminal blocks on the side of the unit. The maximum line loop-resistance, including the telephone, of any distribution pair should not exceed 500 ohms between the extension and the subscribers unit; for the four pairs back to the main exchange the resistance must not exceed 700 ohms. These four pairs are also terminated on the subscribers unit.

At the automatic exchange, a special unit is provided which serves as a terminating point for calls incoming to extensions on the line connector and also gives access to the selectors on an outgoing call. This unit is mounted on a 2-ft 6-in wide rack and provides extensive testing facilities for the subscribers unit. In the exchange, 22 calling equipments and multiple numbers are allocated to the extensions off the connector and the cross-connecting jumpers run in the normal manner.

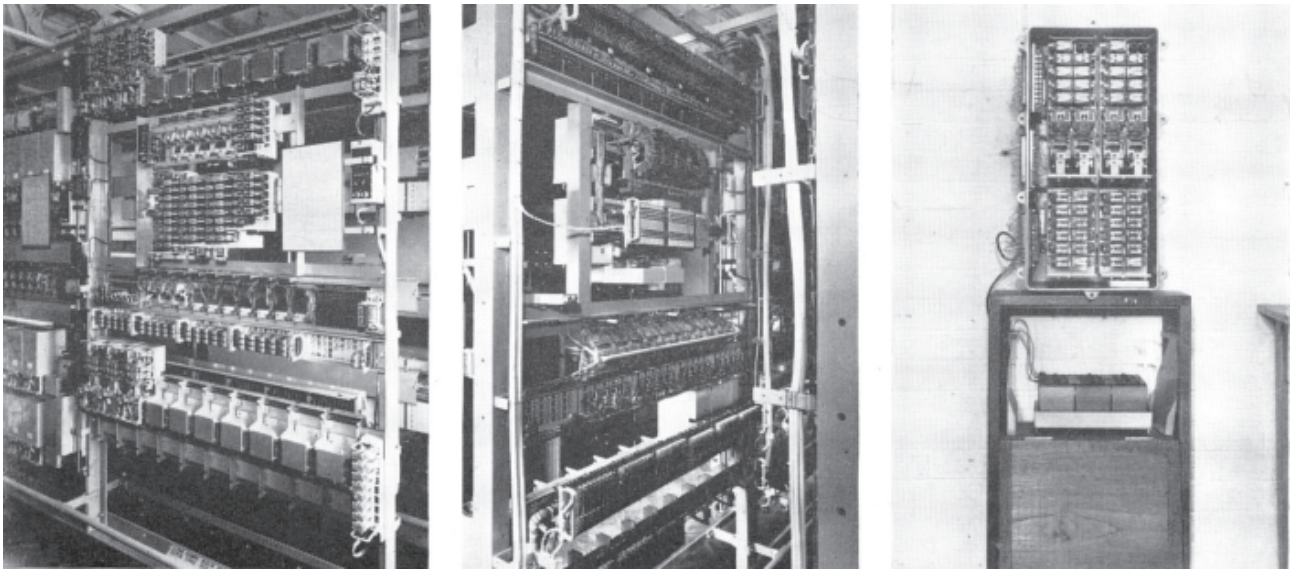
Method of operation

When the receiver of an extension working off the line connector is lifted, a calling signal is extended from this telephone to the subscribers unit. This actuates a start circuit which causes a uniselector associated. with the first free link in the unit to step to find the calling extension.

In synchronism with the uniselector stepping at the subscribers unit, loop-disconnect pulses are sent back over the link to step a uniselector in the exchange unit. When the calling extension is found and extended through to the parent, a signal is already being sent indicating the number of the calling extension. The loop signal from the calling extension seizes a first-group selector and the call is completed in the usual manner.

Battery charging

A novel feature of the Line Connector system is the method adopted for battery charging at the subscribers unit. The uniselectors and relays are worked off a 24V, 8Ah lead-acid battery which is charged over the idle links from the main exchange 50V battery supply.



The line connector system installation between Minster and Margate showing (left and centre) the fron and back of the exchange unit at Margate and (right) the subscriber unit at Minster

When a link is brought into use, the charging battery is automatically disconnected from it for the duration of the call.

