THE
Institution of Railway Signal Engineers
(INCORPORATED)
FOR THE
Advancement of the Science of
Railway Signalling

Proceedings: Inaugural Session, 1913

List of Officers and Members

AND

Annual Report

Manchester:
1914.
The Institution of Railway Signal Engineers

(INCORPORATED)

Council and Officers, 1913.

President:
ALFRED THOMAS BLACKALL, Reading.

Vice-President:
JOSIAH SAYERS, Derby.

Members of Council:
WILFRED C. ACFIELD ... ... Derby
ARTHUR F. BOUND ... ... Guise Bridge
CHARLES DUTTON ... ... London
CHARLES H. ELLISON ... ... York
HAROLD W. FIRTH ... ... London
ARTHUR HURST ... ... York
CHARLES M. JACOBS ... ... Reading
ARTHUR H. JOHNSON ... ... London
PERCY D. MICHÉD ... ... Easton
GEORGE NEALE ... ... ... Hull
JOHN T. ROBERTS ... ... London.

Hon. Treasurer:
ROBERT J. S. INSELL, Reading.

hon. Auditors:
ARTHUR H. JOHNSON
WILLIAM H. CANNON.

Hon. Secretary:
WILLIAM H. COTTERILL,
Telegraph Department, Midland Railway, Derby.
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The Institution of Railway Signal Engineers

ANNUAL REPORT.

In presenting this, the First Annual Report of the Proceedings of the Institution of Railway Signal Engineers, the Council feel that the members may on the whole congratulate themselves on the result.

There have not been as many meetings of the members as the Council would have wished, but this has been mainly due to the large amount of inside work which has been necessary to place the Institution on a proper footing.

The convening of meetings and the production of Papers with a membership so widespread is also a matter that calls for a considerable expenditure, and, as will be seen from the Balance Sheet, the expenses of incorporation alone have been very heavy.

In making mention of this, however, the Council wish it to be understood that Papers are most welcome, and they take this opportunity of again inviting members to assist in this direction as one means of making the Institution a controlling force in all matters coming within its scope.

The invitation for Prize Papers has met with some response, five Papers having been sent in, and the decision with respect to these will be announced at the Annual General Meeting.

The membership is rapidly increasing, and up to date consists of:

<table>
<thead>
<tr>
<th>Membership Type</th>
<th>Members</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundation Members</td>
<td>7</td>
</tr>
<tr>
<td>Honorary Members</td>
<td>7</td>
</tr>
<tr>
<td>Members</td>
<td>91</td>
</tr>
<tr>
<td>Associate Members</td>
<td>51</td>
</tr>
<tr>
<td>Student Members</td>
<td>10</td>
</tr>
</tbody>
</table>
The Institution is well represented abroad with 35 members, resident in the following countries:—Egypt, India, Australia, Ceylon, Malay States, United States of America, and South America.

A reference to the Balance Sheet shows that the income has not kept pace with the expenditure, but the most formidable item on the debit side is, fortunately, a non-recurring one.

The following Papers have been read during the year:—

"Signalling and its connection with the Construction and Management of Railways"—R. J. Insell (Member of Council);

"Colours and Colour Blindness"—A. Hurst (Member of Council);

"Sympathetic Numbering and Grouping of Levers"—J. Parsons (Member);

and these, together with the discussions upon them, will appear in the first year's Book of Proceedings which will be issued shortly.

With respect to those Papers which were read under the auspices of the old Institution, and which, owing to the lapse of the old Institution, were not included in a Book of Proceedings, the Council decided that these should be printed complete with discussions, and the following:—

"Theory of Track Circuit"—G. H. Crook (Member);

"Installation and Maintenance of Track Circuit"—A. F. Bound (Member of Council);

have been completed and distributed to those who were members of the old Institution.

Arrangements have been made with the Railway Signal Association of America for an exchange of literature, and as far as possible the American journals will be circulated amongst members. Forms of application for membership of the American Railway Signal Association can be obtained from our Secretary by any one desirous of joining that Association.
Apropos of this it may be mentioned that Mr. A. E. Rudd, a past President of the American Railway Signal Association, has promised to forward a Paper on "American Signalling Practice," to be read at one of our next meetings.

The Council feel that they cannot close this Annual Report without referring with much gratification to the fact that Mr. A. T. Blackall, who did so much in the initial stages of the formation of the old Institution, and who acted as President during its existence, has so ably fulfilled the office of President to the new Institution during its first year of existence.

W. C. ACFIELD, Member of Council.
C. H. ELLISON, Member of Council.
W. H. COTTERILL, Hon. Secretary.
Income and Expenditure Account of the Institution of Railway Signal Engineers,
for Year ended December 31st, 1913.

<table>
<thead>
<tr>
<th>EXPENDITURE</th>
<th>£</th>
<th>s</th>
<th>d</th>
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<tbody>
<tr>
<td>To Hire of Rooms for Meetings</td>
<td>4</td>
<td>17</td>
<td>6</td>
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<tr>
<td>&quot; Printing, Stationary, Postage, etc.</td>
<td>41</td>
<td>14</td>
<td>7</td>
</tr>
<tr>
<td>&quot; Expenses for Incorporation Proceedings</td>
<td>68</td>
<td>2</td>
<td>4</td>
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<tr>
<td>&quot; Late Secretary's Assistant</td>
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<td>12</td>
<td>6</td>
</tr>
<tr>
<td>&quot; Secretary's Honorarium</td>
<td>20</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>£138 6 11</strong></td>
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</table>

<table>
<thead>
<tr>
<th>INCOME</th>
<th>£</th>
<th>s</th>
<th>d</th>
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<tr>
<td>By Balance from old Institution</td>
<td>21</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>&quot; Subscriptions—</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot; Members, 70 at 21/-</td>
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<td></td>
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<tr>
<td>&quot; Associate Members, 50 at 10/6</td>
<td></td>
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<tr>
<td>&quot; Students, 12 at 7/6</td>
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<tr>
<td>&quot; Arrears, 1 at 21/-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot; Paid in advance, 4 years at 21/-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot; Balance due to Treasurer</td>
<td>7</td>
<td>13</td>
<td>7</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>£138 6 11</strong></td>
<td></td>
<td></td>
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</tbody>
</table>

We hereby certify that the above Accounts contain a full and true statement of the financial condition of the Institution.

R. J. INSELL,  
Hon Treasurer.

W. H. CANNON,  
Auditors.

ARTHUR H. JOHNSON,  
Auditors.

January, 1914.
MINUTES OF PROCEEDINGS
Of Inaugural Session, held at Birmingham, Tuesday,
February 25th, 1913.

Present: A. T. BLACKALL
A. H. JOHNSON
W. C. ACFIELD
R. J. INSELL
C. H. ELLISON
C. M. JACOBS
A. HURST
W. H. COTTERILL

Mr. C. H. ELLISON: I propose that we should now commence our Meeting, and our first duty is to elect our first President for the ensuing year. I have the honour to-day to submit to you the name of a gentleman who is known throughout the Railway Signalling world as a man of integrity and ability of a very high standard. I refer to our friend, Mr. Blackall, who did so much to forward the interests of the Society now defunct, and who likewise has done his level best to resuscitate it and to bring it to to-day's successful issue. I am sure that you will agree with me that Mr. Blackall will adorn the office of President, that he will bring ability to it, and that when his year of office shall come to an end, we shall feel that we have been well served by a very excellent President. I have, therefore, great pleasure in proposing that Mr. Blackall, the Signal Engineer of the Great Western Railway, be the first President of this Institution.

Mr. W. C. ACFIELD: I have very much pleasure in seconding Mr. Ellison's proposal that Mr. Blackall should be elected for the ensuing year, and in doing so I thoroughly endorse everything Mr. Ellison has said. Mr.
Blackall will, I am quite certain, do everything predicted of him by Mr. Ellison.

