Technical Meeting of the Institution

held at

The Institution of Electrical Engineers

Wednesday, March 2nd, 1960

The President (Mr. D. G. SHIPP) in the chair

Before the business of the meeting commenced the President said:—

Gentlemen,

Tonight we meet in the shadow of a grievous loss, and I am sure all of you would wish me to express our most profound sorrow at the passing of Mr. T. S. Lascelles who died peacefully in his sleep on Wednesday, February 17th.

Thomas Spooner Lascelles joined the Institution as a Student in 1913, that is, just one year after its incorporation, and has occupied with great distinction most of the Offices of the Institution, including that of President.

There is no doubt whatever that the status enjoyed by the Institution today would never have been attained were it not for all that Mr. Lascelles has done almost since its foundation.

We have lost not only an ardent and valued supporter of our Institution, but one who was a friend to so many who will forever treasure his memory and be grateful for all the kindly help he so readily gave.

He held a unique position not only in our affairs but also in our hearts, and you may wish to stand with me for a few moments in silence and reflection as a tribute to his memory.

(*The meeting stood in silence for a few moments*)

The minutes of the Technical Meeting held at the Institution of Electrical Engineers, London, on Wednesday, February 3rd., 1960 were read and approved.

The President introduced and welcomed to the meeting Messrs. A. A. Bello, J. F. Burton and S. R. Batty (Technician Members) and B. D. E. Blackman (Student).

The President then requested Mr. M. E. Leach (Member) to read his paper entitled " Modern Developments in Train Describer Technique."

Modern Developments in Train Describer Technique

M. E. LEACH, B.Sc. (Member)*

Preface

It is not the purpose of this paper to serve as a treatise on train describer design but to review in general terms some of the developments which have taken place in train describer technique since the reading of the paper " Train Describers " by the late J. E. Mott before this Institution in November, 1938.

In a paper whose length must be confined to reasonable proportions, it is not possible to cover every aspect of the sub-

* British Railways, Western Region

ject. Some facets have been highlighted; others omitted. The treatment has been illustrated by references to the present standard train describer system of the Western Region, not because this is necessarily superior but because it is the system with which the author is most familiar.

Introduction

(1) The advent of miniaturised control panels and versatile techniques for remote operation has enabled the Signal Engineer in modern signalling centralisation schemes to concentrate as large an area of control as possible under the supervision of one signalbox, so as to obtain the maximum efficiency and flexibility in traffic working. Central signalboxes thus tend to occur at main interlocking centres, with long stretches of intervening automatically signalled territory, subsidiary intermediate interlockings being either remotely controlled or relegated to ground frame status according to their importance. As an example of such a layout can be quoted the adjacent central boxes to be provided at Slough and Reading, Western Region, separated by eighteen route miles of quadruple track. The latter box will control over 120 track miles of line, with some 179 absolute, and 21 permissive, running signal sections.

(2) In schemes of this order of magnitude, it becomes essential to provide the operator with a memory device so that he can readily identify the correspondingly greater number of trains which, as a corollary of centralisation, will now come simultaneously under his jurisdiction, and it would appear logical to extend the application of the conventional box-to-box storage type train describer to achieve this end, by providing a display indicator for each running signal section in the layout, in which would be exhibited the description of any train movement occupying the section in question. By suitable means, this description could be transferred automatically from one display indicator to another in sympathy with the movement of the associated train in the layout.

(3) Basically, this conception is not novel. In recent years however, larger control areas, miniaturisation, and the changing climate of opinion in methods of traffic operation have brought about considerable changes in techniques.

(4) Perhaps the most fundamental of these has been in the form of the descriptions themselves. Hitherto, except where amplification was necessary to cover special local conditions, the compromise between economics and operational requirements led to descriptions which were comprehensive enough to identify the train expected to appear at the time set by the time-table pattern, out of course working being advised by telephone message. To enable the full advantages to be gained from the increased flexibility of centralised control, especially where fundamental regulation of traffic, such as re-routing, by-passing etc., is carried out, it is nowadays desirable that each train should be uniquely identifiable.

(5) Equally, larger areas of control require the provision of more display units which, because of equipment miniaturisation policies, must be physically smaller. These requirements render the use of combinations of words or initials as used in describers in the past, impracticable in those of the future.

Four Character Train Identification System

(1) To resolve this difficulty, a scheme was developed by the Western Region of British Railways in which use was made of four digit numbers for the classification and identification of train movements. Early in the consideration of this development, it was apparent that apart from its use in the train describer, such a scheme could be of general value in the supervision and administration of daily train working. When considered from a train describer point of view, the problem is purely one of identification of a given train movement in the working time-table, for which allocation of the numbers progressively in the series of 9999 available is perfectly satisfactory. The wider implications of the scheme, however, require a more sophisticated approach in which, for example, the number assigned to a particular train is blocked or coded to indicate in an easily recognisable form, its type or operating classification (headlamp code), destination station or district, basic routing, etc.

(2) A system meeting these requirements was introduced into the Western Region

1958 Winter Service time-tables: subsequently the possibility was considered of devising a similar but extended scheme applicable inter-regionally. It was found however, that the limitations imposed by the availability of only ten different symbols in each of the four digit positions did not allow a sufficiency of variations to cater for the whole of the information which had to be encoded, without such duplication as would prove difficult in application. In the scheme now authorised for adoption nationally, a four character alphanumerical system has, therefore, been employed, in which the first, third and fourth characters are retained as numerals, whilst the second character is a letter of the alphabet, selected from the 20 available after omitting I, Q, R, U, W and Y.

(3) To illustrate the basic principles of this inter-regional four character train identification system, its typical application to the Western Region will be briefly treated.

(4) Basically, every train and engine movement on running lines between signal-boxes is allocated a four character reference which, other than when the class of the train is altered *en route*, is carried without change throughout the journey. This reference code is used to identify the train in the working time-table, extra traffic notices and other documents or telephone messages related to train running. It will also ultimately be exhibited in indicator boxes fitted to diesel locomotives and multi-unit trains, on which the use of orthodox headlamp codes will be thereby superseded.

(5) In order to identify the category of a particular train the first digit of its four character identification is related to the existing headlamp and block bell codes as shown below:—

Class of Train	*Head-code*	*Bell Code*	*First Digit*
Express passenger train	A	4	1
Newspaper train ...	A	4	1
Ordinary passenger train	B	3–1	2
Mixed train	B	3–1	2
Branch passenger train	B	1–3	2
Parcels train	C	1–3–1	3
Livestock or perishable train composed entirely of vehicles conforming to coaching stock requirements	C	1–3–1	3
Empty coaching stock train	C	2–2–1	3
Express freight, livestock or perishable train:—			
with the automatic brake operative on not less than:—			
75% of the vehicles	C	3–1–1	4
One-third of the vehicles	D	5	5
4 vehicles ...	E	1–2–2	6
not fitted with continuous brake, but with limited load ...	E	1–2–2	6
not fitted with continuous brake ...	F	3–2	7
Through freight mineral or ballast train ...	H	1 4	8
Freight, mineral or ballast train stopping at intermediate stations ...	K	3	9
Branch freight train ...	K	1–2	9
Light engine or engines	G	2 3	0
Light engine and brake van	G	1–1–3	0

(6) Some express passenger trains running within the confines of a district, or over short distances between districts have 2 as the first digit of their reference codes.

(7) For all train movement other than local freight trains and light engines, the letter in the second position of the four character code identifies the destination area or district in which the train terminates, or in the case of a purely local train, the area in which it runs. For this purpose, letters are allocated on the Western Region as follows:—

Booked trains, their reliefs and divisions, running within the Region and terminating in the	
London District	A
Bristol District	B
Exeter & Plymouth Districts ...	C
Cardiff & Swansea Districts ...	F
Birmingham & Worcester Districts	H
Chester & Oswestry Districts ...	J
Newport & Gloucester Districts ...	T
Inter-regional booked trains, their reliefs and divisions, running from or via the Western Region to the	
Eastern Region	E
London Midland Region	M
North Eastern Region	N
Southern Region	O
Scottish Region	S
Inter-regional booked trains, their reliefs and divisions, having destinations within the Western Region	V
Excursion, Military and Special trains, running:—	
Inter-regionally	X
Entirely within the Western Region irrespective of destination area ...	Z

(8) All train movements, with the exception of local passenger and freight

trains and light engines, have an individual number represented by the third and fourth digits of the four character code. One hundred individual train numbers are available for any one destination area in each headcode group, and in certain areas, some duplication of numbers in respect of trains running over entirely different routes is necessary in order to encompass all the trains within the numbers available. For terminating trains in the London district, this duplication is arranged on a.m./p.m. basis.

(9) Where the destination area is composed of more than one Operating District, the hundred individual train numbers which are available in each headcode group for such areas are blocked to enable the terminating district within the area to be discriminated. Parcels trains in headcode group 3 are individually numbered in the series 00–49 only. Spare individual numbers are available in each headcode/destination group for allocation to relief trains and trains running in several parts.