After some initial maintenance difficulties because of the novelty of the equipment, the Line Connector system has worked well during the two years it has been in service, its fault rate being marginally higher than equivalent main exchange equipment. The principal difficulties experienced have been caused by prolonged link failure because of line faults which has allowed the battery to become discharged, and by the excessive rate of revertive calling which has caused some congestion on the links. This is partly attributable to the smallness of the main exchange, for example, 100 lines at Margate, compared with the Line Connector's 22 extensions. The ideal installation would be worked off a main exchange of a minimum size of 400 extensions, with daily attendance by a skilled maintenance man. It is planned to use a number of these equipments in the new Waterloo Exchange area.

"Minirax" system

The "Minirax" miniature rural automatic exchange, is a small self-contained exchange equipped for a maximum of 20 extension lines with three junctions back to the parent exchange. It has its own individual numbering scheme in the range 20-39 and is ideally used to serve a small group of extensions having a high local community of interest and which also require access to the general telephone network.

Siting of the exchange is simplified by the provision of a "charging over idle junctions" facility similar to that on the Line Connector. Consequently, it is not necessary to have a power supply at the exchange site for battery charging, this being done from the parent exchange battery. It is also possible to use only one physical junction back to the parent and work two additional carrier-channels over the same circuit.

These operating conditions were met on the branch line between Totton and Fawley which carries the traffic from the Esso Petroleum Co. Ltd oil refinery at Fawley, on to the Southern Region main line at Totton. Operationally, the branch line is a self-contained unit, but administratively comes under the District Manager at Southampton some 10 miles away. Consequently intercommunication is required throughout the branch and also through the Southampton area railway telephone exchanges.

The exchange was therefore installed at the electrical centre of the branch at Hythe. No special accommodation was available and so by arrangement it was agreed to put the unit in the Stationmaster's Office. The exchange is 5-ft high x 2-ft 9-in wide x 1-ft deep.

Ease of installation

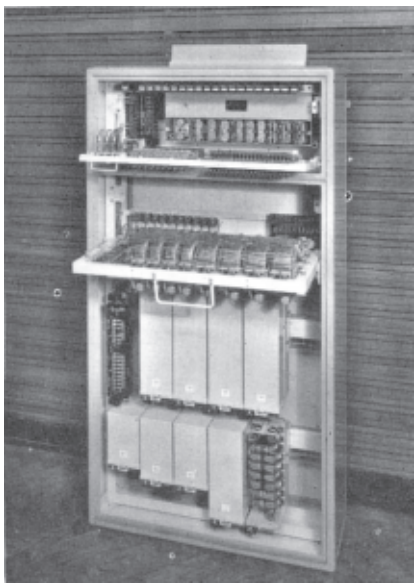
As the exchange unit contains lightning arrestors and fuses for all incoming lines, the only connection made to the cabinet was the main cable running out on to the station and it was possible to arrange for the work to be carried out by the local signal staff without any specialised assistance. They also installed the 20 extension telephones required along the branch.

Level "8" was adopted for access to the parent exchange at Southampton and two physical both-way junctions were provided to give access both to the Southampton operator (80) or the Southampton exchange area (8 followed by the extension number required). It is also possible to obtain extensions at Eastleigh and Southampton Docks by dialling the special codes for these exchanges.

Ringing and tones are similar throughout the entire dialling area and in the "Minirax" are produced by transistor ringing and tone generators. As maintenance is carried out by periodic visits, it is possible for the maintenance staff at Southampton by dialling "7" to ascertain whether a fault exists on the equipment. In these circumstances, a distinctive tone is returned to the caller to indicate the nature of the fault.

Conclusions on "Minirax" system

The equipment has been in use for the last two years, but has had access to the parent exchange for the past three months only. During the whole of this time, it has been virtually trouble free. This is probably because of the use of 3,000-type relays and uniselectors for all functions on the equipment and the high reliability and ease of maintenance of these particular components. The circuit operation of the "Minirax" is basically simpler than that of the Line Connector. It is similar in principle to that of conventional exchanges and is consequently familiar to the maintenance men who come in contact with it. An important feature is the ability for a man at the exchange to observe the call progressing stage-by-stage through the equipment rather than having to rely on a colleague at the subscribers unit passing information back to him.



"Minrax" equipment for 20 extensions installed at Hythe

The principal disadvantage is that if the "Minirax" is incorporated into a common area-numbering scheme, the selector levels in the main exchange are under-used and it is necessary to provide a two-digit access scheme for a comparatively few extensions. Furthermore, as it is not extensible, it should only be provided where the growth will not exceed 20 lines within the next five years.