Mr. A. T. Blackall: I am very much obliged to you, Gentlemen. It is our duty now to propose someone for the office of Vice-President.

Mr. C. H. Ellison: It is a great pleasure to me to propose as Vice-President of this Institution our friend, Mr. Sayers, the Telegraph Superintendent of the Midland Railway.

Some of you no doubt know that Mr. Sayers has been the one man in this Institution during all the trouble we have passed through during the past 12—18 months, a trouble arising from our illegal position in the eyes of the law. It was necessary for someone to undertake to rectify that position, and I do not know how we should have got through if it had not been for the strenuous labours and the unselfish devotion which Mr. Sayers gave to the work, and I am sure we only pay a compliment to ourselves in electing him to-day as the first Vice-President, and I have very much pleasure indeed in proposing that you accept the nomination.

Mr. W. C. Acfield: It gives me very great pleasure indeed in seconding Mr. Ellison’s proposal that Mr. Sayers be our Vice-President for the ensuing year. As Mr. Ellison has said, Mr. Sayers has devoted an immense amount of time to pulling this Institution out of the fire, and making it what it is at the present time. To one who holds the position Mr. Sayers does, it has meant a great tax upon him, necessitating, as it has done, amongst other things, a great deal of consultation in London with the lawyers. It was entirely due to Mr. Sayers’ efforts that we were fortunate in getting the very best lawyers in the country to act for us. In speaking so highly in this connection, I should like to say that the unfortunate position in which we found ourselves must in no way be regarded as any reflection upon Mr. Byles, our first Secretary, who had so much to do with the Incorporation of the Institution.
Mr. Byles has, I know, felt it very deeply that the old Institution got into such an unfortunate state, and I take this opportunity of mentioning it, and of expressing our sincere regard for him, and our appreciation of his efforts as one of the pioneers of the Institution. Mr. Byles, as most of you are aware, now occupies the position of Signalling Expert to the New South Wales Government Railways.

Mr. C. M. Jacobs next proposed, and Mr. A. H. Johnson seconded Mr. Insell as Treasurer, and the same gentlemen proposed and seconded Mr. Cotterill as Secretary.

Mr. A. T. Blackall then said that according to the Standing Orders, two Auditors would have to be elected, and he would be glad if someone in the meeting would be good enough to submit a proposition. If he (Mr. Blackall) might make the suggestion, it was that Messrs. Cannon and Johnson would be very suitable gentlemen to act in the capacity.

It was proposed by Mr. J. R. Downes and seconded by Mr. A. Oldham, that Messrs. Cannon and Johnson be elected Auditors.—Carried unanimously.

Mr. A. T. Blackall next pointed out that the Articles contained the names of certain gentlemen from whom the Council should be elected, and suggested that it would be a good plan if someone proposed that the whole of the gentlemen mentioned in Article 23 should be appointed members of the Council.

Mr. R. G. Berry proposed, and Mr. A. Oldham seconded, that the gentlemen named in Article 23 be elected members of the Council, and this was carried unanimously.

Mr. A. T. Blackall: You see, I have been elected President in the last two or three minutes, and it would be obviously unfair to expect me to address you at any length. I believe I did so when I presidentially addressed the first meeting of the old Institution, but I propose to content myself with few remarks on this occasion.
When I accepted the office, which I felt to be a great honour, as President of the old Institution, I thought that my term would close with the end of the year, but our legal troubles have placed us in the position of having to begin life over again, and, Phoenix-like, we have risen from the ashes of the old Institution. We are now properly and legally constituted, and I hope there will not be any more trouble.

We were very unfortunate in losing the services of Mr. Byles, who took a great interest in the Institution, and who did his level best to bring everything to a proper conclusion. Owing to a legal quibble he got wrong, but no one regrets it more than he does. I am sure you will agree with me that we hope some day to see him at one of our meetings again.

Mr. Michôd, who acted as Secretary following Mr. Byles, and who has rendered very great services, has now felt it necessary to relinquish the position.

You will, of course, be aware that in the old Institution the eligibility of persons to become Members and Associate Members was rather restricted. It was required that they should occupy certain positions in railway service, and so on. In the new Institution we have considered it desirable to broaden the basis altogether, and we shall be able to welcome many gentlemen who, whilst not in railway service, are connected with the signalling industry as well as the signalling profession. I am sure these gentlemen will be a great acquisition to us.

Turning again to the difficulty we have been in, I do not think we should have extracted ourselves from the tangle but for the great efforts put forth by Mr. Sayers, and it is entirely due to him that we are a living Institution to-day. We all very much regret that having finished his task, which was entirely a self-imposed one, he has felt obliged, owing to considerations of ill-health, to refrain from any active part in our work for the present, and although we have elected him Vice-President, I very much fear he will not be able to act for some time to come. His loss is perhaps
the greatest misfortune we have had, but I hope that now we are rid of our troubles he will stand by us, and that he will soon recover his usual good health.

I do not think I need say much more, and in concluding these somewhat desultory remarks, I will ask Mr. Insell to read a Paper which he has been good enough to prepare for this meeting, on "Signalling and its connection with the Construction and Management of Railways."

The Secretary then read Mr. Insell's Paper on "Signalling and its connection with the Construction and Management of Railways," and on its conclusion Mr. Blackall invited discussion, which was opened by Mr. A. H. Johnson
Signalling and its Connection with the Construction and Management of Railways.

BY R. J. INSELL

(Member of Council).

The Incorporation of the Institution of Railway Signal Engineers is an important event in the history of signalling, and if the Institution is to be successful it is very necessary for all members and Associate members to endeavour to advance the science of signalling in all its branches.

The successful engineer of to-day must possess an extensive knowledge of the working and practice of many Departments, in addition to his own, and while some of you may think that signalling must not be too embracing, I hope during the reading of this paper to convince you that the Signal Engineer is the man upon whom future traffic managers of railways will rely for the lay-out and general arrangements necessary for the expeditious and safe transport of traffic.

The aim of the Institution is to secure the advancement of the science of signalling, and while great progress has been made in recent years much remains to be done, and to the younger members in a great measure the success of the Institution is a matter for serious consideration.

The Signal Engineer of the future will have to be a man of many parts, and if he is to take the position which a competent Signal Engineer is entitled to, there will be no lack of work for the Institution for many years to come. The formation of the Institution is, I hope, an earnest desire on the part of the members to increase their knowledge and practice in the art of signalling in order that when the time comes we shall have the men to take the positions, and carry out the duties of what I may call for want of a better term a "Line Transport Engineer."

Signalling enters very largely into the management of the railways throughout the world, and when we consider the
enormous number of trains, the working of which is safely controlled by the various systems of signalling, the Signal Engineer may claim to represent a very important section of railway management.

As the traffic of the railways increases, the duties and responsibilities of the Signal Engineer will also increase, and we should do everything in our power to improve the science of signalling in order that the new problems, which will no doubt arise, may be successfully dealt with.

The knowledge required by the Signal Engineer can scarcely be set forth in general terms, but it can be stated at once that long experience of railway working generally is very essential, as although there are definite principles to work upon, it is necessary to apply them in so many different ways that it is impossible to lay down rules and regulations to cover the multitude of cases which one must deal with from day to day. One of the most important functions which the Signal Engineer is, or should be, called upon to decide is the lay-out of Station Yards and Junctions, and it is in this connection that the science of our profession is of the greatest value, as the design and position of the various junctions should be that which will ensure the safe manipulation of trains, combined with economy in capital charges and working expenses and the use of the line to its utmost capacity. Such work can only be done satisfactorily by someone with a thorough knowledge of signalling, and of railway working generally.