(10) The system of individual numbering of main line train movements does not lend itself to adoption for local passenger services due to the number of trains which come within this category. These trains are, therefore, identified on a route numbering basis which in any case is more appropriate to local working. Each area denoted by a letter in the second position of the train identification code is divided into sections of line conforming to the pattern of local services, these sections being assigned two digit numbers which form the third and fourth characters of the identification codes of all local passenger trains operating through the section in question.

(11) To distinguish between local passenger trains of a semi-fast or more important character (at present carrying "A" headcode) and purely local services (carrying "B" headcode) each section of route is allocated two numbers, one in series 00–49 and one in group 50–99, these two numbers being in arithmetical relation, e.g. 09 and 59, 22 and 72. The lower numbers are allotted to the local trains running under present "A" headcode, and the higher numbers to the purely local services ("B" headcode).

(12) The higher series route numbers (50–99) are also applied to empty coaching stock movements in headcode group 3.

(13) Light engines and local freight trains, with the exception of certain cases instanced in the following paragraph, similarly do not lend themselves to individual numbering. These movements are more appropriately designated according to destination by the last three symbols of their identification codes. Within the Region all Running and Maintenance Depots, Stations, Yards and other places to which trains and engines work regularly are allocated individual three character references consisting of a letter and two digits. Numbers in the series A00–C99 are allocated on a district basis to yards, stations and depots not generally associated with inter-district movements. These numbers are repeated from district to district and are allocated with inter-district co-ordination to avoid confliction at points where freight trains or light engines cross a district boundary. Main Running and Maintenance depots between which regular inter-district light engine movements are made are allocated individual numbers in the series Z20–Z99, which have universal meanings throughout the Region.

(14) Station and Yard pilot engines, transfer goods, bank engines etc., are allocated individual numbers on a district basis in the series F, H, J and T 00–99, again with inter-district co-ordination where necessary to avoid confusion in district boundary working.

(15) In each headcode group, the series Z00–Z19 is reserved for special purposes to which they have been specifically allocated. A list of these special codes is given below:—

	Bell Code	*Special 4-character Code*
Inspection special, not stopping in section	4	1Z01
Existing diesel cars or lightweight railbuses which cannot be relied on to operate track circuits	5–1–3	2Z01
Elliott Track Recorder Cars when not recording ...	5	5Z08
when recording	3	9Z08
Weed Killing train	1–2–2	6Z07
Out-of-gauge loads:—		
Train which can pass out-of-gauge load similarly signalled on adjoining line	2–6–1	8Z02

Train which cannot pass out-of-gauge load similarly on adjoining line	2–6 2	8Z03
Train which requires adjoining line to be blocked...	2–6–3	8Z04
Trolley signalled through tunnel or placed on line in a multi-aspect signalling area	2–1–2	8Z05
Matisa machine not stopping in section	1–4	8Z06
Freight, ballast, inspection or other train requiring to stop in section	2–2–3	9Z01
Shunting movement into forward section	–	0Z10
Describer test description, or not described	–	0Z00

Other special codes have been allocated as follows:

Breakdown or Snow Plough Train		
going to clear the line ...	4	1Z99
not going to clear the line	3–1	2Z99
Royal Train	4–4–4	1X01, 1X02, 1X03 according to priority

(16) The series Z00–Z19, when prefixed by the digit "0," is reserved for local allocation, for use exclusively in the train describer, to describe movements within station or signalbox limits, not otherwise described as through running movements. The purpose of this facility is to indicate for example, the station pilot engine, vans standing alongside platforms for loading etc., which would otherwise be shown blank or as "not described" on the describer display field, and for which it is of assistance to the signalman to be able to set up a unique description as an *aide-mémoire* of the traffic being dealt with in his panel area.

Display Presentations

(1) Radical changes have also taken place in modern train describer installations in the techniques of display presentation. In the past, descriptions were exhibited by the illumination of visuals or stencilled characters housed in indicator units mounted or suspended over or alongside lever frames or panels. Such indicator units were necessarily large, both to be readable at a distance by signalmen, traffic regulators and others, and to display the multiplicity of type, destination and other letters or initials required to form the full train description.

(2) With the extension of areas of control and the provision of more comprehensive

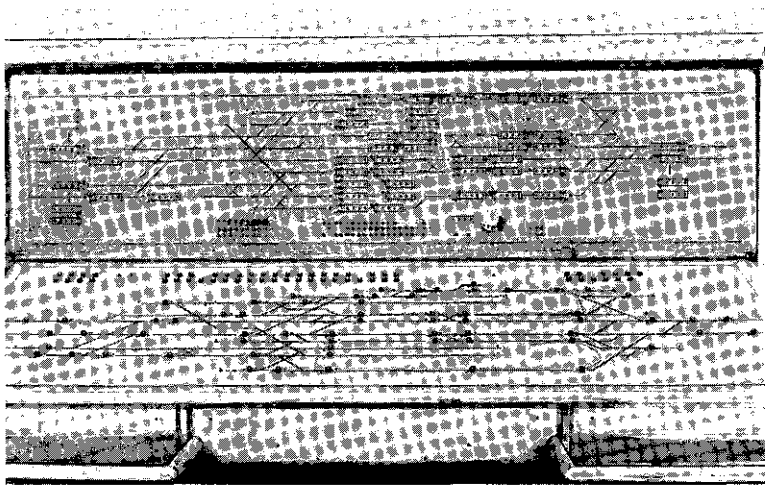

Fig. 1 Birmingham Snow Hill. General view of control panel and train describer equipment

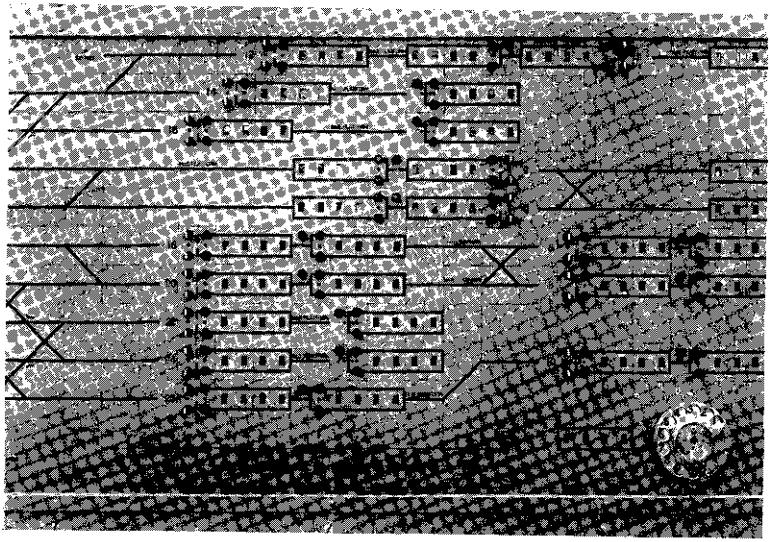

Fig. 2 Birmingham Snow Hill. Close up showing part of train describer display field

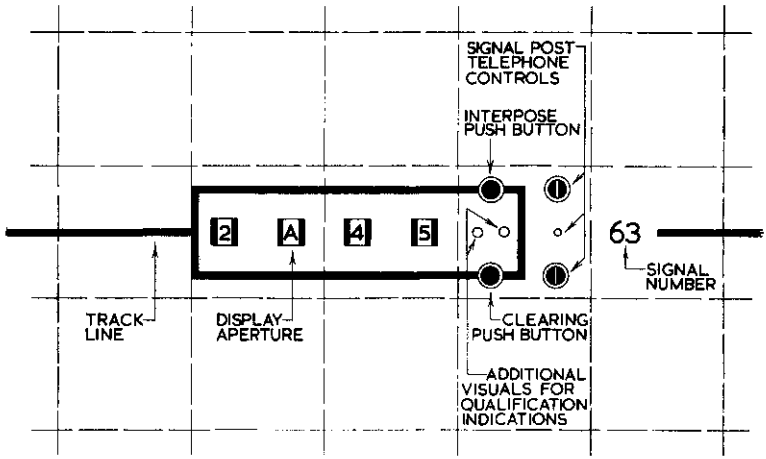

Fig. 3 Western Region train describer basic display unit

train description facilities, the panel operator is in possession of a much wider overall knowledge of the traffic position in the territory under his control and it can be argued that because of this, the traditional role of the traffic regulator is obsolescent. On this basis, display indications need only be large enough to be seen by the operators themselves; if describer facilities are required for other purposes, for example for the information of train announcers, it is more elegant and in keeping with modern opinion to provide slave indicators repeating selected display units.

