Technical Meeting of the Institution
held at
The Institution of Electrical Engineers
Friday, October 24th, 1947.

The President (Mr. F. L. CASTLE) in the chair.

The minutes of the previous meeting having been read and approved, the **President** welcomed members to the first meeting of the new session and said he was very glad to see such a good gathering. He hoped that there would be equally good attendances at subsequent meetings. Members were to hear a paper written by Monsieur E. J. F. Derijckere, an esteemed overseas member from Brussels, who had taken much trouble and time to prepare it and had come over specially to read it to them. He had pleasure in calling upon him to do so.

New System of Signal Aspects for the Belgian National Railways.

By E. J. F. DERIJCKERE (Member).

Diagrams—Inset Sheet No. 11

The experience we obtained with colour-light signalling on the Charleroi-Namur and Antwerp-Brussels lines led us to draw up plans during the war covering the design of signals intended for use on electrified lines.

These plans followed the same principles on which the existing colour-light signalling is based and had received the approval of the departments interested in such matters, notably the operating and traction departments. The arrangements thus provided for did in fact constitute a step forward on those in use on lines already being operated electrically. In the majority of cases indeed the mean effective centre of the group of light units had been brought down to the level of the driver's eye, the number of shunt signal units was reduced to one set per bracket signal and the grouping of the lights on the various dolls was considerably better than it is on the existing bracket posts. This

allowed a three-way bracket light signal to be brought within the space available between the centre structure gauge clearances on a four-track line (see the diagram in fig. 1). However, even in this case the upper lights were still located at some 6 to 7 metres (19¾ to 23-ft.) above rail level.

The wish to use such bracket post layouts on lines fitted with automatic signalling and, should the case require it, for wrong road movements, and the detailed investigations made of the wiring arrangements required to cover the multiple combinations of signals called for in practice, led us to direct our thoughts towards the total abolition of bracket post signals. Such signals would in fact in some cases have had to have over twenty individual light units for a three-doll post, an inacceptable number.

The reason for this situation is that with us, as with other foreign railway systems, it has been the practice at first with light signalling to retain the aspects previously used at night with the mechanical type signals. This method of proceeding is admissible, and even logical, as long as a few sections of line only are to be fitted with the new signalling and there is mixed steam and electric operation. But it is no longer justified directly electrification of a system on a large scale is in question.

Thus we find, for example, on the French railways that at first the indications given by the four signals—semaphore, distant or caution disc, reduced speed reminder signal and square absolute stop signal—were replaced by independent light unit groups, but that later, after a period of development, one signal combining all these functions was used instead. However, the indication of the route set up is still given by a separate light signal showing a certain number of lunar white lights arranged horizontally, their number being equal, in any particular aspect, to the number of the route in the group concerned, counting from the left. In like manner, the indication of the speed to be observed, when it varies from the standard reduced speed of 30 km. p.h. (18½ m.p.h.) is shown by a separate illuminated sign.

The problem we set ourselves to solve was much more involved than this. It was with us a question of designing one universal type of signal capable of giving, if required, the whole series of indications met with in practice, namely, stop, proceed, direction set up, speed, wrong-road movement, shunt forward, set back into siding, caution or attention.

Description of the Signal.

The new signal, in its most complete form, is shown in fig. 2. It is made up of three distinct and essential parts :—

1. The centre portion gives the main indications, by means of the main light units, and the shunt indications ;
2. The upper portion gives the direction indicator signs, formed of illuminated arrows ;
3. The lower part gives indications relating to speed, by means of illuminated figures, and by means of subsidiary light units the indications governing the conditions under which a signal may be passed at danger.

As may be seen in fig. 2, the background plate is 0·80 metre (2-ft. 7½-in.) wide at its bottom part and thus gives on a straight track a clearance of 0·05 metre (2-in.) between it and the structure gauge line. The upper part ot the background plate is 1·20 metres (3-ft. 11¼-in.) wide.

We see therefore that we have a clear distance of 2·55 metres (8-ft. 4⅜-in.) above the pathway at the side of the line, allowing of a cyclist passing along it. On platforms that are level with the footboards of the coaches the signal has to be fixed so as to bring its lowest light at least 2 metres (6-ft. 6¾-in.) above platform level, in order to get the proper effects from such light. On those signals which do not have to give either direction or speed indications, only the main background plate has to be provided, carrying the running and shunt signal aspects, but a small supplementary fitting is needed to carry the marker lights already referred to. This type of background is seen in fig. 3. It affords a greater clearance still than that just mentioned above the pathway alongside the track.

Indications given by the Lights.

(*a*) *Stop Signals.*

Stop is signalled by the red light located in the centre part of the main background plate. However, in order to cover the conditions met with in automatic signalling, a small white and a small red light unit, or marker units, have been added under the signal proper. The conditions under which a driver may pass a signal at stop will vary according to which of these small units is lighted. The white marker will indicate that the order to proceed is to be given in writing by the head guard (fig. 4*a*) the train running prepared to stop short of any obstruction as

far as the next signal. The red marker (fig. 4*b*) however, will indicate that such order must be given by an assistant-station-master or signalman, either in writing or over a telephone. The white marker will be burning permanently at all purely automatic signals, even when showing proceed (yellow or green).

In this way should the main lights be out on account of failure of the supply, the white marker will continue to burn from a separate source, so allowing train crews to locate the faulty signal (fig 4*c*). In addition, such signals will carry on their post a white enamelled ring to indicate that the signal may be passed at danger on a written order issued by the guard. The trainmen will thus be made acquainted with the character of the signal even should all the lights be out. In the case of signals located so as to protect fouling points and junctions, the white marker light will be capable of being replaced at certain times by the red one for absolute stop, through suitable relay action. This marker will likewise be fed from an independent supply and will continue to show should the main signal lights fail. It will thus of itself give a stop indication to any approaching train (fig. 4*d*).

This second arrangement will also be applied on those lines fitted with light signalling and lock-and-block apparatus, and each signal governing the entrance to a block section will give the stop indication in the same manner as the signals used with automatic signalling at fouling points and junctions. Signals carrying a red marker light will also have a red enamelled ring showing that they may not be passed without an order from the station staff or the signalman, trainmen thus being advised of the nature of the signal should all lights have failed. In this way a uniform system of working will be obtained wherever light signals are in use.