Fortunately, at Southampton, the Southern Region provided, as part of the initial equipment, a two-digit access scheme for other exchanges and it was not necessary to modify the main exchange to accommodate the "Minirax". Consequently the cost per line of the "Minirax" worked out somewhat cheaper than that at the parent exchange and under half the cost per line of a Line Connector extension. If it had been necessary to modify the main exchange to receive incoming "Minirax" traffic, this saving would have been fully absorbed.

Initially, when designing a railway telephone system, the planner encounters a condition which has no parallel in public exchange work. This occurs when it becomes necessary to incorporate the stations on a long lightly-loaded section of line into an automatic network. To give each of the telephones an individual pair of wires back to the main exchange would be prohibitively expensive, yet in many cases no true centre can be found where a "Minirax" or Line Connector system can be installed.

Apart from the economic limits on a telephone line, there exist technical operating standards which limit the line length of a normal automatic extension to about eight miles. Beyond this, special measures must be taken to improve the transmission efficiency of the circuit if it is to be acceptable when used for long-distance calls.

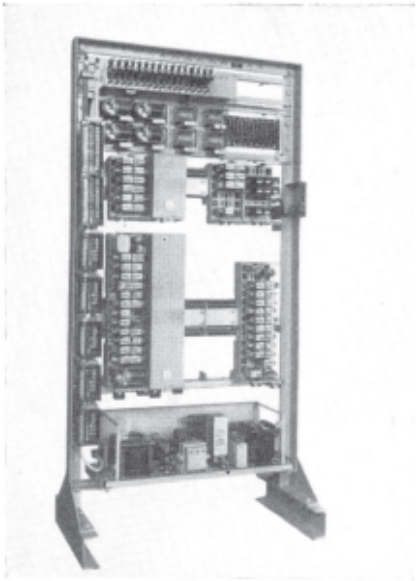
Party-line working

An obvious way of reducing the initial line-plant cost, is to provide a party line and thus make a number of users share a common pair back to the exchange. If this is done, some form of selective signalling must be adopted.

The system of party-line working on a manually-operated basis has been established on the railway for many years, but because of a number of technical limitations, such as its inferior transmission characteristics, high maintenance costs, and reliance on direct-code signalling, the existing system was not considered suitable for modification to automatic working.

Instead, the aim was the provision of a system which gave a party-line user virtually all the facilities enjoyed by a main automatic extension, but incorporated, in addition, a high-efficiency transmission circuit to compensate for the higher line resistances encountered in party-line operation. All this was to be achieved using standard G.P.O. telephone instruments and components and without requiring any power supply at the individual waystations.

Development of a party line meeting all of these conditions was carried out by Associated Electrical Industries Limited (Telecommunications Division) and the prototype equipment is at present being installed on the Southern Region to serve the stations between Tonbridge and Ashford.



Party-line unit rack equipped with two connector relay sets

The exchange equipment provides for a maximum of 12 stations along any one line and employs a selective ringing system which selects the station required and rings that bell only: the ringing signal being similar to that encountered on a main exchange.

The selection codes are built up of four basic signals. These are positive and negative 130V pulses which are applied to either the "A" or the "B" wire of the physical line as required. A complete station selection code consists of two of these pulses, each of 150 millisecond duration, and following each other in rapid succession. These signals are used to strike cold-cathode tubes and operate relays mounted in each station associated with the telephone instrument.

Following the selection pulses, a holding condition is applied to the line, the bell is rung, and ring tone is returned in the usual manner. If another station on the same party line is to be called, the procedure is slightly different. The calling station dials the required number and, because he is holding the line, he will receive "busy" tone. It is apparent to the user from the number listed in the directory that he is making a revertive call and on hearing the "busy" tone he presses a button on his telephone momentarily to free the line. The calling signal is automatically transmitted and when he releases the button he hears ring tone. The call now proceeds in the usual manner.

The exchange rack is wired to carry a maximum of nine party lines, thus giving service to a total of 108 stations. all of which can inter-dial or dial into the general network by using the access digit "0" and seizing a relay set into the parent exchange automatic equipment.

The party-line station then has access to all the facilities given to a main exchange extension. At present, the Southern Region has no experience of the maintenance of apparatus of this pattern, and it is intended to observe the performance of the prototype equipment, both operationally and technically, over a number of months before recommending that the use of this type of equipment be extended.

Recreated from Railway Gazette May 10th 1963, Pp 520-522.