(3) These considerations, coupled with the altered format required for the display unit itself, which must now be capable of exhibiting three decades of ten, and one range of twenty characters, and the much larger number of units which must be accommodated as a result of berth display facilities being equipped at all main running signals, lead to the conclusion that the most logical place operationally to locate the display units is on the signalling diagram or control panel, adjacent to the signal section to which they refer. Such an installation exists between Crewe and Manchester on the L.M. Region, where the train descriptions are shown in miniature display units mounted in the diagram.

(4) The Western Region has adopted a miniature control panel of the combined diagram and operating console type, as the standard for major signalling schemes, and has developed, as part of the system, a train describer with signal berth display and "walking" or progressing description facilities. Early in the development it was apparent that although it was desirable to incorporate the display units in the control desk proper, this, at the present stage of availability of miniature display equipment would have resulted in an increase in size of the control desk incompatible with regional ideas of miniaturised panel technique.

(5) The number of additional visuals and pushbuttons required for train describer purposes would also have unduly complicated the face presentation of the console, leading to possible confusion of the operator.

(6) For these reasons, the present method of displaying train descriptions in W.R. panel schemes, is to divorce the describer from the signalling control panel proper, and to employ instead a separate display field, of similar "mosaic tile" construction, located at eye level on a ledge at the rear of the control panel.

(7) This describer display panel carries a track line diagram of the main running routes in the layout for which train description facilities are available. Disposed on the track lines at the geographical position of the running signals to which they refer are miniature four character display units, each unit being situated as far as possible vertically above the associated signal berth track circuit indication on the control panel, thus facilitating rapid correlation of track circuit occupation and train description.

(8) The characters of the description code are exhibited as illuminated figures and letters which appear in four adjacent apertures provided at each display position. Alongside these apertures are two pushbuttons for clearing the display and interposing from the set-up unit respectively, together with space for two additional visuals which may be equipped where it is necessary to show indications qualifying the main description.

(9) To assist the operator in associating at a glance the apertures, pushbuttons and visuals forming the display unit, these are enclosed by a border line, with the number of the signal in question alongside. As a further assistance to the operator, the signal post telephone call lamp and answer pushbuttons are also located adjacent to the display unit of the signal to which they refer.

Operational Facilities

Set-up of descriptions

(1) Facilities are necessary to enable the descriptions of originating train movements to be set up and interposed into the appropriate display unit. In the W.R. describer, a standard telephone dial is used for set-up purposes, the required figure/letter combination being "dialled" as in automatic telephone practice. Each character appears in a verifying display unit when it has been dialled, and a "set-up effective" visual becomes illuminated when all four characters have been successfully dialled.

(2) A dial has been chosen for set-up purposes as a convenient generator of the trains of impulses required for the W.R. describer mechanism. In other techniques where codes are stored as a pattern of energised relays, pushbuttons may be more convenient and are perhaps speedier in operation.

(3) In large installations, duplicate set-up facilities may be required to avoid interference between operators. Each set-up unit may have access to all or only part of the describer display field; in the former case, the set-up units must be mutually exclusive to prevent mutilation of descriptions should interposing be attempted from both simultaneously. Whilst overall access may not be required operationally, it may be advantageous in that one set up unit may cover the whole installation in the event of a fault in the other.

(4) In the W.R. describer, separate interpose and clearing pushbuttons are provided at each display unit. This facility enables descriptions to be changed or corrected, and local *aide-mémoire* codes to be inserted or cleared at any point. It also provides a convenient means, in conjunction with the set-up unit, of bringing the describer into step when handsignalling is in operation, without the need of equipping special emergency stepping pushbuttons. All interpose pushbuttons are mutually exclusive.

Stepping of Descriptions

(5) The stepping of a description from one display unit to another in sympathy with the movement of the actual train to which it refers is usually initiated when the track circuit immediately ahead of the controlling signal is occupied, the interconnection of the display units during stepping being established from the appropriate signalling route relay circuits. W.R. describer practice also requires the controlling signal to be showing a proceed aspect at the moment of occupation of the stepping track circuit. This condition is incorporated to cover the case of calling-on signals where, because of lack of berth accommodation ahead of the signal, the first track circuit may not clear between successive train movements. In such cases the stepping initiation circuit is " one shot " and remains locked out after stepping has taken place until the signal is restored to danger.

(6) In the interests of the operator, who must readily remember when he is required to intervene in the operation of the describer, it is necessary to establish firm principles governing the classes of signals at which train describer stepping facilities are provided. Early in the development of the W.R. system, it was decided that only running signals should initiate stepping, running signals in this context being defined as signals displaying main, calling-on or miniature yellow aspects. Thus any movement taking place under the authority of a shunt signal, either ground or elevated does not affect the describer. This principle has been enunciated because of the complexity of shunt movements which may be admitted into, or withdrawn from, both unoccupied or occupied sections, where no display facilities may exist for the exhibition of more than one description at a time. A description would also have to be set up and interposed for each shunt movement, and the amount of

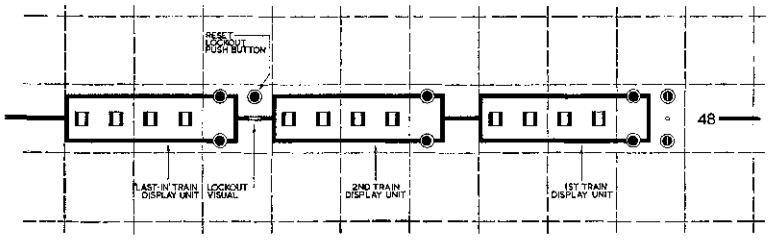

Fig. 4 Western Region train describer permissive section display unit

manual adjustment to the describer under these conditions would become a nuisance to the operator.

(7) Certain locations are regular points where train engines are changed or pilot engines are detached. If such movements take place under the authority of a signal which causes the stepping of descriptions, it may be necessary to provide a "hold back" or "retain description" pushbutton which if depressed after the signal is cleared, but before the stepping track circuit is occupied, locks out the stepping condition for the one movement only.

(8) If a train movement occurs without an accompanying description being exhibited in the corresponding display unit, due for instance to omission by the signalman to set up and interpose, some means are usually provided to indicate the error so that the description equipment may be kept in step with track conditions. In the W.R. describer, "not described" (0Z00), is automatically interposed into the display unit in question under these conditions.

Permissive Working

(9) In places where permissive working is authorised, several running movements may occupy a signal section simultaneously, and in such cases, means must be provided to store and possibly display, the descriptions of the maximum number of trains which it is anticipated will be in the section at the same time.

(10) Schemes can be devised, following orthodox storage describer practice in which the descriptions of the first one or two trains in the section are displayed, the remainder being held in "hidden" storage from which they are withdrawn in order when display capacity becomes available as the previous train moves forward. Whilst this arrangement reduces the number of display units which have to be provided, and thus limits the size of the display field, it can lead to confusion of the operator when the description of a train which is to be withdrawn from the rear of the permissive section is still in storage and not exhibited on the display field. Moreover, the situation may arise when, because of special working, the number of trains in the permissive section exceeds the equipped storage capacity.

(11) To overcome these difficulties a full display solution has been adopted in the W.R. describer. As many display units are provided for the permissive section as are required to cover the advised normal maximum number of trains simultaneously acceptable, the additional units being disposed in series on the display field track line to the rear of the signal berth display unit.

(12) The description of the last train to enter the permissive section is displayed in the first blank display unit to the rear of the berth display unit. When this latter unit becomes cleared as a result of the first train in the section moving forward, all the descriptions exhibited in the additional units automatically advance in cascade.

(13) If a further train should enter a permissive section for which all the display units are in use, that is a train additional to the maximum number for which the system caters, the description of this train displaces that already showing in the rearmost display unit. The displaced description is flashed, and an audible alarm sounds, for a period long enough for the operator to note down the description before it is cleared prior to the incoming description taking its place. The rearmost display unit now acts as a display of the description of the last movement to enter the section, and to draw attention to this altered function, and the existence of a "lost" description, the automatic forward cascading of the "last-in" description is locked out, this being indicated to the operator by the changing from white to red of an illuminated aperture in the portion of track line joining the rearmost and penultimate display units.

(14) With this method of working, the operator must set up and interpose "lost" descriptions in the correct order as display capacity becomes available ahead of the final display unit, and ultimately, when all these have been dealt with, to restore normal operation by depressing the "reset lockout" pushbutton. It is to be emphasised that the procedure detailed above would be resorted to only occasionally under abnormal conditions.

Box-to-box Working

(15) When an ongoing train reaches a certain point in the territory controlled by one signalbox, its description can, under

appropriate conditions, be transmitted forward to the next signalbox in advance. The point at which forward transmission occurs will be dictated by the extent of the advance warning period required at the box ahead for the regulation of traffic and estimating of operating margins; this in turn will depend on the speed and density of trains, incidence of shunting movements etc.

(16) By convention, all signals, both automatic and controlled, existing in advance of the outermost signal controlled by the rear box, are regarded as coming under the jurisdiction of the forward box. Thus if the point of forward transmission of descriptions is at, or in advance of, the rear box outermost controlled signal, the description of a train passing this signal can appear directly in the display unit of the first signal at the box in advance, at the same time as it is cleared from the display field of the rear box, when the train leaves the territory of that box.