In the early days of railways the lay-out of stations did not perhaps matter very much, as the traffic was not heavy, nor of such importance as it is to-day. With the constantly increasing traffic of to-day, however, the importance of laying out Station Yards in a scientific manner is obvious to all interested in the working of a railway, and the advent of signalling has been the means of bringing about great improvements in the lay-outs of railways generally, but much remains to be done in this respect; and it is to the Signal Engineer that railway managers must look if the work is to be done in a scientific manner.

It may be thought that the author claims for the Signal
Engineer important functions which should be undertaken by Traffic or other officers, but the duties of the Signal Engineer are such that his mind becomes trained in a manner which enables him to foresee not only what is likely to happen, but what must happen, when a yard is properly signalled and locked; and those of you who have prepared locking diagrams of complicated stations will, I think, bear me out in this. It is therefore in the interests of true economy and greater working efficiency of the railway that the Signal Engineer should be endowed with such power as will enable him to control the lay-outs of stations and junctions throughout the line.

Having put before you what the aim of the Institute should be, namely, the advancement of the science of signalling and the improvement of the position of the Signal Engineer, it will be necessary to see in what way signalling has improved the lay-out of junctions. That there is a right and wrong position for all junctions the Signal Engineer will be the first to admit, and seeing that so much depends upon the facilities at a junction for dealing with the various classes of trains using it, too much importance cannot be given to the way in which the junction is laid out. The signal box should be placed in such a position as will enable the various points to be worked therefrom, and, in addition, facilities should be given for holding trains waiting line clear without interfering with trains travelling in a different direction. Unless the Signal Engineer is consulted, it very often happens that these conditions are not fulfilled, and expense and delays which might have been avoided are incurred.

Various considerations have to be taken into account when laying out a junction, and the Signal Engineer who has previously made himself acquainted with the traffic to be dealt with, and having in mind the signalling requirements, knows exactly what is possible to enable trains to be accepted and despatched without any wastage of time or space. He will be in a position to ask for many conditions to be fulfilled which could not be contemplated by the Engineer without expert signalling knowledge.
Please do not think that this is a reflection on the Engineers, as I do not think they can be expected to know all the signalling regulations, and are mainly concerned in the safe construction of a railway, and when informed of the requirements may be relied upon to provide junctions suitable for the traffic requiring to use them. The point, however, which I wish to emphasize is that to the Engineer a junction is very little more than a pair of switches, but that to the Signal Engineer it may be, and very often is, a source of trouble in the particular position in which it is placed.

This source of trouble often remains owing to the great expense involved in making alterations. In the meantime, the Signal Engineer is perfectly aware that many delays might have been avoided if the junction had been laid in its proper position in the first place.

I should like to illustrate what I mean by a few diagrams. In diagram 1 is shown a junction leading from a double line to two single lines. You will observe that in this case it is not possible to have two trains approaching the junction at the same time without using the warning signal, and even when this is utilized it is not possible for more than one train at a time to use the junction. Such an arrangement is therefore bound to cause unnecessary delay. If, however, the junction had been properly constructed as in diagram 2, trains from A and B could be running at the same time as trains were proceeding in the opposite direction, C to D. The warning signal could also be dispensed with in the case of the trains using the single line C, as the junction points could be set so as to avoid a collision in case of an overrun.

It will, I think, be admitted that no Signal Engineer would allow the junction shown in diagram 1 to be laid in if he had the power to prevent it, as his training would at once detect the difficulty of dealing with the signalling of trains in a safe and expeditious manner.

In diagram 3 is shown a connection to a siding at a roadside station. The points in the main line are laid in some distance inside the platforms, which has the effect of shortening the platform from A to B, or destroying the safeguard of the
signalling if the signal is placed at A. It is obvious that the lay-out shown in diagram 4 is the correct method.

The practice of laying in a crossover road, as shown in diagram 5, to be used for single line working is well known to many of you, and it is clear not only from a signalling, but from a traffic point of view, that it is very objectionable, as not only can no proper protection be given to it by signals, but trains during single line working have to draw up twice, in addition to causing delay to trains travelling in the opposite direction.

In the case of facing junctions at the ends of platforms, it is necessary to allow for space between the points and the platform for the locking bar opposite the end of which the signal should be fixed, and where water columns are required sufficient space should be allowed in addition before the platform is commenced. If this rule is not observed it is obvious that either the platform is not used to its full extent or the signal must be passed and the engine stand on the points or locking bar, which will generally mean delay of some sort. Diagram 6 will perhaps more clearly show the two methods.

It should be mentioned that in laying out Station Yards, where more than one box is required, the connections should be so arranged that sufficient space is allowed for each box to work independently of each other, as it follows that unless this space is provided ordinary block regulations cannot be observed without considerable inconvenience. If block regulations are to be considered, no two boxes should be nearer to each other than 800 yards, and if this distance cannot be given it is certainly a question for consideration whether the whole of the work cannot be controlled from one box, seeing that a distance of 600 yards can be covered so far as the point connections are concerned. Many other instances might be given, but the foregoing will, I think, be sufficient so far as double lines are concerned.

The lay-out of single lines is of great importance to the Signal Engineer, as there are so many more problems to solve than in the case of double lines, and we are, I think, very far from perfect in the arrangements which at present generally
obtain. I should like therefore to set forth what in my opinion should be the ideal system. For crossing stations the loop should be formed in the manner shown in diagram 7. If this were done trains could run to the platform or starting signal from each direction simultaneously, without fear of collision in the event of an overrun, the provision of the dead ends preventing this, and at the same time allowing the home signals to be free of each other. The advantage of this system of lay-out, while being of great value when the line is level, becomes imperative if the line outside the home signals is on a gradient steeper than 1 in 260, as in such a case it is not permissible to stop a train at the home signal, and a free run to the starting signal should always be given in order that the whole train may be clear of the runaway catch point, which would be provided at the fouling point of the loop when the gradient of the loop makes it necessary.

In the absence of overrun dead ends where the gradient is steeper than 1 in 260, it should not be permissible to allow two trains to approach a crossing place simultaneously, and the second train should wait at the rear station until the first train has been brought to a stand in the loop. The delay to trains in such cases would be considerable, and could be avoided by laying out the loop in a proper manner.

The siding connections at crossing stations should be laid in such a position as will enable the loop to be used for holding trains of the maximum length running over the line, and diagram 8 shows how this can be done.

In order to avoid signalmen having to cross a running line or to pass under a train for the purpose of exchanging a staff or tablet, the author is of opinion that it might be an advantage to construct an island platform at crossing stations and fix a signal box between the lines, and at those places where platforms are not provided the lines should be widened out to give sufficient space for the signal box.

Under the Board of Trade regulations, it is not permissible to have siding connection on a single line where the gradient is steeper than 1 in 260, without the provision of a loop line which will enable a train to run in clear of a runaway catch point,
but as this involves considerable expense the author has designed a scheme whereby the loop may be dispensed with. This scheme is shown in diagram 9.

It will be observed that a facing dead end at A is provided in the single line, a train's length from the inner home signal B, and the locking is arranged in such a manner that before a train staff or tablet could be withdrawn for a train to travel from C, the lever working the points at A would have to be set for the dead end, and is locked in that position until the staff or tablet is restored to the instrument at C or D.

The points being fitted with a spring would then act as a runaway catch point while the train was doing its work over siding points E, and until it had proceeded on its journey towards F.

In the opposite direction the locking is so arranged that before a train staff or tablet is withdrawn for a train to travel from F, the lever working the facing dead end A is locked with the points set for the single line and would remain locked in that position until the train staff or tablet is restored to the instrument at F or D. In the event of a train from F having work to do at the siding connection G, the staff or tablet from F would be restored to the instrument at D and thus enable the facing dead end to be used as a safety siding while shunting was being performed. It is hoped that this scheme will enable sidings to be provided in those cases where the cost of the loop line has hitherto prevented such works being carried out. If this scheme is adopted very considerable expense would be saved by not having to provide the loop line, and less signalling work would be required; safe working in the case of trains on the down grade would also be ensured, and this is an advantage which the loop does not provide, unless a shunting spur clear of the main line is provided, involving considerable extra cost.