(*b*) *Caution or Distant Signals.*

The following indications are to be given by the centre portion of a distant or caution signal assembly, namely :—

1.—A green light, to indicate proceed and normal speed at the next signal in advance (fig. 4*e*).

2.—A green light and a yellow light, exhibited horizontally, to indicate that the next signal is to be passed at reduced speed for some reason associated with the layout at that point, such as a junction, curve, opening bridge, etc.

At the next signal in advance yellow figures on the lower part of it will indicate the maximum speed permissible (fig. 4*f*).

3.—A green light and a yellow light, shown vertically, to indicate that the next signal in advance is to be passed at reduced speed, in those cases where the two signals next in advance are situated on a normal speed line but located at less than the normal distance from each other. In this case therefore the reduction of speed at the next signal is called for because the next signal to that is indicating stop (fig. 4*g*).

4.—A green light with a yellow light directly below it and another on the same horizontal line, an aspect derived from a combination of 2 and 3 above, to indicate that reduced speed is to be observed at the next signal in advance because the next signal beyond that on the diverging route is itself at stop and located at less than the normal stopping distance from the junction. In this case also, the next signal immediately in advance will carry warning yellow figures to denote the maximum speed permissible (fig. 4*h*).

5.—Two yellow lights arranged diagonally at 45 deg. to indicate that the next signal in advance is at stop (fig. 4*j*).

(*c*) *Shunting Signals.*

1.—A red light combined with a horizontal yellow illuminated bar will authorise a drawahead movement or indicate that the train is entering an occupied track (fig. 4*k*).

2.—The same indication, but with the addition of an illuminated arrow displayed vertically, point downwards, will indicate to the driver that the train is to take siding by setting back (fig. 4*l*).

Indications given by the Illuminated Arrow Signs.

The indications conveyed by the white illuminated arrows are of two kinds :—

(*a*)—Indications denoting the route set up, replacing in a much improved form those hitherto provided by the existing bracket type signals, or those given by the French and German directing signals. The direction to be taken

by the train is shown by lighting up one of the arrow signs on the reversal of the corresponding route-handle, in accordance with principles explained below. In order to enable a driver to realise clearly what diverging routes there are, and what the direct route is, and so on, every signal which forms a bracket signal in intention (*chandelier fictif*) will be preceded at a certain distance by a board, lighted by reflection at night, bearing in black on a white background a diagram of the junction layout ahead and the name of the station or locality in question (fig. 5).

The distance between this approach board and the junction signal itself will be 300 metres (328 yd.) on ordinary running lines but will be less in large station layouts or in other special local circumstances.

The conventional signs adopted with the arrow indicators are :—

1.—Vertical, point up, direct (non-diverging) route ;

2.—Inclined at 45 deg. to the left, first route to the left ;

3.—Horizontal, point to the left, second route to the left ;

(In like manner directions to the right can also be indicated). These arrangements allow every case shown in fig. 5 to be dealt with satisfactorily. In addition they allow of cases which cannot be treated with the existing bracket type signals, as shown in figs 5*x*, *y* and *z*, to be signalled, while they are not open to the criticism levelled against the French or German systems of directing indicators or signals of not permitting of the direct and diverging routes being distinguished clearly from each other.

A system of signalling the direction to be taken by a train, based on the same principles, has been applied of recent years on the British Railways (position-light junction indicator) but at the same time when we worked out our own ideas we were unaware of its existence.

It is to be noted that in every case where the speed at the point where a signal bearing such arrow signs is located is less than the normal maximum for the section of line concerned, yellow figures, on the lower part of the signal, will give the maximum permissible speed.

From this it follows that the arrow signs are purely indications of the route set up, that is they are geographical indications, and not of speed. This separation of the functions performed by the

various parts of the new standard signal is held to be a great advantage.

(*b*) *Indications governing Wrong-road Movements.*

The wrong-road movement indication, which will require to be given to drivers both at the signal governing the connection giving access to the wrong line and at the signal in rear thereof, is formed of two arrow signs exhibited in the form of a cross, at 45 deg., and in addition the former signal will carry yellow figures showing the permissible speed over the connection.

As a train running on the wrong line is called upon, during that time, to pay attention to the signals applying to the normal or right line, the last signal but one and the last of all met with must likewise show this St. Andrew cross sign ; the last signal too must carry yellow figures. These indications will show that the train is to be passed back to the right line.

It is to be noted that the white marker is extinguished on the signal giving access to the wrong line because the train is entering a non-automatic block section.

Speed-Indicating Figures.

Speed indication figures are not lighted up until the route concerned has been established and controlled. The figures indicating the speed will be lighted in yellow. To simplify matters and render the figures as visible as possible speed will be given in tens of kilometres, which will allow of larger numerals being used, 60 cm. (1-ft. $11\frac{5}{8}$-in.) high in place of 30 cm. ($11\frac{3}{4}$-in.) as at present. No speed indication will be given when the normal maximum speed is permissible at a location.

Details of Stop Indications used on the Nord-Midi (Brussels) Line.

At the stopping places on the line connecting the Nord (North) and Midi (South) stations in Brussels, it is advisable to prevent a second train coming forward to the rear of another stopped at a station platform, something which ordinarily could occur with the usual automatic signalling circuit. For this purpose the signal acting as a home signal to such stopping places will exhibit the red marker light when a train is in the section which it governs. Moreover, in consequence of the way in which the signalling circuits have been divided up on this

line certain signals at the departure end of the stopping places are not at the platform end but somewhat short of it. In this case, when such signals are at stop the yellow drawahead sign will be illuminated in addition to the red light, to allow long trains to draw right up to the end of the platform. When the signal is not at stop this sign will not be seen and the usual indications, double yellow or green, will be shown.

Symbols used to designate the Signals on Plans and Diagrams.

In order to facilitate our explanations of the principles we propose to adopt for operating lines equipped with automatic signalling we will now give details of the symbols adopted to represent the new type of signal. We require to do this also in connection with explaining the construction of the frames required at signal boxes at stations and junctions, and in large stations.

A distant or caution signal will be represented by a ring in which will be marked the various indications the signal is able to give. The green light will be represented by a small filled-in circle. The two yellow lights by a diagonal bar, the green and yellow lights, shown together, by a horizontal or vertical bar, as the case may be, and finally the combination of the green with the two yellow lights will be shown by a filled-in right-angled triangle.