(17) When the forward transmission point is to the rear of the outermost controlled signal of the rear signalbox, however, the transmission forward of a description must be dependent upon the intention of the operator that the associated train is in fact proceeding forward. This may be achieved in principle by proving that all relevant signals in advance of the forward transmission point are "off" before automatic transmission is initiated. Because of the close spacing

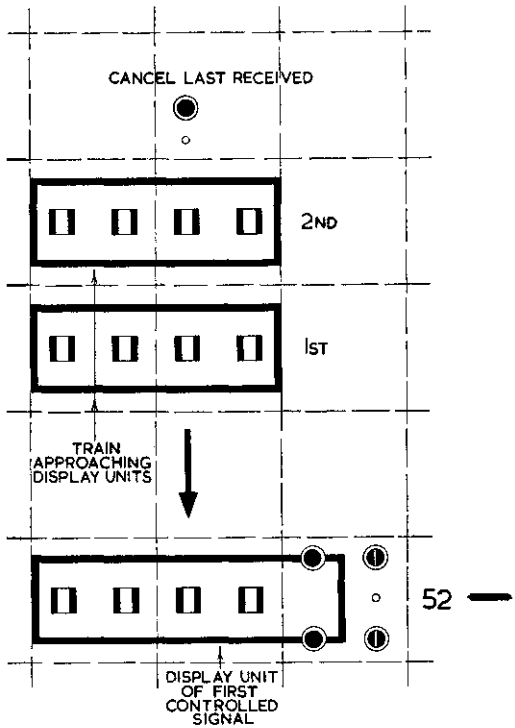

Fig. 5 Western Region train describer. Trains approaching display unit

or the signalboxes (as is implied by virtue of the position of the forward transmission point) and especially at places where trains stop for station work, through clearing of the signals for a train may not be possible operationally until it is ready to proceed, with the result that forward transmission of its description takes place too late to avoid delay to the train at the box in advance. To overcome this difficulty, pushbuttons, associated with selected display units, are provided for manual forward transmission, which override the conditions for automatic transmission. In certain cases, for example, Birmingham (Snow Hill) where there are few through movements, no automatic transmission has been equipped: all forward transmission is carried out manually. Some manual transmission facilities must, in addition, be always provided to cover handsignalling.

(18) When the forward transmission point is located in the rear box control area, it follows that descriptions will be exhibited on the describer field of the forward box whose trains are still under the supervision of the rear box. In the W.R. describer, to draw attention to this fact, these descriptions are shown in display units offset from the track line. Sufficient of these " train approaching " display units are provided to meet advised operational requirements. The description shown in the first of these units steps into the berth display unit of the first signal as soon as the train concerned passes the rear signal; the remainder of the train approaching descriptions then advance in sequence.

(19) It is necessary to indicate to the signalman in the rear box when a description shown on his display field has been transmitted forward, so as to avoid for example, a further duplicate manual transmission. In the W.R. describer, this is achieved by the lighting of a " transmitted forward " marking visual in each display unit where this condition obtains. This marking qualification accompanies the description as the latter progresses through the rear box display field, and an audible alarm, combined with the flashing of the visual in the display unit concerned, is given if a train whose description is unmarked should pass into the forward box control area.

(20) Facilities must be provided to enable descriptions sent forward to be cleared in the event of the train concerned not proceeding or the description having been transmitted in error. The W.R. system provides for co-operative cancellation acting on the last description displayed in the train approaching units. Co-operative cancellation is desirable to establish mutual understanding between the two operators concerned.

Bank Engine Indication

(21) At places where trains are assisted in the rear by bank engines, the train describer must provide facilities to enable the description of a train to be qualified for the indication of this condition whilst it applies. The method of indication will obviously depend on the technique of display in use; in the W.R. system, space is available within the framework of the standard display unit for two additional qualifying visuals, one of which could be used for bank engine indication.

(22) A pushbutton would be located on the display field at the point at which assistant engines are attached, to set up the marking condition. This would then progress with the train description up to the point of detachment of the bank engine, where it would be cleared from the display automatically. One refinement which could be provided, should it be feasible to allocate a common description code to all bank engines at a given locality, would be to set up the bank engine description automatically in the appropriate display unit after the main train had gone forward, if the descriptions of the latter had arrived in a marked condition. The marking condition could also be used to sound an audible warning, or perform some other similar function.

Intermediate Ground Frames

(23) Provision must be made where intermediate sidings exist which are controlled by ground frame, to modify the stepping controls of the train describer whilst the ground frame is open, to prevent a description being stepped forward irregularly by track circuit occupation whilst shunting is in progress.

(24) Where trains are " shut in " at intermediate sidings, the Western Region describer employs a storage display unit

associated with the siding, into which the description of a train which has been shunted clear of the running line is transferred. This transfer of the description to the storage display, and its subsequent reintroduction to the main describer field when the train leaves the mid-section siding, is initiated automatically by the sequential occupation of the appropriate track circuits.

Methods of Display

(1) The conception of the modern train describer, outlined briefly in the foregoing paragraphs can be realised only if a fully versatile technique of miniature display presentation is available, and it is proposed to review below a few of the systems of digital information display which have been, or might be used, in train describer practice.

(2) Perhaps the simplest approach makes use of a reduced scale form of the conventional stencil indicator, with the stencil units mounted together in honeycombs, or vertical or horizontal strips to form as many decades as are required. A complete number exhibited by this system is, however, difficult to appreciate rapidly, due to the spacial distribution of its individual digits.

(3) More sophisticated optical read-out techniques employ in-line presentation of the digits. In one such system, a stack of transparent plastic plates, each engraved with a separate character or numeral, is contained in a magazine with the plates mounted on top of one another. Each plate can be individually edge-illuminated by one of a series of lamps contained in the magazine, when the associated character becomes visible by refraction at the lines of engraving.

(4) The characters can be engraved in either continuous or dotted lines. The latter appear to be superior for viewing under bright ambient lighting conditions, probably because of the " sparkle " produced by the refraction of the internal light at the dots.

(5) The number of characters which can be displayed is limited by the thickness of the individual plates and the depth of the stack, which if too great, unduly restricts the viewing angle. At the same time, characters at the rear of the stack tend to become mutilated during display by the lines engraved on the plates at the front of the stack. The use of dotted lines, however, reduces this mutilation by presenting less obstruction at which the emergent light can suffer secondary refraction.

(6) Attempts have been made to display more characters than there are plates equipped, by synthesis of the characters from basic elements which are engraved on the plates, several plates being lit simultaneously as required to form the required character. The form of these synthesised characters deteriorates rapidly however, when they are viewed other than normally. It is also necessary to take into account the heat dissipation of several lamps alight at the same time.

(7) Coloured filters can be inserted in, or at the front of the stack, so that some, or all of the characters can be displayed in colour.

(8) Typical viewing angles are $\pm 15°$ vertically and $\pm 10°$ horizontally.

(9) A second method of in-line display makes use of a unit containing a number of lamps each housed in an individual cell fitted with a simple lens and stencil of the character to be exhibited. When the appropriate lamp is energised, an image of the associated character is projected on to a ground glass viewing screen at the front of the unit.

(10) In this system of display all the characters are exhibited in the same plane, with a consequent improvement of the viewing angle over the edge-lit system. Viewing angles as great as $\pm 80°$ have been claimed for some types of projection unit. The screen on which the characters appear is usually neutral tinted, which improves contrast by darkening the background, since light incident on the face of the unit must pass twice through the screen, whilst light from the projected characters passes once only.

(11) As in the edge-lit plate method, several basic elements could be projected simultaneously to synthesise a given character.

(12) A further form of in-line numerical display makes use of the cold-cathode numerical register tube. This is a gas discharge tube having a common anode and ten separate cathodes constructed of

thin wire, each formed into the shape of a numeral. The chosen digit is caused to glow by connecting the appropriate cathode to earth, the remaining extinguished cathodes being sufficiently thin not to be prominently noticeable. One pattern of this device is designed to be viewed end-on; this construction gives enhanced viewing qualities due to the absence of anode meshes intervening between the envelope of the tube and the cathodes. To reduce reflection from the bulb and electrodes caused by external light, these tubes are sometimes viewed through dark orthochromatic filters to improve the readability of the characters.

(13) These tubes can usually be energised directly from alternating current: typical operating values under these conditions are 3 milliamps mean current passed with a supply voltage of 240 volts RMS, with an anode series resistor of 33,000 ohms. A refinement to improve uniformity of cathode glow intensity from figure to figure, to compensate for the spacial distribution of the cathodes in the electrode structure, is to introduce additional equalising resistors in the cathode leads. Dimming can also be achieved by suitable reduction of anode current.

(14) Typical viewing angles are $\pm 40°$ up to ten feet, whilst some manufacturers claim readability up to 40 feet.