Runaway catch points are necessary on both double and single lines where the gradient is steeper than 1 in 260, and from a signalling point of view the position and number of those in use leave much to be desired.

In the case of double lines, the Board of Trade regulations stipulate that a runaway catch point shall be provided a train's
length outside the home signal, the distance being, of course, sufficient to provide for the longest train working over the section of line concerned, but if the line is on a continuous rising gradient, this is not sufficient, and each block section in such circumstances should be properly protected at the entrance and exit of the section on the up grade, as it may happen that after a train has passed the clearing point of box A, line clear is given for a following train before the preceding train has passed over and is clear of the runaway point outside the home signal at B. Now in the event of a breakaway occurring the section at A would be fouled owing to the absence of a catch point immediately in advance of the clearing point for A. Diagram 10 shews what is required from a signalling point of view. Where signal boxes are so situated that it is not possible to provide the independent runaway points for each section, the block regulations should be so drawn that not more than one train is allowed on the section of the line between any two catch points. On single lines the same principles should also be carried out, namely, that each section controlled by a staff or tablet should be properly protected at each end. The means for doing this will vary considerably according to the lay-outs of loops at the stations at either end, but diagram 11 will shew how the principle should be applied.

It would be necessary for regulations to be drawn up for the guidance of the signalmen as to the position the points should occupy during the passage of trains in both trailing and facing directions, and it is a question whether safety should not be ensured by interlocking the points with the train staff or tablet. Another important feature which I fear has been frequently overlooked in the past, is the position in which signals are fixed. It is most important that signals should be so placed that the block regulations may be properly observed, and at the same time give the utmost freedom in working. This applies particularly to distant and advanced starting signals. In the case of distant signals they should be so placed as to avoid the necessity of using the “Line clear to clearing point signal” whenever possible.

In the case of advanced starting signals these should be so
placed that the longest train can stand clear of any junction in the rear. This practice can be easily accomplished in most cases, now that we have the advantage of track circuiting the line which may be out of the signalmen’s sight.

Home signals may often be so placed as will avoid the use of the warning or section clear, or station or junction blocked signal, and intermediate signal boxes may be dispensed with by the provision of outer home signals. This latter practice is now made practicable in a number of cases by the use of track circuits.

In conclusion I would like to impress upon the younger members of the Institution the necessity and importance of studying the rules and regulations, and appendices to same, paying particular attention to those relating to the working of the Block Telegraph and Electric Token systems, as it is only by a full knowledge of the regulations that it is possible to properly carry out signalling schemes.

From these few illustrations it will, I hope, be seen that signalling enters very largely into the working of a railway and has become so important a subject of railway management that the time is not far distant when the Signal Engineer will take his place as one of the most important officers under the General Manager, or other official, responsible for the satisfactory, economical and safe working of the railway. The members of this Institution should one and all take their share in endeavouring to further the aims and objects in the interests of which the Institution of Signal Engineers was founded.

DISCUSSION.

Mr. A. H. Johnson: I think Mr. Insell’s Paper is a very good and a very timely one, and the subject is well chosen, because we, in this country, seem to have got into a position where we must go forward in Railway Signalling taken as a whole.

We have in the past, and I have said so in the Railway Press and other places, been obsessed by the Operating
Department. I do not think it has been the fault of the Operating Department at all, but it is a position which has been forced on them. The old engineers were followed by a state of things in which construction and design stagnated, because the roads together with signals, etc., had, to a large extent, been constructed, and it was quite natural that the importance of improvements in operation should, for a time, dwarf the constructional and engineering part of the business. Perhaps it was quite natural, and my view is that the Operating Department has been unintentionally forced into a false position; so much so, that you get young men writing to the papers saying that we, and the Loco. Engineers, and others of our Constructional Departments, are merely the servants of the Traffic Department.

Well, Sir, I venture to state that we will not allow ourselves to become the helots of another Department, for under such a condition, we cannot perform those great functions that should be expected of us. There is no Department which ever performed a great function in a great way, unless it has had free initiative to a great extent. Well, I think we are in a fair way to overcome this domination by the Operating Department. This Institution, I think, will do a great deal towards that end, but it will take time, of course. We are not the first in the field: the Americans, as usual, have got ahead of us in late years. They have formed a great Institution of 1,200 members, and affiliated with them is a powerful Contractors' Association, and they are doing a great work. They are, many of them, 'Varsity men, but they have not the advantage of the length of our experience in this country; most of them are men of 10 years' experience, and so on, and they are using their Institution as a means of education by trial and error; all that is nothing against them, for they are doing a great work.

Coming to the details of this Paper, there is nothing I can criticise at all. It is, as I have said, a very timely Paper, bringing forward as a subject the lay-out of the roads. We have had to do this road-planning, but it has
been accepted from us grudgingly. The time will come, as Mr. Insell says, when we shall do it as a regular thing. One thing I did not quite understand referred to what I call the sub-division of a long block section by an extra signal. He prefers doing it by means of an Outer Home. I was disappointed, because I understood the G. W. to prefer treating the sub-divisional signal as an "Advance." There are present rules applicable to the use of an "Advance" for such a purpose.

Mr. Insell urges the members of the Institution to make themselves conversant with the Rules and Regulations, and I agree that our people have neglected this feature in the past. Most of us were raised in the Signal Department, where we had nothing to do with block working; this used to be thought to concern the Telegraph Department alone. It is necessary that we should be masters of the whole subject, whether Interlocking or Block Signalling.

Mr. A. Hurst: Mr. President, there are one or two things, I think, which we might consider in connection with the Paper we have just heard, and which I quite agree with Mr. Johnson is a proper subject to bring forward, and at a very opportune time, because I feel that we shall have to go ahead, and we must make a position for ourselves. I do not quite take the same view of Railway Signalling, perhaps, as everybody else, for we must remember that it has grown gradually; that the first great advance which took place in it was the introduction of the Block Telegraph System, and that rather took the signalling, for the time being, out of the hands of the Engineer and put it in the hands of the Traffic Department. That was the starting point of their growth, and they have grown to a point now when they cannot manage all their concerns, and they will have to come back to the Signalling Department to help them. In the meantime, we have turned our attention to the mechanical side of signalling, and it has grown steadily during the interim. During 30 years it has made many strides, because everything connected with it has grown
and has changed, with the exception of the bare outline of the post. We have been called upon to deal with signalling in different ways to anything before, partly because of the natural growth of the traffic, and partly because the Traffic Department required additional facilities, and put before us problems which never were thought of in the early days. The Signal Engineer must be prepared to grapple with any problem put before him, and to solve it in such a way that whilst making provision for absolute safety, he gives at the same time the greatest possible facilities for traffic working. How are we going to attain that which Mr. Insell has put before us? There are many ways in which Lines might be arranged to give better facilities than we have now, and it is our business certainly to see that those arrangements are carried out properly. We know, for instance, that a crossover between two platforms is a difficult thing to get rid of. The Traffic people like it; we do not, and it is our business to see that we get rid of it.

Our signals should be placed so that we give the greatest possible facilities to drivers to read them (a point requiring much care and study) and not only to place them, but be very careful with respect to their grouping, and to use all the other means we have to assist the drivers to read them with the greatest amount of ease and least likelihood of mistake.

Then again, we have many problems to solve with regard to providing additional signals. It may be an Outer Home, an additional Starting Signal or Intermediate Signal, and it is our duty in making our suggestions to have good reasons for the position of the signal, and to tell the Traffic Department what the effect will be on traffic working. If we do not do this, then we shall not rise to the high position which has been foreseen by Mr. Insell and Mr. Johnson, but if we do, and make up our minds what the effect of its position will be and tell the Traffic Department so, and they come to rely upon us for so doing, then we attain the greatest object that a Signalling Expert can rise
Mr. A. Hurst.

to, that is, determining the position of the signal and the
way the Line shall be worked.