A few examples of applications of such signals are given by figs, 6*r*, 6*s*, 6*t*. It is to be noted that all the indications capable of being given by the new caution signals are not susceptible of being conveyed by the older types, seeing that the new signal allows of dealing with cases not solvable by the old methods (see, for example, figs 6*u* and 7).

A stop signal, whether " simple " or " combined "—to use the language common when speaking of the mechanical type signals—that is, used without or with a distant type arm below, will be represented by a square in which the proceed or caution aspects will be shown by signs, but the stop aspect will be considered as being shown by the square itself.

The shunt aspect is shown by a small horizontal line or bar in the lower right-hand corner of the square, while the *take siding by setting back* aspect is designated by a vertical arrow, point down, above the square. Figs. 6*m* to 6*p* give some examples of this.

The white marker is shown by a small circle, not filled in, *the red marker* by a small circle which is filled in. Fig. 6*q* thus represents the most complicated from of "combined" signal that can be met with in practice. Obviously, there is no way of representing it by the symbols at present in use.

Signals which form a bracket signal in intention—that is take the place of one, so forming a "*chandelier fictif*" or imaginary bracket post—are shown with the aid of these signs at the right of fig. 6. The first deals with a junction out on the line away from a station, both branches being worked by lock-and-block. The other represents the entrance to a large station, line No. 2 being fitted with automatic signalling, the starting signals for tracks Nos. 1, 2, 3, 4, being situated—for simplicity in this case—at proper braking distance from signal B.

The speed indications are given by figures denoting the tens of kilometres marked in the squares corresponding to the indications given by the arrow signs—seen symbolically *under* the signal—and a hatched square means that that route can be taken at normal speed.

As a typical example of the use of this new signal we give in fig. 7 a diagram showing the application of the new signalling systems to an ordinary through station layout, operated under lock-and-block.

It is to be noted that no doubt exists regarding the route set up and the speed to be observed in the case of the indication given by the distant *a-b-c* in fig. 7 where the indication is a triple one (*x*1; stop at signal B; *x*2; diverging route towards C and that signal off; *x*3; diverging route towards C and that signal at stop).

The *shunting* movements have their indicating reference number ***underlined*** (see figs. 6 and 7).

A few of the Advantages of the Proposed New Signalling compared with the existing Colour-Light Signalling.

1. Bracket type posts are got rid of completely. This gives a much greater freedom in arranging the position and layout of the standards carrying the overhead traction contact wires.

2. The signalling equipment itself is standardised and the amount of equipment used out on the line is materially reduced.

3. It will be possible, wherever operating conditions allow of it, to attach the signals to the overhead standards, something which was out of the question with the older bracket posts.

4. The signal lights are brought lower down and their effective centre point is now at about the height of the driver's eye (3·50 metre) (11-ft. $5\frac{5}{8}$-in.) as against 7 metres (22-ft. $11\frac{5}{8}$-in.) in the case of the three-doll bracket post shown on the drawing in fig. 1 and 10 metres (32-ft. $9\frac{3}{4}$-in.) in the existing colour light signalling. This is a very great advantage in foggy weather, while the reduction in the size of the signal background plate, compared with what is needed for the bracket arrangement, will ease the problem of securing proper visibility among the overhead standards preceding a signal on a curve.

5. Problems which cannot be solved with the existing methods are capable of being solved with simplicity and exactness.

6. The violet stop indication for shunt movements is abolished. This light derived its origin from the fact that the shunt arm used in mechanical signalling was reproduced by a light unit in light signalling.

7. The fact of having but a single red light in the main indications means that ordinary running movements never have to pass such a light, as they do with the existing bracket signals. When a signal has to indicate proceed the red light is extinguished and replaced by the green light or the yellow lights, or a combination of these.

8. The out-of-level effect produced by showing a green light in one of the dolls of an equal level doll-post group is got rid of.

At the present time this light necessarily appears at a lower level than the red lights on the remaining dolls. A very great reduction in the danger of confusing the lights at the entrance and exit to large stations, where there are numerous bracket type signals and other signals, will be effected.

It is to be particularly noted, in this connection, that any confusion between the red and the yellow light, made impossible in the present signalling by always using *double* yellow, never *single* yellow, is equally provided against in the new arrangements, while the setting of the two yellow lights on a diagonal line makes it impossible either to confuse the caution indication with the single red stop indication, or with the stop indication and the red marker light under it.

9. A speed of 140 km. p.h. (87 m.p.h.) having been adopted for our main routes, it follows that the trains will in future be making longer journeys than in the past and pilot-drivers will need to be familiar with a much bigger area of the system than hitherto. As the proposed signalling is much clearer and explicit, from the point of view of understanding each layout met with, the instruction of these men—and consequently of the ordinary drivers too—will be much easier to effect than before.

APPLICATION OF THE NEW SIGNAL TO LINES EQUIPPED WITH AUTOMATIC SIGNALLING APPROACH LOCKING AND STICK CONTROL.

Approach Locking and Stick Control.

In order to make this explanation clearer we will take an actual example of a layout, the junction at Bois-de-Nivelles, on our Line No. 124 (fig. 8). We will assume that the Brussels-Charleroi line is fitted throughout with automatic signalling and that the first section on the Bois-de-Nivelles-Fleurus line is fitted with lock-and-block. We will also, to simplify matters, omit all consideration of shunting movements from Commune towards the junction. (Commune is the first station on the Bois-de-Nivelles-Fleurus line.)

The signals such as A and F protecting junction movements will each have both a white and a red marker, lighted under certain conditions hereinafter explained. Signal box X will have in addition to the point levers, route-handles and signal handles. Both these will be of the 3-position type, to reduce the size of the apparatus. When only through traffic between Brussels and Charleroi is operating, signals D, C, B, A, and J, and I, H, G, F, and E, will function automatically and normally show a green light. In addition, on all these signals the white marker will be illuminated. At signal K, which will be at stop, the red marker will be burning.

For signal A, in the conditions obtaining, route handle $h1_r$ will be reversed, and the handle A_r to clear signal A. On that signal the vertical white arrow, point up, will be showing.