(15) Two further methods of in-line display can be briefly mentioned. Characters can be synthesised on the face of a cathode ray tube after the well-known Lissajous figure technique, the figures 0, 1 and 8 being very simply produced with sinusoidal voltages in the correct phase relationships. Additional elements for phase changing and rectification enable a whole range of basic characters to be generated, and by the use of scanning techniques, several characters may be displayed simultaneously on the tube face to produce a four character code. Pre-set or adjustable variation of brightness, size and aspect ratio of the characters can be provided, and special characters such as asterisks can be produced.

(16) This method suffers from the disadvantage that high voltages are required for tube excitation and time base purposes. Maintenance charges for cathode ray tube and other valve replacements may also be high in a large installation.

(17) Use could also be made of the phenomenon of electroluminescence. This is the property possessed by certain chemical substances in the solid state of emitting visible light when excited by an electric current, and broadly analogous to the luminous discharge which occurs in neon and similar gases. Electroluminescent "lamps" have been developed which consist of a layer of sensitive material, approximately 0.001 inch thick, sandwiched between two electrically conducting surfaces, one of which is transparent. When an alternating voltage is applied to these electrodes, the sensitive material emits light, and if one or both of the conducting surfaces are shaped in the form of characters, since light will only be emitted from between the surfaces, these characters will appear brightly illuminated against an unlit background, yet will be invisible when the supply is switched off.

(18) The brightness of the emitted light is proportional to the frequency of the supply, and a typical operating condition is with a supply of 200-300 volts at 400 cycles. Power consumption is about 100 mw. per square inch.

(19) For train describer display purposes, the required characters could be synthesised from basic elements, energised in groups to form the desired letter or figure. Since all the elements would be situated in the same plane, the form of the character would remain faithful over a reasonably wide viewing angle. Two possible objections to the use of this technique are the relatively high supply voltage required at the display panel and on the relay contacts of the selection network, and the need to provide a special converter or generator to produce the excitation frequency required.

(20) The methods of display presentation so far discussed are essentially techniques for the read-out of encoded information previously written into a separate storage device. In the following paragraphs, a system will be described which combines the function of storage and visual in-line read-out in the same apparatus.

(21) This system, which forms the basis of the W.R. describer, makes use in each display position of four individual high speed electro-mechanical counter units, assigned to the four decades of the train recognition code. Each of these counters

has a single register drum, which carries round its periphery ten characters at equidistant spacings. Any one of these characters can be positioned behind a viewing aperture in the front plate of the unit by rotating the drum through an appropriate angle from a fixed "home" position. When it is desired to display a description, all four drums are independently but simultaneously revolved from their home positions by extending to their driving coils trains of the appropriate number of impulses. The characters located behind the viewing apertures are invisible until the drums are internally illuminated by small lamps contained in each unit.

(22) Viewing angles are approximately $\pm 70°$, and the characters are 3 mm. x 8 mm. in size, giving reading distances in subdued lighting environments of up to eight feet.

(23) The "home" position of the drum is electrically detected by a contact assembly which changes state when the drum is in the off-home position. To reproduce the angular position of one drum in another a train of ten impulses is extended to the operating magnet of the first drum through its off-home contact in series. A train of ten impulses is also applied to the second drum magnet through a home contact of the first drum. Assuming the first drum to be standing in position six, the first four impulses of the train will step it to its home position, when the off-home contact will break, disconnecting the magnet from the impulse train. The remaining six impulses of the train will, however, be applied to the second magnet through the now made home contact of the first drum.

(24) The travel of the counter driving escapement is small and the inertia of the moving parts is low: the mechanism will faithfully follow continuous impulsing at 50% mark/space ratio up to 30 i.p.s. The drum is positively locked against rotation whilst quiescent.

(25) The fundamental disadvantage from a train describer point of view of most of the methods of display presentation reviewed above is their inability to exhibit successfully more than ten individual characters. The inter-regional train recognition system demands accommodation for twenty letters in the second position, and it would appear that up to the present time no satisfactory solution, other than the miniature cathode ray tube approach, has been devised which permits this being achieved.

(26) With projection and edge-lit indicators, the practice has been to equip five units, two of which share the display of the twenty letters. This leaves an inelegant gap in the complete display, since one unit in the group is always blank. The compromise adopted for the time being on the Western Region is to use only one letter (V) in the train describer for all inter-regional trains irrespective of their destination region. The disadvantage here is that a discrepancy exists between the describer description and the time-table description codes for these trains.

(27) The ideal display technique should also be capable of exhibiting simultaneously with the train description, and without auxiliary apparatus if possible, supplementary qualifying indications such as "description sent forward" or "bank engine in rear."

(28) Description codes exhibited by optical techniques, or other means involving illumination, can be flashed to express qualification, although it is considered that the flashing of visuals or displays can with advantage be confined to the indication of the need for action by the operator, bearing in mind the implications of urgency associated with a flashing light. Thus "cancel last received" and "not described to forward box" should be indicated by flashing visuals.

(29) Projection or edge-lit displays can exhibit more than one character simultaneously in the same display unit, and by making use of this facility, a coloured background can thus be displayed in conjunction with the train description as a qualifying indication. The background colour, being separately controlled, can be flashed whilst the description characters remain steadily displayed, to denote for example, some special action required by the operator in respect of the qualifying condition. Again, red coloured visuals should be used only to indicate conditions which affect the operation of the describer, for example, "receiver full" and "fault."

(30) In the cathode ray tube approach, the aspect ratio of the characters displayed

can be altered to denote qualification. Thus block numerals or letters may be changed, say to italics, or underlined, to represent the empty stock of a train with the indicated description, running from shed to station at commencement of journey.

(31) In the W.R. describer, the flashing of visuals and descriptions has been specially co-ordinated with the flashing requirements of the signalling control panel, telephone supervisory equipment etc., so that all such flashing indications operate in synchronism. This, combined with the use of a generator circuit providing a strictly equal on/off ratio, improves presentation, and helps to reduce operator eye fatigue.

Miscellaneous Facilities

(1) The availability of a train description coding system which enables the greater part of the train movements in the working time-table to be uniquely represented, makes it possible to detect the presence of predetermined train movements by comparing their descriptions against preset code combinations stored in the train describer.

(2) One example of the use of this facility will occur at Old Oak Common, where all trains appearing in the control panel area in the down direction which are routed over the facing junction to the Northern line will raise an audible alarm to draw the operator's attention to their approach. This facility will be operative when the junctions are set for the main line with auto working of the signals in force. In this problem, it is not sufficient merely to detect the presence of Northern area destination characters in the description codes, since some of these trains are routed via Reading. Further secondary discrimination is needed in the third and fourth digits of the codes.

(3) Other possibilities are the control of platform signs, public address equipment, the setting of junctions and determination of priorities, and perhaps in the not too distant future, a more general application of automation by the use of programmes prestored on magnetic drums or tape.

(4) A further possible development is an automatic recording equipment to take the place of the train register book. The passage of a train past a nominated point on the line could cause its description, previously set up automatically in the recording device by a slave feed from the main describer equipment, to be printed on a paper roll along with its time of passage, derived from a convenient clock system. Having been printed, the description would be cleared from the apparatus and the paper roll stepped on in readiness for a further recording. A number of sets of such equipment could be located in a central control office with descriptions and other supervisory signals relayed from the reporting points over line wires; information derived from these sources could also be made available to station announcers and for the operation of train arrival indicators.

Trends in Equipment Engineering

(1) It is proposed finally to deal briefly with the engineering of the control apparatus of the W.R. describer, the design of which has attempted to make available standard equipment, with standard facilities, applicable at any signalling installation in the future. The aim has been to develop the control apparatus in the form of a limited number of standard plug-in relay sets which provide the basic operational facilities of the system. These relay sets, which make use exclusively of B.P.O. 3,000 type relays, are mounted in Post Office standard exchange apparatus racks, to which the W.R. design of relay room ironwork has been adapted for fixing purposes.

(2) Twelve basic types of set have been designed, which provide the required operational facilities, perform switching impulse generation and counting, supervisory and box-to-box transmission functions, etc. Modifications of the basic function of these sets is obtained where necessary by straps equipped between tags on the plug-in mounting jacks.

(3) The relay sets are located in their equipment racks according to a co-ordinate system. Each set has individual connections through alarm type fuses to the 50 volt d.c. and 24 volt a.c. (lighting) bus bars; other services such as buzzer and alarm circuits, flasher and impulse generator start circuits etc., are distributed to each set on ring main principles, each service appearing on the same tag on all

relay sets. With one exception, two 32 way terminal jacks have been sufficient on each relay set for connection purposes.