I think the Institution will give us the means of coming
together and comparing notes on working questions; of
hearing discussions and papers from time to time upon
subjects which are special in themselves, and which may
direct our energies into other channels. Unfortunately,
I know, to my cost, that different Railway Companies have
different systems of working, and unfortunately some have
the unhappy knack of making the permanent way so com-
plicated that the difficulties of signalling are very great.

These are things which we should study, because we may
move from one railway to another, and we should all have
at our fingers' ends the means of dealing with any problems
which may arise. Keeping this in view, I think it is very
desirable that we should make ourselves acquainted with
other systems which may be brought to our notice, and with
the complicated as well as the simpler methods adopted of
putting down the permanent way, as to enable us to make
alterations, simplifications, and so forth. Then again,
there are methods which differ on various railways and
should be studied.

In Mr. Insell's Paper he states the Board of Trade
require that no siding shall be put on a falling gradient
steeper than 1 in 260. This is perfectly correct, normally,
but the Board of Trade will allow such a siding to be put in
upon a gradient of 1 in 260 conditionally upon the engine
being always on the lower side of the train. Then again,
we have other difficulties to contend with in permanent way
connections: for instance, there are many ways of dealing
with long trains at stations, and the lay-out of station yards,
but we all find a difficulty in this country because our yards
were mostly bought in the early days when the land pur-
chased was comparatively limited, and they have been,
and are being, built round about, and we can, in many cases,
no longer get the facilities necessary. Then again, we have
the difficulty arising from short sections. It is very nice
to have as an ideal that we should put our junctions half
a mile apart, but, in practice, we cannot always so arrange them. These are points requiring a great deal of study, and we should be alive to the problems, for we never know how or when they may come before us.

We can help the drivers in many ways: First of all, by grouping our signals; secondly, by the arrangement and height; and, thirdly, by the size of the arms or lights which are exhibited. If that is correctly and carefully done, I feel quite sure it does help the drivers very much. We do, occasionally, have complaints which require careful consideration. I do not say that I am doing differently to other people. Every signalling engineer is doing the same work throughout the country, though the methods vary in detail, some being more complete than others; but what I would impress upon the younger members is that there are many ways in which they can be of assistance to the driver. As I have said before, the provision of facilities for working the traffic and the ensuring safety are the two points upon which our whole being hangs.

Mr. A. Oldham: Mr. Insell, in his remarks with regard to diagram No. 9, says that "the locking is arranged in such a manner that before a train staff or tablet could be withdrawn for a train to travel from C, the lever working the points at A would have to be set for the dead end, and is locked in that position until the staff or tablet is restored to the instrument at C or D."

I should like to ask if it is arranged to set the points of the facing dead end A for the single line before a staff is taken out at D for a train to travel from D to C. This would appear to require a special arrangement, seeing that the same staff, when taken out at C, is arranged to lock the points to act as a catch point.

When it can be arranged to keep the engine at the lowest end of the train, it is possible to work the traffic into the siding in the following manner:

The points of each crossing should be connected to a small lever frame, this frame being controlled by the staff.
Mr. A. Oldham

The locking in the frame being arranged so that the facing points of the crossing at E are opened to lead into the siding before the crossing at B can be used. The train proceeding from F with engine in front, that is, at the lower end of the gradient, stops clear of the crossing E. The wagons to be put into the siding are then uncoupled and the engine moves forward with them clear of crossing B, leaving the rear of the train clear of crossing E. Before the crossing B is opened for the wagons to be put in or taken out of siding, the facing points of crossing E are opened, so that if the rear part of the train started away, it would move into the siding.

This arrangement saves providing the facing dead end points which are somewhat objectionable, and no signals are required, seeing that the frame is controlled by the staff.

Mr. R. G. Berry

Mr. R. G. BERRY: With regard to Diagram No. 9. We have a point at A which is used in one direction as a runaway catch point, and that is fixed sufficiently behind the Home Signal to allow the longest train. On the Lancashire and Yorkshire, it would be fixed 900 yards in the rear of the Home Signal on a double line. I take it that that point is within the working distance of the box. Had the Board of Trade sanctioned a point like that on a single line in their Regulations?

On page 20 it is said that "the locking is so arranged for a train coming from F, the lever facing the dead end A is locked with the points set for the single line, and would remain locked in that position until the train staff, or tablet, is restored to the instrument at F or D. That means to say that restoring the staff at D liberates the locking on these points. Are these points again held by a tablet taken out at D when the train is proceeding to C?"

On Diagram 10 we have a runaway catch point in the rear of the Home Signal for B sufficiently far behind the Home Signal to hold a train. Another catch point is provided ahead of the Starting Signal for A. In that case,
what is the utility of the catch point in the rear of the Home Signal for D? Why not dispense with this catch point, simply retaining the one in advance of the Starting Signal for A?

In Diagram No. 11: What is the utility of the catch points on the outlet crossing?

On page 21, I should like to be quite clear what Mr. Insell means by "Using the Line Clear to Clearing Point Signal."

Mr. R. J. INSELL: With regard to Mr. Johnson's remarks, I do not quite understand his reference to rules for working Outer Home Signals. Perhaps he will quote some particulars. I have nothing in mind in the rule which governs the working of an Outer Home signal; nothing at all; so far as I know, the ordinary Block Regulations apply.

We have dispensed with a number of signal boxes by providing Outer Home Signals. Mr. Johnson said we should study Rules and Regulations. I am inclined to think we ought to make them and let somebody else study them.

Mr. Hurst said there were exceptions to sidings on gradients considerably within 1 in 260. In my Paper I am working by the Board of Trade Regulations. Exceptions are granted under certain conditions, such as engines in the rear, or heavy brake vans, but we must deal with the Regulations as they stand.

Mr. Hurst also referred to junctions being half a mile apart. I referred to signal boxes.

Regarding Mr. Berry's remarks, 900 yards is rather a tall order on a single line with a gradient of 1 in 260 for a runaway catch point. On a line where the scheme will apply, the gradient perhaps will be 1 in 40, where the load will be reduced to 20–30 wagons, but the facing point at A must be, of course, within 250 yards of the Signal Box to enable it to be worked.

With regard to Diagram No. 10, the necessity for the second catch point naturally, of course, depends upon the distance between the starting signal for the box in the near
and the catch point for the box in advance, and we should be
guided by circumstances as to whether a second catch point
is necessary. If on a continuously rising gradient, and
there is a margin of a half to three-quarters of a mile
between the Advanced Starter for one box and the catch
point outside the Home Signal for the box in advance, some
precaution is necessary. It depends entirely on the distance.

With reference to the catch points in the top end of the
loop, referred to by Mr. Berry, these catch points are
required in the event of a train breaking away on its journey
up the gradient. Such catch points act as a trap until the
train has arrived at the station in advance; otherwise, a
train which may be accepted from the rear would be liable
to be damaged by a collision.

With regard to the “Line Clear to Clearing Point:
Signal”: Where a distant signal is not sufficiently far
from the Home Signal to which it applies to enable a driver
to get his train under control, a bell signal is used in con-
nection with the Block Telegraph, and the signalman in
the rear keeps his Distant at Danger to provide a repeating
signal for the man ahead at a sufficient distance.

With regard to Mr. Oldham’s remarks. Trains going
from D to C would be controlled by fixed signals. If you
like, of course, the train staff or tablet working from D to C
could also be made to lock those points for the single line,
but that seems to be unnecessary, seeing that you would
have a signal at the facing points.

With regard to his ingenious mode of working sidings
by means of an engine in the rear, if the gradient should
happen to change after the siding, I do not know what he
would do. It can be done by having one in front and one in
the rear.

If my Paper is the cause of any suggestions or improve-
ments, I shall be only too pleased.