For signal F handle $h2_r$ will be reversed, locking the corresponding route, and handle F_r also, clearing signal F.

Now let us assume that a train requiring to go from Brussels to Fleurus is approaching. Two conditions can present themselves :—

1. There is no other train in front of this one and it has not itself yet reached the sections 1 or 2. The signalman at box X will return handle A_r to normal, proving through the approach locking that no train is in sections 1 and 2. The green light in the signal will be replaced by red, and the white marker will be replaced by the red one. This operation will allow the signalman to return route-handle $h1_r$ to normal, and the arrow over the signal will be extinguished. The signalman is now free to change the road and set it for the movement towards Fleurus.

The reversal of handle $h1_l$ will lock this route and light up the inclined arrow sign and the yellow figure, with speed indication. Reversing handle A_l will now put out the marker and light the green light in the main part of the signal. As soon as the head of the train passes the signal the latter will go to danger automatically, showing the main red light and red marker. When the last wheel has cleared the treadle and insulated rail P, acting as block release and release of the route, as well as for automatically putting the signal to danger, the signalman can, by means of the reverse order of operations, re-establish the normal conditions of affairs, with automatic working on the main line.

2. The train to Fleurus is preceded immediately by one to Charleroi., In that case the approach locking will prevent the restoration of the handle A_r behind the train, because the following one to Fleurus will already have reached sections 1 and 2 in advance of signal C. We therefore have recourse to the stick-control effect, or "*aubinage.*" This operation consists in actuating a rotary switch the effect of which is that, after the train to Charleroi has passed, the signal A will automatically give the stop indication with red marker showing. The resetting of the handle A_r to normal will now allow of the operations just outlined above being carried out, but this resetting is dependent on the train passing clear of the so-called "fouling point clearance track" (*circuit de voie de dégagement*) which extends for a certain distance M beyond the junction crossing. This is to prevent a train stopping a short distance ahead and setting back in starting, fouling the route towards Fleurus. This "*aubinage*" or special

stick-control, cancels out the approach locking directly this clearance track section is unoccupied and so permits the handle A_r to be put back to normal. It is to be noted that the clearing of signal A for the movement towards Fleurus is further dependent on receiving " line clear " on the lock-and-block from the box in advance. The triple function of treadle P has already been mentioned. The putting back to normal of the stick control rotary switch has to be effected before it is possible to set signal A to clear again for the Charleroi line, that is before the reversal of handle A_r again for that line.

Case of a train coming from Fleurus and proceeding to Brussels.

In the case of a Fleurus to Brussels train approaching it is obviously necessary to put signals A and F at stop before clearing signal K. To do this the approach locking or the stick control action, already described, is made use of, according to the position of trains on the main line at the moment.

Siding Lines.

Let us now consider the case of a siding line or relief line leading off the main Brussels to Louvain line (fig. 9). The signal box Y will have a three-position route-handle $h1$, as at the box X at Bois-de-Nivelles, but the handle for signal A will be a two-position one, as both main and siding lines will be equipped with automatic signalling. All signals in the diagram will have the white marker light burning continuously, save signals A, H and O, which will have a white or a red one, according to conditions.

In the case of ordinary through movements from Brussels towards Louvain on the main line, all signals C, B, A, D, E, F, G, H, and I will give indications similar to those used at the Bois-de-Nivelles junction, and if the siding line is unoccupied signals K, L, M, N, and O will present the indications shown in fig. 9.

When a train has to be sent into the siding line the signalman will set up the route concerned through the approach locking or the stick control, as at Bois-de-Nivelles, as automatic signalling is in use throughout and no " line clear " is needed from the box in advance. If the first block section is unoccupied therefore signal A will give the indications green with arrow inclined to the left and speed restriction of 40 km. p.h. (25 m.p.h.). The

white marker is lighted, because automatic working is in use on both lines, but it will be understood that *one* of the two routes is set up, detected and locked by the handles $h1_l$ or $h1_r$. Two cases can now present themselves, according to whether a train to the siding is or is not followed by another going to that same line.

1. If the second train has to travel to that line the signalman has nothing to do and everything will take place automatically, as for movements along the main line, and the same occurs if other trains following also travel to the siding. In that case, after the first train has passed, the main signal aspects will change automatically.

2. If the second train is not for the siding the signalman must intervene again, through the approach locking or stick control. The reverse operations to those described in the first part of this section will re-establish the normal condition, with the road set for Brussels-Louvain movements.

The working at the outlet signal box V is similar to those just described.

Shunt Movements in Stations serving Goods Yards.

The operation of points giving access to goods yards will as a rule be effected locally, the keys locking the levers being interlocked, either directly on the frame itself, or indirectly through control instruments. In those cases where such points are required to be operated from the signal box, mechanically or electrically, ordinary direct interlocking will obviously be applied. This being understood, reference may be made to fig. 10 in which signals A and E can show shunt aspects.

First case.—When a train travelling from X to Y requires to make a shunt, we have first of all to cut out the automatic working of signal A, proving through the approach locking that sections 1 and 2 are unoccupied, or by using the stick control on signal A after the train preceding the one required to shunt. This will produce the situation of signal A being at stop with red marker lighted and signal B showing two diagonal yellow lights and white marker light.

The putting to stop of signal A will also act on the stick control of signal B, which will itself go to red immediately it is passed by the front of the train requiring to shunt, with red

marker lighted. It is not satisfactory to leave the white marker showing, since should the train set back in starting after completing the shunt it might collide with one which had entered section 2 under caution.

Directly signal B is put to stop with red marker burning the signalman can reverse the handle of signal A controlling the shunt aspects, which will light up. This will free, either the keys for the points *b*, or the levers or handles actuating them.

When the shunting is completed and points *a* and *b* are properly secured again, the automatic working of signals A and B is re-established. The train may now proceed on its way.

Second Case.—When a train travelling from Y towards X requires to make a shunt, we have to perform for signals E and F the same operations as those which we effected for signals A and B in the case just dealt with. However, in addition to that, it is necessary to put signal B to red with red marker lighted—after using the approach locking or stick control effect—and it follows that at the moment when the keys of the points, or the point levers are freed the signal E will show a red light with yellow shunt indicator under it.