(4) Inter-set and rack wiring is drawn up in schedule form, with one schedule, which consists of one or more foolscap sheets, for each relay set. The schedule indicates the style of the set, its function and rack location in the specific installation, and shows in tabular form any special straps required for the set concerned, together with the interwiring between the set and other sets, the display panel, signalling circuits etc. These schedules are used for the initial factory wiring of the racks and with the standard circuit diagrams of each style of set are issued to the maintenance staff as their record of the installation wiring.

(5) Whilst it is true to say that in some cases the use of standard relay sets can lead to redundancy of certain relays in a set whose basic function is modified to meet particular requirements, judicious circuit design can reduce this to negligible proportions. It is considered that this disadvantage is easily outweighed by the achievement of the main objectives of these techniques—the minimisation of drawing office design work, the reduction of installation time on site, the facilitation of advance planning, production and stocking of components and the reduction of overall costs.

Conclusion

To appreciate the historical background and deeper technicalities of this branch of the art of railway signalling, the reader is referred for further study to the paper mentioned in the preface and to other literature and brochures published by the Institution and the various manufacturing organisations.

Acknowledgment is due to the Signal Engineer for permission to present this paper and also to other colleagues of the Western Region whose advice and assistance have been freely available and certainly made use of in its preparation.

DISCUSSION

Mr. Duffield. I would like to thank Mr. Leach for a very interesting paper.

The train describer is my field at York.

Regarding the display of head codes on locomotives, in the modern signalbox, the signalman cannot see the train. I would like your views on that point.

How do you classify electric trains?

On the North Eastern Region, we get electric trains and steam trains running into various stations. Some of the lines are electrified and some are not. How do you make certain that the electric trains do not get off the traction area?

Where you get early transmissions and a train starting out from a station, do you effectively guard against a wrong route being set, or are you happy to get the price of two trains for one description, or two descriptions for the price of one train?

You get 20 alphabetical symbols. How do you dial 20 symbols on a 10 digit dial?

Do your descriptions move automatically forward?

Mr. Leach. As I pointed out in the paper, train identification codes exhibited on the locomotive or train supersede the headlamp code. The display has been provided so that staff other than signalman, who admittedly in modern signalling schemes usually has only a very limited vision of the line, can uniquely identify each train with a corresponding overall increase in the efficiency of daily traffic working.

We have no electric trains on the Western, but I think it would be possible to identify these by allocating a special head code number, by blocking the individual train identifying digits or providing some additional qualification character.

Regarding re-transmission, could you put your question again?

Mr. Duffield. After you have set up and the signalman decides to re-route the train, how do you guard against it? Does the signalman have to cancel that route, or restore the signal to normal and re-set up?

Mr. Leach. If an incorrect description has been sent forward, say because the train is re-routed, the signalman will have to cancel the last description sent, re-set up the correct description and transmit it

forward. This, I think, is standard practice.

Referring to your final point, the requirement to be able to dial 20 letters with a 10 digit dial does not arise at present because a compromise has been worked out with the Operating Department of the Western Region in the allocation of the destination letters in the identification codes so that only ten letters are used. This has been effected by using the letter V on the describer to identify inter-regional trains from the Western Region to other regions as well as for inter-regional trains terminating on the Western Region. As I pointed out in the paper this is a shortcoming of the arrangement as it exists for the moment, because for the class of trains involved there is a discrepancy between the code used on the describer and the actual code of the train.

If a dial is retained for set-up purposes when a solution enabling the full twenty letters to be displayed has been worked out, I think it will be necessary to equip a pushbutton on the set-up unit acting rather like the shift key of a typewriter, which would have to be depressed before dialling the letter required if this fell in the second decade of the range of letters used.

Descriptions are frozen in the event of a general track or power failure. A " power off " relay releases which freezes the stepping of descriptions and there is a time delay on restoration to enable the equipment to settle down before coming back into use.

Mr. Cardani. First of all, I would like to express my thanks to Mr. Leach not only for the paper, but also for the hard work and enthusiasm that he and his colleagues put into the development of the Western Region train describer and in bringing it to its present state.

I should also mention that as this development work has been going on for quite a little while now, neither Mr. Woodbridge nor Mr. Tyler can altogether disclaim some responsibility for it.

I would also like to thank our Operating colleagues on the Western Region particularly for their help in determining standard conditions of operation which have enabled us to get somewhere near one ideal of standardisation, that of being able to pre-manufacture this equipment before its specific application is known, which is a very highly desirable facility in order to free the supply lines these days.

I do not think you will expect me to criticise the paper. There are sufficient controversial points in it to ensure a vigorous discussion, but I would like to refer to one by way of an historical note.

Originally, it was envisaged that the system would give 10,000 unique descriptions from 0000 to 9999. Unfortunately, with later developments, certain of the digits began to acquire specific meanings which greatly restricted the number of unique combinations available and finally, we had this alpha-numerical system whereby a very high degree of assymmetry has been introduced, changing what was originally a straightforward decimal system to one in which the second digit in fact dictates a vintigesimal system of numbering. It is rather regrettable, and to be controversial, I am not altogether convinced that it is an essential requirement that these digits should have restricted meanings. I think that, after all, the signalman's work is in large part repetitive and I do not think he would have great difficulties in becoming familiar and instantly recognising the straightforward four-digit number applicable to a particular train.

You have heard that the coming of the alpha-numerical system cut us off in midstream. We were too far advanced to go back and here again I would like to say thank you to our Operating colleagues on the Western who have managed to compress their requirements into 10 letters for the 2nd " digit " and thus preserve to a very large extent the original decimal pattern of our train describer.

Mr. Leach. The only point I would like to make in reply to Mr. Cardani, is that although the signalman may not find difficulty in getting to know a train by a number in which the individual symbols are not limited in meaning, I do not think this applies to other staff who will be associated with the system and who may not have easy means of reference for identification purposes; consequently I think there is some justification for an attempt at a logical application of the available numbers.

Mr. Kent (Operating Department, Paddington). I would like to thank you, Mr. Chairman, for allowing us to attend the reading of this most interesting paper.

It seems complicated at first sight, but when one realises that much of the working will be automatic, we feel much happier about it.

I wish to express thanks to Mr. Cardani for his kind reference to our Department at Paddington, and should mention that we have here some gentlemen from Birmingham where we shall experience our first system of four-figure numbering describers.

There are just one or two points:—

Is there any advantage in the dialling system over the pressbutton system as we see it at Sandbach? What is the difference in time for operating, and is one system more subject to mistakes than the other?

On the question of transposing from ordinary block signalling to numbering for the describers, is this carried out at the next box immediately in rear of Sandbach or is it carried through a number of boxes?

Mr. Leach. Mr. Kent refers to the complexity of the system, but expresses satisfaction that much of its operation will be automatic. In the establishment of a train description scheme of this type, it is I think essential to make its working as automatic as possible. Otherwise, if the signalman is forced to perform frequent manual operations to ensure its correct functioning, the system can easily become a hindrance rather than an assistance, with the psychological corollary that this elaborate equipment tends to fall into disuse. As I stated in the paper, it is equally important to establish logical principles of operation, so that the signalman is well aware under what conditions he is required to intervene manually in the operation of the system, and that these conditions remain consistent throughout.

The dial has been used for setting-up purposes because it is a very convenient method of obtaining the trains of impulses which are necessary in the W.R. system to generate the numbers in the first instance. It takes approximately one second for the dial to run back after dialling zero, so that to set up 4 ciphers would involve the dial being pulled right round four times and will be somewhat in excess of 4 seconds. The signalman with pushbuttons would have to select and press four pushbuttons, and whilst I agree there would be some sort of time saving, I do not think it would be significant. The dial made our task in the circuit design very simple, and so far as the operation is concerned, it is still necessary with pushbuttons to wait for the display to come up to verify that the intended number has been set up. In course of time we may have to revise our opinions, but at the moment, having mind to the engineering principle of the W.R. system, I am yet to be convinced that push-buttons would be superior.

Mr. Kent alluded to Birmingham where because of staff shortages and the work loading of the boxes adjacent to Snow Hill Panel, the Operating Department are unable to put the additional work of translation of block bell codes to four character codes on to the signalman in those boxes. Thus it will be necessary to extend the train describer system in a simpler form to outlying boxes where translation can be easily achieved with the existing staff.

I am sorry I am not conservant with the operation at Sandbach, whether the existing signalman does the translation or whether special staff units are provided for it. Perhaps we have someone here from the London Midland Region who can give us details.

Mr. Knowles. What we have done on the L.M. Region is to select a suitable box. That is all changed in time order, giving the title of the train.

Mr. Jones. I would like to ask a question regarding the circuitry—whether you transfer all your numerical counters, one digit to the other.

You do not mention the impulse rate. I am wondering what percentage of failures you will get bearing in mind that the proving relay must release after one impulse is finished, but before the commencement of the succeeding impulse. What standard of failures do you get with this particular circuitry feature?

Mr. Leach. I did say in the paper that the counter would follow successfully up to 30 impulses per second. The actual maximum speed of operation in the describer equipment is, of course, dependent on this very point that I mention. The circuit is more complicated than that shown on the slide that I put on. In fact, the proving relay is double wound, with one winding in parallel with the counter so that it does not release, when the off home contact breaks, until the end of the particular impulse.