Mr. A. T. Blackall: I think we should not part with-
out suggesting that someone should propose a vote of
thanks to Mr. Insell for his Paper. I should like to say
Signalling and its connection with the Construction and Management of Railways.
that it is a very great pleasure to me to see such a good attendance to-day. I rather thought that our recent trouble might perhaps have caused interest to wane, but, on the contrary, the attendance is most satisfactory, and augurs well for our next meeting.

Mr. J. T. Roberts: I have much pleasure in proposing a vote of thanks to Mr. Insell for his interesting Paper.

Mr. L. M. G. Ferreira: I have much pleasure in seconding this, and in doing so I must say that I think Mr. Insell has given a lead to some of the younger members as to what branches their study should take.
Colours and Colour Blindness.

BY MR. ARTHUR HURST
(MEMBER OF COUNCIL).

In order to successfully deal with the practical use of colours for signalling purposes, and to know how far colour blindness of varying degree affects the use of such colours, it is obviously necessary that we should at the outset realise what colour really is, and to some extent how it is produced.

Strictly speaking, the appreciation of a colour is merely a sensation produced in the eye by the observation of some substance having certain properties; and conveyed from the eye to the brain through the connecting nerves. But as all substances have not the same properties, we get, on observing different substances the varying sensations which give to us the idea of colours which we call red, blue, yellow, etc. This is best observed by taking a ray of sunlight which is the purest and whitest light we possess or can conceive, and splitting it up in such a manner that it produces the sensation which we call colours, when we find that it is really capable of producing every possible sensation, giving us the idea that it is composed of all the known colours which are always produced in the same order. Nature has shown that this is possible in the case of the rainbow, and man can produce the same colours in the same order by means of the spectroscope. As, however, all the colours mixed together in certain proportions compose white light, it follows that if we take one colour away we no longer have white light, but merely the remaining colours. Supposing that we pass a ray of light through a piece of glass capable of absorbing all the red in such ray, then only the other colours will be transmitted by the glass, and we shall see green which we call the complementary colour to red.

The sensations giving the idea of colours are conveyed from the substances producing them to the brain by waves
and just in the same way as we have heat waves, sound waves, and electric waves, so we have light waves of definite and known lengths, those at the extreme red end of the spectrum being 76,040 per meter, or 395 millions of millions per second, and those at the extreme violet end of the spectrum being 89,830 per meter, or 760 millions of millions per second; the figures for the other colours falling between these extremes.

Colours may be produced in various ways: thus we have colours produced by dispersion as in the spectroscope and the rainbow. Again, colours may be produced by interference which alters the wave lengths, and so produces another colour. Another way is by giving out light previously absorbed as in phosphorescence. But by far the commonest way of producing colours is by absorption; indeed we may consider that for all practical purposes colours are produced by absorption or filtration, whilst for scientific purposes the purer colours produced by dispersion, i.e., those of the spectroscope, are employed.

The production of the spectrum band, as seen in the spectroscope, is due to the fact that various colours have, besides a difference of wave lengths, a difference of refrangibility, so that if a ray of sunlight is passed through a prism it is refracted, but as all its component colours have not the same refrangibility they are spread out in a continuous line or band called the solar spectrum.

The production of the spectrum band depends upon the principle of refraction, and is explained by a reference to the diagram (Figs. 1 and 2). In Fig. 1 a stake ABC standing up in a pond of water when viewed from the point D appears as if bent in the middle and to take the form ABE. This is due to a law in physics, which may be briefly stated thus:

"When a ray of light passes through any substance of greater density than air it becomes refracted or diverted from its pathway; thus we see that the portion of the stake BC as viewed by the eye is seen partly through the air and partly through the water, and the line of vision DFE
becomes refracted at the point $F$ where it penetrates the water, from the line $FC$ to the line $FE$, and hence the stake appears to the eye to the form $ABE$. To apply this principle to the spectrum: a ray of light travels from the sun and is passed through a prism $XYZ$ which it enters at the point $E$, where it is refracted from the straight line across to the further side of the prism, and again refracted or bent upwards. As, however, all colours are not of the same refrangibility, the colour with the greatest refrangibility takes the path shown from $E$ through $AF$ to the point $G$, and that with the least refrangibility, from $E$ through the path $BH$ to the point $K$, and thus the spectrum becomes spread out in a straight line from $G$ to $K$, $G$ representing the violet light and $K$ the red end of the solar spectrum, the other colours following between these points according to the amount of the refrangibility."

The production of colours by absorption may be thus explained:—If we take a plain surface and cover it with some substance which has the power of absorbing one or more of the colours and throw upon it a ray of light, only those colours will be reflected which are not absorbed by the substance; thus, if the substance used will absorb all the red out of the solar spectrum then the mixture of the other colours which are reflected will be a more or less pure green. Again, if we take a piece of glass which is capable of absorbing or filtering all the red out of the ray of light then the other colours transmitted give us the sensation of green.

As we might expect, some persons are found physically incapable of receiving the impression of colour, and we then term them "colour blind," but there are other persons who are able to distinguish some colours but not others, and these we term "partially colour blind." But as there is in every case a very serious risk of such persons misinterpreting signals by not being able to appreciate the colour exhibited, it is clearly necessary to take precautions by eye-sight examination and by rendering the colours used in
signalling as distinct and as little liable to be confused with others as possible.

The older theory of colour blindness was that there were three sets of nerves connected with the eye, sensitive respectively to red, yellow, and blue, and if one set of nerves was defective the person was described as red, yellow or blue blind. There are many reasons for regarding this theory as not adequately accounting for the phases and peculiarities met with in those who are colour-blind, and it seems more probable that it is in the eye itself and not in the nerves where the defect is really situate. Be this as it may, modern practice has shown that persons who are at all colour-blind seem invariably to be unable to distinguish orange when the rest of the colours are clear to their perception, and as orange is in practice composed of red and yellow, it would indicate, according to the older theory, that the red and yellow nerves were affected, yet the person may well be able to distinguish the red and yellow, showing thereby that both nerves are active. It seems better, therefore, to assume that it is a certain number of vibrations to which the eye is unresponsive, though it may be to other vibrations greater or less in number per second.

There are six colours in the spectrum as seen by a normally sighted person, viz., red, orange, yellow, green, blue and violet, but there are a few persons who see a seventh which consists of a dark blue band in the blue portion of the spectrum. It follows, therefore, if we regard the six colours forming the spectrum for normal sight that persons with defective colour vision may see 5, 4, 3, 2, or 1 colours, as illustrated in Diagram 3.

Dr. Edridge-Green has proved after examination of a large number of persons that the colours seen by those persons who can only distinguish five colours are red, yellow, green, blue, and violet; those persons who see four colours distinguish red, yellow, green and violet; and those who see three colours distinguish red, green and violet. Those persons who see two colours are not always the
same; some distinguish red-brown and violet, whilst others distinguish red-brown and violet with a neutral band between, and those persons who can only see one colour distinguish red-brown. These colours are set out on the diagram as given by Dr. Edridge-Green, but it will be observed that the red becomes a brownish-red below the Tetrachromatic vision. Those persons who are totally colour blind see everything in shades of grey, much as we see an Indian-ink drawing. It should also be understood that where a person fails to distinguish a colour at all he will see it as grey, but in certain cases where the eye is not quite insensible to that colour the grey will doubtless appear as if tinged with the colour, but not sufficiently so to be clearly appreciated.

But just as in the case of a blind person other faculties such as touch and hearing are very much more greatly developed than in the normal person, so in the colour blind we often find that their appreciation of the varying amount of light reflected or transmitted as a colour, gives them a more accurate knowledge of the colour employed than would be appreciated by a person of normal colour vision. Thus we find that persons with a Trichromatic vision are able to distinguish very readily between the yellow of a primrose and the blue of the sky, but if the colours are modified in character by being mixed with grey, or seen through some semi-opaque substance which renders them comparatively dull in tone, then we find that they are quite unable to distinguish the one from the other.