At the conclusion of the shunting and after the points *c* and *d* have been properly secured again the signals B and E will show green and white marker lights. The train may now proceed on its way and automatic working will be restored on both tracks.

Setting back into a Siding.

From the point of view of the protection of the movements by the signals in rear, the operation of taking siding by setting back does not differ from other shunting movements.

Note.—The following should be noted in connection with the diagrams, Inset Sheet No. 11. In fig. 7 signals B and C should have a small horizontal line in place of the letter M. In fig. 8 the starting signal to Charleroi should be marked J. In fig. 10 signal E should have the small horizontal " draw-ahead " sign added.

DISCUSSION

Mr. A. Moss, opening the discussion, said while the paper was being read he wondered whether it was a case of coming events casting their shadows before. There was no doubt that the French National Railways and the Belgian National Railways had given a considerable amount of time and thought to the question of unification of aspects in signalling generally. That was a subject with which signal engineers in Britain were not altogether unfamiliar, and it was not an easy one to handle. It was very interesting to see how the Belgian railways had tackled the problem, and for his own benefit he had made a quick comparison, taking a straightforward main line in a four-aspect territory. In Britain one got red preceded by yellow, preceded again by double yellow and then green signals, but it would appear that in Belgium a fundamentally different view was taken because in Britain the single yellow was looked upon as the most restrictive aspect apart from the red, whereas in Belgium they had double yellow leading up to a red. The author stated the reason for that was to avoid confusion with the red light, but in Britain that difficulty had been surmounted by the use of the rather palish yellow light commonly known in the early days as " daffodil yellow."

In British practice with single yellow, where there was less than braking distance, it was preceded by double yellow ; but at that point the Belgian practice appeared to be at variance with the British. The Belgians went to far more trouble than we did in an endeavour to advise the driver what to expect ahead. Their comparable indication on a straight route was given by green over yellow, leading up to their double yellow. That was equivalent to the British double yellow leading up to a single yellow. In addition at that signal almost invariably the direction to be taken was given. In other words, they had the equivalent of splitting distants. In Britain in colour-light areas splitting distants were not generally provided. There were cases where such signals were of particular advantage to the traffic department and in consequence were provided but they were more the exception than the rule. It appeared from the paper, however, that it was common practice in Belgium to indicate the direction at the green over yellow signal.

In addition to that, the Belgians seemed to have another

aspect for giving the direction and indicating also that there was less than braking distance, which was different in form from green over yellow. Then there was for the straight route green and yellow, in horizontal line, which seemed a little confusing. It was difficult to see why one indication could not have sufficed, for either the diverging route or the straight, and perhaps the author could give some indication as to what led up to that practice. He also noticed that stress was laid on standardisation where electrification works were being installed. That was interesting, but it would be interesting too to know whether in Belgium it was found necessary to place the signals low down on the ground, because it would seem that trouble would ensue with the Belgium set-up and British clearances. It was bad enough when a four-aspect signal had to be put low down. There were cases when it had to be done in Britain, and it would be interesting to know whether anything like that happened in Belgium. The British standard method was driver's eye level, which was about 11 ft., but there were cases where it was necessary to come down because of obstructions. For instance, on emerging from a tunnel the signal had to be brought low down in order to get out of the smoke.

Referring to marker lights, Mr. Moss said the standard, of course, under stop and proceed on British main lines was by the illumination of a 6 in. letter " P " for " proceed," and these signs were controlled by the signalmen. That was the sole permission for a driver to pass a signal exhibiting the danger aspect. There was also a telephone from the signal to the controlling cabin, and the track indications were repeated back there.

The Belgian junction indicator was interesting, because it followed largely the British practice, except that we had no arrow sign. The British practice was to have a row of lights, in some cases five lunar whites and in others three. One of the stipulations in Britain was that the junction indication lights should be plainly visible 300 yd. on the approach side. That was about equivalent to the 320 yd. mentioned by the author with regard to the placing of a marker board. Years ago the marker board had been tried in Britain at the distant signals. A yellow board with stripes was fixed on the approach side of a mechanical distant, but it was found to be not too good, and it would be of interest to learn whether the Belgian drivers found any difficulty in picking up the junction marker board. Could it be seen at night quite clearly ? He would

have thought that drivers would have experienced difficulty in seeing the signs when travelling at 40 km.p.h. In Britain no junction indicator was given for the straight ; it was illuminated only for the diverging route. The aspects were approach controlled if a reduction in speed was called for.

Mr. S. Williams had been particularly associated with the application of colour-light signalling to main line working for a considerable time. He had read the paper with special interest, tinged, perhaps, with regret at not having had sufficient time to do the justice to it which it merited. On Wednesday evening at their annual dinner M. Derijckere had made a reference to men of thought and action. There was no doubt that the system of signalling put before them that evening was the result of such men applying themselves to an exacting problem, with a considerable degree of effort and concentration. The Institution was to be congratulated on receiving such a refreshing treat. The scheme illustrated the wise procedure of making a gradual departure from the mechanical semaphore practice when endeavouring to arrive at a modern system, able to meet, so far as was possible, all requirements of speed and safety in handling railway traffic under both up-to-date and anticipated future conditions. Presumably its final application was intended for electric traction, which envisaged these two great advantages, constant factors for accelerating and braking. There was some resemblance to German principles in the use of the obliquely displaced yellow-yellow and the inverted triangular speed indicator. The scheme differed fundamentally from British practice in that apparently no use was made of an unqualified single yellow aspect as a running signal, nor of our accepted arrangement of the sequence of aspects, green, double yellow, yellow, red. He assumed that was on account of the desire not to depart too radically from the night indications of the existing semaphore signals.

Of particular interest was the differentiation between two conditions of " stop and proceed " in automatic working, for which two distinct marker light signs had been provided. He thought that the negative sign, represented by a horizontal bar of yellow light below a red one, was an apt application of a universally accepted sign for authorising the movements for which it was intended, though as a " know nothing " signal the sign might be well applied to the marker light (white or red) previously

referred to. We might consider it unnecessary to exhibit a white marker light when the main aspect gave an " off " indication, having in mind that in automatic working the caution indication in any given signal invariably proved the signal ahead at red, or alternatively, the next one in sequence with two sections clear.