The proving relays are fairly heavily

loaded, so that they release reasonably rapidly, and we have not had any failures at the impulsing speed at which we are working which is 12 impulses per second.

Mr. Tyler. I would like to say that I entirely agree with what Mr. Cardani said about introducing the letters and making it a numerical system. It seemed to me when we were first thinking about this, that the simpler you can make the describer, the better. For years past, all over the world, trains have been numbered, and it seemed to me that there was no reason at all why the trains should be referred to by number, which is very common by signalmen. There are 10,000 numbers available with 4 digits and, with definite rules, there are plenty of numbers to spare. For instance, odd numbers can be used for up trains and even for down. It seems to me a pity that when this proposal was developed, it became complicated by letters. The interesting thing is that it was as a result of pressure to adopt a standard system. Yet when the panel at Sandbach was shown, there were four numbers. Perhaps Mr. Knowles could tell us a little about that. It seems a pity that the London Midland Region is not adopting the standard method.

With this type of describer, I would like to think that it is only a first step. The difficulty is that we cannot make these numbers small enough, and as a result, on the Western Region who have adopted a miniature panel, it has been necessary to make another diagram and to put the train describer on it. That is only an interim stage, and what we want is a small display which can be put on the track diagram on the approach side of the signal. That will extend the diagram a little but not as much as at present. After all, the idea came about because it was visualised that as time went on, we would have very much bigger areas of control and it was clear that the ordinary form of describer was no good at all.

At London Bridge, or similar places, which may have panels in the future, it would be quite impracticable to expect the signalman to associate a particular description on the vertical part with a signal or section on the sloping part. Ultimately, I would hope that we can devise some means of reducing the size of the display.

There is another matter that Mr. Leach did not touch on, and it is the question of the type of panel shown, and the train regulator. We are constantly coming across the Traffic Department argument that the regulator must see the descriptions on the panel.

I would put a plea in for a proper definition of duties between the signalman and the regulator so that the regulator may be given only those indications and descriptions which are necessary for this work.

Mr. Leach. It is, of course, true that as soon as an attempt is made to limit the application of the available letters and numbers to indicate specific operating detail, there is duplication, which I have mentioned in the paper. For instance, in the London district of the Western Region, it has been necessary to duplicate some of the train numbers on an a.m./p.m. basis.

Turning to Mr. Tyler's point regarding the ability of the signalman to associate a train description on the separate train describer display field with an associated track occupied indication on the signalling control panel, Birmingham is an example of a layout with some " width " in comparison with length: in one part of the station there are ten parallel tracks with ten corresponding levels of display indicators on the describer field, and the identification of a particular indicator presents no difficulty at all. I think this is facilitated by the provision on the describer panel, of a track line diagram linking the display indicators and showing the routes for which train description facilities are applicable. Each display indicator also carries the number of the related signal alongside.

My view is that with designs of panel and train describer display equipment at present available, incorporation of the describer units into the signalling panel cannot be recommended, on the score of increased panel size required, confusion which must inevitably be associated with complex track layouts, increased number of pushbuttons, etc., required for interposing clearing, manual transmission, all tending to increase the complication and decrease the clarity of the panel face presentation.

I did touch briefly in the paper on the possibility of giving train description indicators to regulators. I think it is quite impracticable to have a regulator sitting at the back of a box which contains a miniature control panel, with or without

a separate train describer display, because he will be able to see neither. Once this basic reasoning is accepted, if the regulator is to be retained, it is necessary to provide him with a slave display for himself rather than expect him to see the signalman's describer or get up and walk about the box. If we could get the function of the traffic regulator defined, or perhaps get him out altogether, things might be improved.

Mr. Young. Mr. President, I think Mr. Tyler made a fundamental point in regard to the information regarding the display of train descriptions on an entirely separate panel, and one must hope that in the attempt to achieve a standard design this is no more than an interim arrangement. It seems a great pity that having combined panel and train describer indications, a system which provides two independent fields of vision should be considered.

Undoubtedly the limiting factor in terms of size in the design of panels incorporating train describer indications, is the design and means of presenting the train description numbers, whether it be by projector, stencil or cathode ray tube. One wonders whether, having reached the stage where train description is presented in the most ideal form, that is related to the signals and the track, whether it is desirable to bring panels down to a size such that suitable visual indicators for train descriptions may not be available, or if so, at a very high cost. One wonders whether the limitation of size of panels to the extent that train description indications cannot be presented on the panel is a good thing. I would prefer to aim, at present, as a practical proposition, at a panel about half way in size between those in general use today, and the miniature panel under discussion, thus easing the problem in the design of train describer indicators.

Mr. Tyler mentioned the train describer system at Sandbach. This system, which is the first train describer system with train number indicators at the signal berths on the diagram, brought into use in this country, was on order before our Operating colleagues had decided that they wanted more than four numbers. For this reason the train describer indicators are based on the four digit system. As the indications are controlled by pressbutton transmitters, it is ultimately decided to transpose for the second number a series of 20 letters, this will be fairly simply achieved by adding the appropriate number of transmitting and interposing keys.

I subscribe to Mr. Cardani's and Mr. Tyler's views that if it is not too late for second thoughts, it would be advantageous, if our Operating colleagues would re-examine their proposals, bearing in mind the considerable increase in expense which will be incurred by the introduction of a fifth digit or letter.

One wonders if the additional complexity, consequent upon providing a fifth symbol is justified.

One special feature incorporated in the train describer system at Sandbach is that if an indication is interposed but the train to which it relates is not released for regulating reasons; although the indication set up on the diagram is not cancelled, a following train will not take up the incorrect description but will eliminate this description and replace it by its own number.

It would be of interest to know whether the system described by Mr. Leach incorporates this feature.

In conclusion I should like to thank Mr. Leach for his most interesting and comprehensive review of modern train describer systems.

Mr. Leach. I agree with Mr. Young that if train description codes are to be shown on the signalling panel, then such panels will have to be larger, or, as I remarked in reply to Mr. Tyler, presentation will suffer.

One of the possibilities which because of limitation of space I did not cover in the paper, is the use of a small display unit in each signal section, capable of exhibiting a simple two digit number. An actual train identification number when the train in question appears in the layout, is not shown in the appropriate signal section display unit, but in a special translation unit on the describer field where it is identified with a two digit number, and it is this latter which is stepped from signal section to signal section to identify the train movement.

This arrangement has obvious advantages of simpler presentation and reduced quantity of equipment. The actual train description code, and not the simpler local panel identification number, would

of course be transmitted forward to the panel in advance when the train proceeds.

Referring to Mr. Young's final point, a similar feature obtains in the Western Region system. Any description left in a signal berth display for any reason is automatically cancelled and replaced by the description of a following train entering the section. Moreover, if a train movement passes a signal without a description showing in the appropriate display unit, " not described " is automatically generated in the display unit of the signal section ahead.

Mr. Ralph. I am very pleased to hear Mr. Tyler's remarks about using a four digit numbering system, I think it leads to good engineering. It is simple and provides for a quicker operating system.

As I listened to Mr. Leach read his paper I noted the following comments which relate to the use of the present letters.

Mr. Leach has told us that the inter-regional train recognition system demands accommodation for 20 letters in the second position. Further, with projection and edge lit indicators the practice has been to equip five units, two of which share the display of 20 letters. This arrangement, I would point out, provides the facility for using two letters together, thus providing 100 letter combinations instead of only 20 single letters. This advantage can be had without requiring additional apparatus. In fact it is accompanied by a reduction, since for setting up only 10 keys or one dial is required instead of 20 keys or 2 dials. There is thus a saving in space on the panel and a reduction in the chances of error in setting up as it is easier to select 1 in 10 than 1 in 20.

Further, by eliminating the requirement for 20 characters in one part only of the descriptive code it keeps the system on a decimal basis and thus allows for more unified circuit design, code transmitting, checking, storage and display equipment since for each part of the code the requirement is to select one of ten characters.

It would also provide for using a choice of existing designs of indicators having $\frac{3}{8}$, $\frac{5}{8}$, 1-in. or even larger characters as may be required according to the location of the display.

In this connection I would mention an indicator has recently been developed to display any selected one of up to twelve characters without the use of lamps. The indication is unmasked by a shutter when required to be displayed.

Mr. Leach. Your proposal is tantamount to the use of a five digit code, which we expressly wished to avoid to keep the overall size and cost of the display equipment and control apparatus within limits. It was because the wider implications of the train recognition scheme demanded more than 10,000 combinations to encode into the identification number all the operating information required, and a five digit code was, for these and other reasons to be avoided, that the compromise of a four character alpha-numerical code with 20 letters in one position giving a total of 20,000 combinations was adopted.