We are indebted to Dr. Edridge-Green for first drawing attention to this fact, as he found that persons who were really partially colour blind could, and did, pass the Holmgren wool test for colour blindness, but when tested with a special lantern which he designed, and which was fitted with glasses which could be interposed in front of the colours so as to affect their respective intensity, then their deficiency in colour perception was at once revealed.

Having now very briefly shown what effect colour blindness of various degrees has on the true perception of
colours, it will, I think, be well to consider what are the
best colours for signalling purposes.

Taking the solar spectrum as seen by a normal sighted
person, who, it will be remembered, distinguishes six
colours, it will be quite clear to everyone that the two
colours at the extreme ends must be the most distinct
because they are furthest apart, which means that both their
respective vibrations and their angles of refraction differ to
the greatest extent. Unfortunately, the violet of the
spectrum is a colour which we cannot match in practice;
the nearest we can get is a violet tone of purple formed of
red and blue, both of which colours are less refrangible and
have less vibrations per second than the spectrum violet,
so that we must substitute for the violet the next colour on
the spectrum which we can produce, viz., blue. By the
same process of reasoning, the next most distinctive colour
would be green because it is midway between, and there-
fore most distinct from the red and violet, but as we are
compelled to move the top of our practical spectrum further
down by omitting the violet, the green we use must incline
rather to a yellowish than a bluish tone to be more easily
distinguished from the blue. If, however, we ignore the
blue altogether, then we naturally select our green at about
its purest tint, neither inclined towards yellowish green on
the one hand or bluish green on the other, and hence it is
that for practical signalling we choose red and green as
the most distinct and most easily seen colours.

But let us go a step further. The next most easily dis-
tinguishable colour between the red and the green is yellow,
which is situate midway between them, and on the upper
side of the spectrum, the blue inclined more towards violet
than green; whilst the least easily distinguishable colours
are the orange, the violet-blue, the yellowish green, and the
bluish-green, and as we might expect, the first colour which
is indistinguishable by those partially colour blind is the
orange, the second blue, the third yellow, and the fourth
green.

There are, however, one or two points which we should
note:—When we consider the very pure colours of the spectrum we observe that each of the six colours are simple colours of themselves, that is, primary colours, and not like the secondary colours made up of two of the primary colours mixed together. If this were not so, such a colour as orange would by the varying refracting powers of its component parts, red and yellow, be separated with a blank space between, but as this does not occur it proves conclusively that orange is a distinct colour.

Moreover, although the whole of the colours of the spectrum mixed together produce a white light, we may also produce white from the mixture of various colours, as for example, yellow and blue when mixed together produce white, but if we mix yellow and blue pigments together we obtain green. Clearly, therefore, the pure colours of the spectrum must be considered quite apart from the colours we employ in practice and which we term pigments, stains, dyes, etc.

We should also do well to remember that the colours generally seen in nature are merely the unabsorbed portions of light which are reflected; thus grass, which appears to us green, has really no colour in itself, but has the property of absorbing all the colours excepting the green which is accordingly reflected, and conveys to us the impression that grass is green.

To turn once more to practical considerations, in pigments we have a distinct variation from the spectrum colours, for we find that we have three primary colours, red, yellow and blue. All the other colours are compounded of them. If we mix any two of these primary colours together we obtain the secondary colours, viz., orange—from yellow and red; green—from yellow and blue; and purple—from red and blue; by mixing the secondary colours we obtain browns and greys, and finally by mixing all the colours we obtain a dark grey or black, in contradistinction with the white produced by the mixture of the spectrum colours. This is due to the impurities in our colours, and partly to the fact that we have no violet of the colour of the spectrum.
We should also remember that just as we have impure colours to deal with, so we have impure lights. Those lights produced by burning gas or oil give a yellow light which shows that besides the white light there is present a considerable quantity of yellow, green and red, and if this is passed through a glass capable of absorbing all the red and yellow, there still passes through a larger proportion of green than would be transmitted by an absolutely white light, so that the resultant colour, instead of being blue will be a greenish-blue, and this is precisely what takes place in our signal lights when we use a bluish-green glass with a yellowish light behind it; the bluish shade is converted into a distinct green, and for the same reason the red glass used before a yellow light should incline more to ruby red than orange, so that when modified by the yellow light it will appear a good red.

In conclusion I would point out that those colours which have the least refrangibility are the most penetrating, whilst those of the highest refrangibility have comparatively little penetrating power; thus red has the greatest penetrating power of all colours, and blue the least (excepting, of course, the violet of the spectrum which we cannot reproduce), and consequently it is very gratifying to know that red—the colour we use as a "Danger" signal—has the greatest penetrating power of all colours, and that green, although not so good in this respect, is the colour practically most easily distinguishable from red. I say practically because blue is really more distinct from red than green, but there are three difficulties in its use, firstly, that it has very much less penetrating power; secondly, that it becomes modified by a yellow light, and to keep its colour would have to be very dark, introducing a lack of luminosity; and thirdly, it is less easily recognisable by partially colour blind persons than the green. Clearly, therefore, our standard red and green lights are the very best colours which it is possible to select, without introducing other difficulties, for the purposes of signalling.
DISCUSSION.

Mr. Fleet: This paper will undoubtedly raise a good deal of discussion, but unfortunately I have not had time to give it the necessary thought and study to enter into any criticism of it. The paper as I see it tells us more definitely what we Signal Engineers want to know, and proves—it seems to me—that the decision we have come to and the colours we use, without any doubt whatever, are the only real distinct colours which can be used; but no doubt some of our friends here will talk to us about yellows and oranges before the meeting closes. It is a pity, I think, that the colours shown on the cartoon cannot be reproduced in the paper, but I understand that it is only possible to do the work by hand, which would be a very long and tedious business.

We have all heard of the alternative colours for Distant Signals which are proposed, and the older we are the less time we give to the consideration of these propositions, the younger the greater. Because without doubt these lights in yellow and orange have been tried and thrown away in this country: In Newcastle, for instance, years and years ago, and were given up as not being comparable with the distinct lights we get by using green and red only, excepting of course the white under the existing circumstances.

As regards criticism, I am afraid I am not in a position to say more.

Mr. Whysall: I should like to know what happens when a ray of light strikes a surface passing into a denser medium. What way is it refracted on striking the surface at right angles?

Mr. Hurst: It is refracted from the normal. If, however, it penetrates the surface of the medium at absolute right angles, there would be neither refraction nor reflection. Refraction only takes place if the ray strikes the surface obliquely. In the case of a ray of light striking a prism at right angles it penetrates the first surface without refraction,
but would be refracted by the opposite side, which it strikes at an angle. If it goes through one facet at right angles it must strike the opposite facet at an angle, but if it strikes the first facet at an angle it may also strike the other facet at an angle, and it is because we get this double refraction that we use a prism. When, however, it is intended to make an accurate measurement of a spectrum a series of prisms, sometimes four or five, are used, and the rays are split up by each succeeding prism, so that they are spread out to a considerable extent.

Mr. Whysall: There is one question I would like to ask in relation to signs, notices, placards, etc., as to the most favourable colour combination for rendering them legible at a distance. I think it is generally considered that black and white give the best result, but according to an article I saw in "Popular Science Sittings" of 5th April, 1913, this is not the case. In this article it is stated that experiments had been made (I believe in France) to ascertain the best combination of colours, and it was found that the most legible print was black letters upon a yellow background. I am inclined to agree. The order of merit obtained for different combinations tested is somewhat surprising, and is as follows:—

(1) Black on yellow  (8) White on red
(2) Green on white  (9) White on green
(3) Red on white    (10) White on black
(4) Blue on white   (11) Red on yellow
(5) White on blue   (12) Green on red
(6) Black on white  (13) Red on green
(7) Yellow on black

It will be noticed that the customary combination of black on white is placed sixth on the list or about half-way down. I would be glad to know if Mr. Hurst also considers black and yellow the best combination, and if so, can he explain to us the reason why it should be so?