Another interesting feature was the inclusion of what we termed the splitting distant signal, a problem which still exercised the minds of signal engineers and traffic officers in this country. Presumably the yellow aspect was given on the right hand side of the green, irrespective of the direction of the turn out at the junction ahead. To what extent this would be accepted by traffic officers in Britain was difficult to say at the moment, but it did enable the signal structure to be arranged so as to bring the running aspects as close to the driver's eye level as possible. Did M. Derijckere prove the yellow aspect showing before the green could be displaced on any combination of green and yellow? Otherwise, the single green in figure 4*e* was open to question and led him to suggest that for high speed running, particularly in congested areas, the double green vertically displayed would be a very desirable indication to consider.

Again their friends in Belgium had adopted the position-light junction indicator to minimise the number of colour aspects at a junction home signal, while at the same time indicating the route set up in a similar manner to ours, though with the marked difference that in Belgium the straight ahead route was also separately indicated to the engineman by the vertical bar of white light immediately above the colour-light unit. Whether this would deter M. Derijckere from fixing the route indication to the right or left of the main aspect in cases of difficult sighting he would perhaps tell them.

From figure 5*x* it would appear that this type of indicator was used irrespective of the permissible speed for any diversion. Apparently, the route indication was exhibited so long as the particular route was correctly set up, even though the main signal might be showing red. This was different from British practice, which only permitted the exhibition of the route indication when the signal lever was reversed. The inclusion of " wrong road " indicators was again a novel feature, though some further illustration of the extent to which " right road " signals were observed in " wrong road " movements would be appreciated.

Mr. T. S. Lascelles wished to point out, on behalf of the

author, that the junction indicators were not lighted up normally—that was they were not lighted all the time—and did not therefore change as the various points were pulled over or returned to normal. They remained dark until the so-called " route handle " or *"manette d'itinéraire"* was reversed. Such a handle did not exist in our signal boxes. It formed an intermediate link between the point and signal levers and actuated the mechanical locking. When a route had been set up for a train this handle was reversed, locking it as set and freeing the signal lever concerned. It was at that moment that the junction indicator became illuminated.

Mr. B. Wagenrieder asked why it should be considered necessary to have the four different aspects depicted by diagrams 4 (*a*), (*b*), (*c*), and (*d*), and what was the need for the marker light? Had the Belgian authorities considered the adoption of the double-filament lamp in colour-light signals, as a safeguard against a signal showing no light, plus sufficiently frequent maintenance inspection? As regards an automatic signal being held at red owing to a track circuit failure, the method laid down of the guard or signalman authorising a driver to proceed under a written order seemed to be unduly cumbrous and fruitful of delay. It was general practice in this country to provide telephones of the selective type at all automatic signals. The driver obtained the signalman's permission to proceed by telephone. In all cases in this country a driver proceeding against the red aspect was required to travel at caution, prepared to stop short of any obstruction, but it was not clear in diagrams 4(*a*) and (*b*) that caution was necessary. Whether or not the guard rode at the tail of the train, the need for a written order was surely productive of delay. It had been found that the provision of telephones at automatic signals was a valuable advantage, not only for trainmen, when stopped at a signal, but also for the engineering staff and others when dealing with emergencies or mishaps. If the signal protected points worked from a signal box or ground frame, responsibility was placed on the driver knowing that, and if the telephone wires were down and the instrument consequently out of use, then the driver had to make sure that the points were not in use at the ground frame, or that the signal box was switched out, before proceeding. Those marker lights, with their independent source of supply, must surely require a lot of line wire. The paper stated that a yellow triangular warning sign would give the maximum permissible speed. It was presumed that that speed

would only apply to fully braked trains running at the highest speed, and not to the unbraked freight trains which would require to observe a much lower speed limit. A point not mentioned in the paper was the length of the normal overlap (*i.e.*, the length of line immediately past the stop signal) which had to be clear before the stop signal on the approach side of the former signal could show " off." Was the length of that overlap varied according to whether the gradient was rising or falling? The standard overlap in this country was $\frac{1}{4}$ mile, but there were many departures from that, due to very dense traffic, speed restrictions, and gradient.

Mr. T. S. Lascelles observed that the author wished to say to Mr. Wagenrieder that in Belgium the head guard on a goods train rode at the front, next to the engine. Regarding telephones, they were being done away at most signals, as there was no time to use them with the heavy traffic that had to be handled. If a train stopped at an adverse automatic signal it proceeded at once under the " stop and proceed " rule.

Mr. F. Horler observed that when one of those rare opportunities to devise a new system of signal aspects occurred (an opportunity which no doubt all signal engineers would covet), they might be very sure that, absorbingly interesting as it might be, it involved some very onerous considerations and entailed a very great deal of responsibility.

One of the first difficulties, presumably, would arise out of the customs and usages of the old system, which were not easily shaken off, because for some period the old and new would have to exist together and to some extent be reconciled. It would be awkward at least—possibly dangerous—were there anything contradictory in them.

Then again if, in the old system, certain indications had been available, even though they had fallen into disuse or become of so little importance that the desirability of discarding them was fairly obvious, someone concerned would be sure to express reluctance to part with a facility once enjoyed, could it be found a place again in the scheme of things. Thus a new system did not mean necessarily a complete departure from the old and might involve some compromises. That was the situation in which he imagined M. Derijckere and his colleagues to have been placed, and he was sure that much credit was due to them for the ingenuity of the new system which had been described that evening and on the fulfilment of which they had to compliment them.

To one familiar with British practice and looking at this new Belgian system in a theoretical way it would seem that a little more simplicity might have been obtained. For instance, excluding the shunt signals, there were six main signal aspects as compared with four in British practice. The single red for stop and the green for unrestricted proceed were common to both, and we could accept without comment the double yellow used in Belgium for the same purpose as the single yellow in England. Following that we found that for the equivalent of our double yellow M. Derijckere used green over yellow. Both those signals give an indication of a short braking distance beyond the next signal ahead, and in fact in British practice that was the only direct indication of a condition beyond the next signal ahead which we gave to drivers. The new Belgian scheme provided two aspects to indicate divergencies beyond the next signal ahead for which we had no equivalent, and one wondered whether the system would not have been a little simpler if those aspects could have been avoided. We provided restrictive controls on the signal in rear of a junction signal when the turn-out speed required it ; but the Belgian signal engineer seemed to have spurned the guile of delayed aspect controls in his circuits. The reaction of the driver would have to be very much the same when observing any of the aspects given by combinations of green and yellow ; and as he would always be further informed before he reached the divergence, were the distinctions between the three aspects really worth while? The dimensions of the junction route arrows might have some bearing on that matter because they did not appear to be of a long range type—certainly not visible as far as British multi-lamp indicators were. He partly anticipated that the answer to these criticisms was that all these new aspects were strictly geographical in character where junctions were involved and were not speed instructions, as ours partially were, all speed limits being displayed in a supplementary way.