Mr. Knowles. On the L.M. Region we could have standardised the train descriptions on a four-number basis which would have fitted in with the Western Region. However, when it was decided to cover all Regions by a standard system it was found that a four-number system would be inadequate to cover each Region, together with interchange descriptions between Regions.

It was, therefore, decided that the best arrangement would be to use a letter instead of a number in the second column to indicate train destinations, thus providing 20 indications in this column as against 10 indications provided by the four-number system. Furthermore, it is claimed that the introduction of a letter in the code assists in memorising the code.

At the present time on the L.M. Region trains are signalled by bell code; they carry a head lamp code on the leading engine buffers and are reported by telephone or telegraph by train title or number. In the future the trains will carry the description as a front indication on the leading engine or unit; any train will accordingly bear a standard description which will be used for all purposes.

It is noted that Mr. Tyler is doubtful as to whether or not the Operating Department are clear as to the duties of a Regulator. In this respect, so far as the L.M. Region is concerned, the duties of a Regulator are clearly defined.

Mr. Duffield. While on the subject of traffic regulators and and slave units, I would like to mention York and Newcastle. You saw on the screen, operation of the York box. That is one quarter of

the box. There are four signalmen on the panel. A signalman who does nothing else but answer telephones, then there is a traffic regulator, and station announcer, they all want the information from the train describer, but I do not see yet how we can provide slave units for all those people. I would like your comments on that please.

Mr. Leach. I contend that the need for a traffic regulator will disappear in centralised control schemes extending over a wide area where full track circuit occupancy indications and train describer facilities are available, because the operators will be in possession of much fuller information of traffic conditions without having to ring up adjacent boxes or control as now to ascertain the whereabouts of trains approaching their box.

I agree the train announcer must be provided with information, but in my mind there is doubt as to whether this official should be accommodated in the signalbox or elsewhere. I frankly deprecate the situation which exists in some places where tiers of regulators, telephone operators, train announcers and so on sit at the back of the box, all presumably requiring to see the layout diagram and train describer which must be made correspondingly large to be legible over these ranges, and I think there must be a reappraisal of the requirements based on a modernised conception of working methods, before slave indicators are equipped at additional cost for these functionaries who may either not require these facilities or may not be required themselves.

Mr. Lowther. I am more of a headache than Mr. Leach because for once I am going to take sides with the Operating Department.

Mr. Leach takes the view that the traffic regulator is not required, but in a busy box where you have perhaps three signalmen, it is rather necessary to have some measure of co-ordination between them, and that is where the traffic regulator can serve a useful purpose because the signalman is turning keys or pulling levers all day; he is getting requests from shunters up and down the yard over a loud-speaker; he is having to attend to his busy frame or panel and he cannot always visualise the whole of the movements in the station of which he is controlling only one part. That is where the value of the traffic regulator becomes apparent.

Mr. Leach. Where closely spaced signalbox working is involved, I think it is desirable to have one man who is in over-all control of traffic regulation, but in a centralised panel scheme with an extended area of supervision, with full train description facilities, I would put it this way—the train regulator is obsolescent.

Mr. Jones. Surely we are losing the point in discussing whether the regulator is necessary or not. This is not a problem of train describers. We could argue that with automatic signalling, we can do away with signalmen.

I see no difficulty in providing slave units as explained by Mr. Leach.

Mr. Leach. The point is, of course, that whilst the argument for or against regulators is not a problem of train description, the provision of train describer display facilities for them leads us into extra cost and extra equipment. We have to decide whether this extra cost is warranted.

Mr. Codd. I would like to thank Mr. Leach for explaining the system. I would like to say that if the problem arises, as to whether we could afford to have a slave indicator or a lady to announce the trains, would it not be possible to have an automatic announcer?

Mr. Leach. It is quite feasible to have an automatic announcer, and such do exist, but you must have manual supervision to cover emergency announcements and out of course working. I think the Operating Department will argue that flexibility is lost at a large station with an automatic announcing system which is really only suitable for a suburban station where trains run to a regular pattern and there is well-defined routing. I do not think you can eliminate the human announcer at a large station where, for instance, platform allocation varies according to the daily train working position or where there is considerable interchange traffic.

Mr. Barrs. On that point, Mr. Leach, I would mention that on the Eastern Region we have found that it is better to interpose the human element between the train indications and the means of starting off the recorded announcement.

With regard to the describer indicators I assume that they require cleaning and oiling occasionally. Can you give us any

idea how often that becomes necessary, and also your remarks on the reliability of the stepping of the indicator. I also assume you are quite satisfied that no proving arrangement is necessary for checking the position of the drum?

Mr. Leach. As far as the maintenance of the indicators is concerned, they will, of course, require to be cleaned in service, but should need little or no oiling. The ratchet wheel is made of nylon and the escapement travel is very limited so that hardly any wear takes place.

A counter-mechanism placed on accelerated life test showed undetectable wear after some ten years equivalent life, without oiling or cleaning. One point which did give trouble, and this is the weakest part of the whole unit, was the off-normal contact, which in the prototype model had very light contact pressure, and was subject to arcing at the points where the contact springs passed over the recessed grub screws retaining the drum. This trouble is now eliminated.

There is no proving between display units on the same describer field, but certain proving is introduced on the line circuit between boxes to verify that the sequential switching circuits have operated properly.

Mr. Batty. I would like to ask Mr. Leach if there are any facilities in the event of a total failure of the system, if there is a failure do they revert to the old bell system, also you said that it was possible for the signalman to let a train go forward without describing it, and that he got no indication of this until the train had actually gone, would it not be better if he got indication of this when he cleared the appropriate signal?

Mr. Leach. If the box-to-box portion of the equipment has totally failed, there is obviously no option but to revert to some form of emergency arrangement, and I think it is the recognised standard that some form of single stroke bell is provided.

In the W.R. equipment, certain faults such as blown fuses, low battery voltage, power supply failure, or the removal of a relay set from its mounting position, are alarmed by the flashing of a red visual and the sounding of a buzzer, which is a general fault indication to the signalman that the equipment is unreliable. When the maintenance man arrives to rectify the fault, he throws a " receiving attention " key which causes the flashing fault visual to show a steady light. The visual is extinguished when the fault condition is removed. Separate visuals are provided on the box-box transmission side to indicate the condition of the receiving equipment in the forward box, and to show when a fault occurs in a transmitted description.

As pointed out in the paper, an alarm is raised if a train passes into the territory under the control of the box in advance without its description having been transmitted forward. This alarm could be given directly the route is set for the train to proceed, and there may be an operational advantage in this method in that the signalman's attention is drawn to the omission whilst there is time for it to be corrected. We have chosen to cover the requirement in the former fashion to reduce complication in our circuit work.

Mr. Duffield. It is a facility we have at York. We transmit it first before we clear the route.

Mr. Leach. That is another way of doing it. We wait until the train comes past before we raise the alarm.

Mr. Duffield. When you transfer from one berth to another berth, you lose momentarily your display. Is that feasible? In some Regions I understand that you not only display the berth to which you are moving, but you also retain the display until your approach track is clear.

Mr. Leach. The reason for stepping the description in two stages is to avoid being left without a description whilst the train concerned is straddling the track circuits whilst in the act of passing a signal, which whilst it could be achieved in the W.R. system appears to me to be an unnecessary refinement. It must lead to complications in the stepping circuitry when the rear signal section is permissive and is occupied by a second train at the same time as the first movement takes place.

Mr. Jones. I would like to ask Mr. Leach information on a point about train describers. The design of them seems to be mainly concentrated on electro-mechanical equipment. My experience has been that when we have equipment to install in a place, and it is usually in a basement and there is a necessity for a very regular routine maintenance and I am wondering, as train describers have been developed and an approach has been made to varying systems, whether this electronic system

has been given serious consideration, and whether the approach that we are using is the right one. Electronic equipment can be used to do all that we are doing with electro mechanical, with a very much less fault liability.

Mr. Leach. I do not know that I am going to agree with you about the fault liability of electronic equipment, but I do agree that some of the conditions under which railway signalling equipment is expected to function are frequently un-unsatisfactory.

With equipment employing electro-mechanical apparatus such as selector switches, relays, etc., there are mechanical adjustments which must be maintained which of course do not obtain in purely electronic systems using transistors or other static switching devices.

In the train describer field, except in certain impulsing circuits relay equipment is not working under onerous duty conditions, nor are contacts heavily stressed, and my view is that an electronic or " transistorised " approach is neither justified economically in view of these virtually optimum operating conditions, nor do the facilities to be provided lend themselves to an elegant solution in the electronic mode. I am afraid I do not support the slogan put forth from many quarters that unless a system is electronic or transistorised it is inefficient or not modern. An attempt has been made to design a transistorised version of the master impulse generator which is the most heavily stressed part of the W.R. system, but we came to the conclusion that the relay solution was equally efficient at half the cost.

The **President** moved a very cordial vote of thanks to Mr. Leach for his excellent paper and this was carried with acclamation.