The provision of roadside signs at the approach to a junction bearing geographical directions of divergencies seemed an excellent idea and fitted in neatly with the arrow directions on the junction signals. The information given was direct and explicit and remained a useful reminder even to a driver altogether familiar with the road. Perhaps M. Derijckere would be good enough to give them some idea of the dimensions of these roadside signs?

With regard to the shunting moves the shunt forward to set

back into siding aspect was clear and unmistakable. One would ask whether it would be the practice to prove the lighted arrow before illuminating the yellow strip in order to avoid confusion with the shunt forward indication, or was that not considered important? Regarding the plain shunt forward indication Mr. Horler was not quite sure whether that was to be used as a signal giving entry to an occupied section in the manner of our calling-on-signal or whether it had some different purpose, such as moving forward into a siding, and he would be obliged if M. Derijckere would explain that.

In this country we did not use speed limit signs, except for temporary speed restrictions and never in connection with signals. He thought it much more reasonable to give the driver the actual speed limit over the path he was to travel, as this Belgian system did, than to put the onus on the driver to remember all the permanent limits laid down in his working time-table instructions.

Having decided on this system of signal aspects, there remained for M. Derijckere a still necessary task of finding symbols to use on plans. Here again great ingenuity came into play and what at first must have appeared a very complicated need was reduced to an easily readable system.

For all that work, and on his presentation of the description of it in a manner so logically and clearly developed and in what to him was a foreign language—though he seemed so well at home in it—their congratulations had to go to the author in no meagre measure.

Mr. L. J. M. Knotts asked the author whether in Belgium the question of automatic train control had been considered at the same time as the use of the present system ? There appeared to be a good deal of room on the Belgian railways to get signals in. In Britain the space was more restricted, and it would probably be difficult to bring the signals down unless there was more. Our signal engineers were faced with old established layouts which, of necessity, had to be met, and although the paper was admirable and very explicit, he did feel that in Belgium and in Britain two different things were being attempted. For example, there was no indication in the paper of the approach view given by the indications. In Britain a long approach view was desired, but the author gave no idea as to what approach view he required. That was a fundamental difference. Another point concerned the arrangement of the green and yellow lights, and it would be

interesting to know what happened if the yellow light went out. If that did occur, the green light, which was less restrictive, was left. The author had stated in the paper that the Southern Railway had junction light indicators, which rather inferred that no other railway in Britain had them, and he desired to point out that in fact the London North Eastern Railway was the first to use them. Finally, he asked whether the junction indicator lights were actually exhibited when there was no signal light in the signal itself ? It rather appeared from the paper that the junction indicator lit up when there was no actual light in the signal.

Mr. R. C. Hider said he spoke as an operating man and would like to know why it was that in Belgium there appeared to be a need for more than one aspect for a restricting signal ? The point had been raised by one of the signal engineers, and it did seem to him rather extraordinary that any operating man should have asked for anything complicated in signalling. Even if the officials of the traffic department did not ask for simplification, he was certain that the staff would or, alternatively, would ask for a very much higher grading ! It was, he believed, correct to say that there were four different aspects for reducing speed, and it would have been fairly simple to arrange for no aspect to be displayed in the signal on a diverging route by approach control. He had had some considerable experience of that. The other point in which he was interested was the rather novel shunt signals. It was rather difficult to see why it was necessary, when an endeavour was being made to simplify the system, to have two different forms of indication—for want of a better word—one to shunt forward and one to set back into a siding.

Mr. C. G. Derbyshire said although the junction indicator was admirable at outlying junctions, the author had not solved the problem of what sort of indication was to be given to a driver when he got to a large terminus. The number of indicator positions was limited, and the use of figures for speed indication probably ruled out the use of numerals, so it was difficult to think of a third way of indicating to the driver which of a number of platforms he was going into, each of which might vary in length and importance. Another point concerned fig. 2, the positioning of the signal aspects in relation to the track. The author's sketch applied obviously to a straight track, but, unfortunately, on some of the British main lines there was very little mileage of straight track and difficulty was often experienced in giving a driver the

best possible sight on a curved approach without pushing the signal up too high. For instance, it might be necessary on a curve to sight a signal over the top of a train on the adjacent parallel line, which might push it up three or four feet. If that were not done, there was a risk of the driver seeing the top green of a green over yellow combination and taking it as proceed at full speed. Quite a considerable mileage of British main lines had three or more parallel tracks, and in order to get the signal in the correct position in relation to the track it had to be mounted on a gantry. In that case the speed indicator at the bottom necessitated elevating the signal about 8 or 10 ft. above the elevation shown in the sketch which, with overhead traction transmission, might give rise to serious difficulties.

Mr. J. C. Kubale said it was interesting to see how the author had solved a problem very logically by means of colour, position and a combination of lights. He had worked out a system which met his own peculiar operating requirements, but it would be interesting to know whether, with the apparently close arrangement of lights—with green and yellow lights burning at the same time—a certain amount of colour mixing did not result and, therefore, perhaps a wrong indication in the confined space of a signal. At every conference dealing with signal aspects the fundamental argument was brought up as to whether the driver of a train should be told where he was going, or whether he should be told at which speed he should proceed. The operating man would say that he wanted to tell the driver that he was going on to, say, road 10 at the second or third branch after the signal, and to do that would necessitate putting up something closely resembling a Christmas tree. In the end one was bound to consider whether it was of any use to the driver to tell him where he was going once he had been told the speed. One could not put a figure up because that was used for something else, which led to the further point that, according to the paper, the speed restriction at various signals was not constant. A speed restriction could be put up against one signal, but with the same signal at a different place the speed restriction might be different. Finally, it would be interesting to know whether any form of enforcing obedience to a signal were contemplated, or whether any form of train control was anticipated on the electrified lines with that system of signalling.

Mr. F. B. Egginton felt they owed M. Derijckere a debt of

gratitude for opening for them a window into the minds of other people, so that we could see how they dealt with the same problems that we ourselves had met, but in approaching them from an entirely different angle and with an entirely different set of preconceived ideas from which to build up a suitable system of colour-light signalling. As description followed description of the various functions and aspects to be displayed in this new system, one's mind's eye immmediately reverted to problem after problem which had arisen in one's own experience and the answers to them which were found in this country. Not all the problems have yet been settled here and others had been but partially solved, but apparently the Belgians had painstakingly found a solution, to their own satisfaction, to each one of those problems as it arose. Whether their ideas were adaptable to our own system of colour-light signalling one could not say offhand, but most certainly they would repay careful examination.

There was only one criticism he would venture to put forward regarding this " universal " signal and that was were the many aspects capable of being displayed by it verging so far on the complicated that drivers would find difficulty in memorising them? He would answer his own criticism by saying that after a third reading of the paper, he found the succession of aspects so logical and becoming so familiar to him that he did not think such a difficulty was likely. After all they had most, although not all, of the various indications in different places in their own system of signalling, and the locations where all the possible indications were likely to be called for were naturally few and far between. It was illustrative of the thoroughness with which the Belgians had gone into this matter, that not only had they devised a new and novel system of signal aspects but they had immediately devised a corresponding set of symbols to go with it, rather than let symbols for the plans grow up in a haphazard sort of way.

Regarding the aspects themselves there were one or two points calling for comment. The use of a combination of yellow and green had not been acceptable in this country, as the possible failure of the yellow would result in the less restrictive aspect of green being displayed. Such a possibility appeared to exist in examples *f*, *g* and *h* of the author's fig. 4 and it would be interesting to know if any particular measures had been taken to overcome that possibility. These three examples *f*, *g* and *h* were particularly interesting as they gave the Belgian answer to the problem which

we had not yet satisfactorily settled, *i.e.*, how to differentiate between restricted speed due to lack of braking distance beyond the next signal ahead on the straight road, and restricted speed due to a diversionary move at that signal. They went even a step further in Belgium and gave an aspect covering lack of braking distance on the diverging route. It was also interesting to hear that the direction arrows, or junction indicators as we should call them, were developed quite independently of our ideas on the same theme. It is to be noted that a vertical arrow was provided for the straight route at such a signal. We had not included that aspect, in the interests of simplification, but it was a matter for consideration whether it would not be useful to drivers at least as an indication of the particular location. In murky weather it would give a definite lead as to geographical location on a through run, which the single green, which we used alone at present, did not give. The use of two yellows as the caution signal preceding the stop signal became logical immediately the reason for it was explained. The possibility of confusion between red and single yellow was quite real in some present day installations in this country. The dark limit for yellow was, in Mr. Egginton's opinion, too near to orange. Many yellow lenses were of a real daffodil hue and gave no difficulty, but those of a darker tint were in certain circumstances liable to be mistaken.

Monsieur E. J. F. Derijckere, replying to the discussion, said that the reason for arranging the combined yellow and green aspects, in one case with the lights vertically, in another horizontally, was to convey the two ideas of proceeding straight on or diverging. The approach boards in rear of the junctions were clearly visible at night, the signs being lighted by sodium lamps. The system of marker lights, referred to by Mr. Moss, was the same as the one which had been adopted in France. It was essential to have some such system in Belgium, because it had become impossible on the Brussels-Antwerp line, owing to the great frequency of the electric train service, to use the telephone system. The drivers had no time to telephone but only to stop and proceed again at once under caution. The new signal would never be placed low down on the ground. Its normal height was such that the arrow signs would always come below the lower level of the bridges over the railway, so that the setting up of the signal would be independent of any of the structures built over the tracks and would remain unaffected by them. The use

of a junction indicator for the direct route, not seen in Great Britain, enabled a driver to locate his position from point at night, which a series of green proceed indications all the way along would not do. As regards the question asked by Mr. Williams, they had never experienced any difficulty in using a green light and a yellow light together, an aspect which had been adopted 30 years ago. Mr. Wagenrieder had raised the question of working under the " stop and proceed " rule. They were forced to adopt such working, just as they were in France in the neighbourhood of Paris, because of the great number of trains to be dealt with. All their goods trains were fitted with the Westinghouse brake. Mr. Knotts and Mr. Kubale had asked whether it was intended to install anything to compel obedience to the signals. The answer was that they intended to apply a system of automatic train control, with braking effect on a train passing a distant signal at caution. Replying to the points raised by Mr. Horler and Mr. Hider, he would like to emphasise that the various restricting aspects were the principal good qualities of the new signal. In Belgium all their stations were arranged so as to give a distance between home and starting signals—the entrance and exit signals—of some 800 to 1,000 yd. and the braking distance, that was the distance between the caution or distant signal and the stop signal necessarily amounted to some 1,300 yd. for fast heavy goods trains. It could however, be much less for light fast passenger trains. It was intended to raise the speed on the Belgian lines to 90 m.p.h., and hence it was essential in the case of the light fast passenger trains to have exact information conveyed to them at the distant signal, because the two classes of driver would not apply the brakes at the same moment. The driver on the light fast passenger train would do so later than the driver of the heavy goods, and in that way would gain several seconds on his running, which was very precious to them on a railway system such as theirs, carrying an exceedingly dense traffic. The delayed approach control could not solve all those cases. This would also answer the points raised by Mr. Egginton. As regards what Mr. Derbyshire had said, the same aspects would be used at the entrance to terminals as at through stations with the outgoing or starting signal at danger. For the wrong road movements they would not use the same signals as for the right road movements but would install special signals, located to the right of the train.

The President moved a cordial vote of thanks to the author

for the very instructive paper he had taken the trouble to prepare for them and for his kindness in coming to London to deliver it before them. The vote was carried with acclamation and Monsieur Derijckere acknowledged it.

The President announced that the proceedings at the next meeting, to be held on November 18, 1947, would take the form of " question and answer."

New System of Signal Aspects for the Belgian National Railways (*Derijckere*).

(See special note on page 179)

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