Mr. Hurst: Referring to Mr. Whysall's remarks, I can...
Mr. Hurst: Well understand, though it did not occur to me before, that yellow and black are more easily discernible than black and white. This probably arises from the fact that the contrast is not so severe to the eye, and consequently the two colours are more readily appreciated than if the contrast was greater. I do not think, however, that the yellow light would be a useful one for Distant Signals. I am firmly of opinion that red and green are the best colours to use. Neither do I see any necessity for another colour for Danger Signals. Red is the colour which most readily arrests attention, and it seems to me to be a pity to depart from it by substituting yellow, which we often term "white."

Mr. Fleet: I suggest whether the other question of fugitive lights should enter into the discussion as well as reflections. Drivers sometimes see a distant green light from reflection. A flash from an electric train wire has got behind a glass, and the driver has taken it as a green signal although a distance of 100 yards away. If one had time to do so, such things could have been woven into this paper.

Mr. Hurst: Cases have been known before and have, as a matter of fact, formed the subject of conversations between myself and the Board of Trade Inspectors on several occasions. It is always possible for a light used at one point to impinge upon a green or red glass of a spectacle of a signal at another point, and to be reflected by the coloured glass to another point, and it has in such cases been known to mislead a driver. This does not often occur, and depends upon peculiar circumstances, namely, that the reflection does not take place from the first surface of the glass in the signal, but from the second surface of the glass. If it was reflected from the first surface of the glass it would be reflected as a white light, for it would not have been through anything to colour it. The fact that it is reflected as a coloured light shows that it must have passed through the coloured glass and that the surface which reflected it.
back must, therefore, be at the further side of the glass. It is probable that this will only take place when the first reflected surface of the glass is covered with a film of dirt or moisture which renders it incapable of reflecting the light.

**Note.**—Mr. Hurst was subsequently asked if he did not think that the lens at the back of the spectacle was the reflecting medium, but he thought not because the lens is curved in both the vertical and horizontal directions and, of course, in an intermediate position. If the light was reflected from the lens out of its true position horizontally, it is only natural to expect that it would be reflected out of its own true line vertically, and we should expect, therefore the reflection to be considerably higher than the original light. There does not appear to be any evidence that this was the case. Besides this, the cases referred to as forming the subject of conversation with the Board of Trade Inspectors took place when the light was seen at the back of the signal, and the lens, therefore, could not have had anything to do with it.

**Mr. Berry: I have two questions to ask.**

With reference to the production of colours by absorption, paragraph 2, page 34 of Mr. Hurst’s paper. What would happen if a ray of light were thrown on to a substance which would absorb the green—that is, what colour would the mixture of the remaining colours give?

**Mr. Hurst: Red.**

**Mr. Berry: With respect to Mr. Hurst’s statement, page 38, that yellow and blue mixed together produce a white light. Does that mean that any two colours of the spectrum produce white light?**

**Mr. Hurst: No, only certain colours. The white light of the spectrum is an absolutely pure light. It contains the various spectrum colours in fixed proportions which, if**
Mr. Hurst: Mixed together in their proper proportions, give a white light, but if an excess of any one colour exists, it of course shows that colour. It is possible to produce a white light by the mixture in certain proportions of less than the full number of the colours of the spectrum. Thus, yellow and blue mixed together also produce a white light, but as you could not produce any other colours but blue and yellow from this white light by refraction it is probable that there is a difference between the two which we cannot distinguish by the eye. If, however, we take blue and yellow produced, not from the spectrum, but through coloured glasses, and throw one over the other, we produce a kind of pink, not pure white. It is quite clear that this pinkish white has not the properties of a pure white light.

With regard to the further question as to how colours could be mixed together, the colours produced from the spectrum could, by suitable reflectors, be thrown on to the same screen.

I might perhaps give a little more complete answer to Mr. Fleet's question whilst we are speaking about reflectors. Reflection is quite different to refraction. In the latter case you alter the light by breaking it up into its component parts, but in reflection you merely alter the course of the light as it appears. If you could throw a light on to a piece of paper it is simply reflected, and you see the paper white because the white light is thrown back from its surface; but if the paper is covered with a pigment, say, of the colour which we call green, it only means that you have covered the paper with a substance of imperfect absorption, i.e., capable of absorbing most of the colours except green, and you get the other colours which are not absorbed reflected. These probably consist of other colours besides green, but the green preponderates; and the other colours, like impurities, simply modify the shade of the green from its more pure form, and we see a modified green.

Mr. Fleet: Mr. Hurst has not distinctly referred to eyesight tests. Can he give us any information?
As violet appears to be one of the last colours to disappear, that is, you can see violet longer than any colour, do you consider it would be a very good colour to use if you could get the exact spectrum colours.

Mr. Hurst: Eyesight test is touched upon briefly in the paper, because it is one of those points which must vary with the opinion of the person conducting the test and also with what you wish to arrive at. There are two general forms of testing for eyesight adopted in this country, one of which is known as the Holmgren wool test and the other is the lantern test. I mentioned that persons who were colour-blind could pass the test of Holmgren wools under certain circumstances, and the lantern was mentioned as being the invention of Dr. Edridge-Green, to whom we were indebted for finding out that persons partially colour-blind could pass the Holmgren test. That test consists of a number of coloured wools all mixed together, one of a certain shade being handed to the person under test, who is told to pick out the wool that most nearly matches it. If he is not colour-blind he will, of course, pick out all the shades approximating the colour and shade which has been given to him; for instance, if a green wool, and his eyesight is perfect, he would not put yellow or red with it but match it with a green, but if partially colour-blind he might match a green with a grey, a blue, or even a red. It is usual to assort these wools in such a manner that the selection gives an indication not only of the fact of colour-blindness but of the extent and direction which it takes, and further tests are made by giving wools of certain colours and shades, the imperfect arranging of which confirms the indication as to defectiveness in colour vision indicated by the preliminary tests. This does not get over the difficulty that where the eye is irresponsive to colour it has left that second sense of telling colours by their brightness or luminosity, and consequently a man may match a green with another colour because the two give off practically the same amount of light, although the colours are different, and consequently
the man is able to match the wool according to brightness, though of different colours, and the test accordingly fails.

Now Dr. Edridge-Green introduced a lantern having slides of coloured glass, very small, not more than $\frac{1}{2}$-in. to $\frac{1}{4}$-in. at most in diameter, which could be put at pleasure in front of the lantern, and not only one, but two or three slides could be put one over the other. He found that if a man was partially colour-blind, say tetrachromatic, although he might be able to tell the yellow from the blue when shown alone, yet when a slide representing grey (ground glass if you like), which threw a kind of fog over the colour exhibited and thus altered the luminosity of the colours, he failed to distinguish them, showing conclusively that his eyesight was defective, but that he used a second sense, that of distinguishing by luminosity to eke out the deficiency in his colour vision. I think, therefore, that the lantern test will probably become the one of the future. It is already very largely used.

Mr. J. Harradine: I was going to raise the same question with regard to the violet end of the spectrum. It is very interesting to notice that in nearly all the diagrams the violet end maintains. This fact may have a bearing on Mr. Hurst's remarks in his paper as to whether partial colour-blindness is a defect in the eye or a defect in the nerve.

We must bear in mind and should commence by saying the rays of light striking the retina of the eyes, the effect is afterwards conveyed by the nerve to the brain. As a matter of fact the violet end of the spectrum is produced by 760 billions of vibrations, indicating even in the case of persons who are partly colour-blind that the retina is very sensitive and does respond to the highest number of vibrations. Going further, we find in the case of people who are colour-blind or partly so the red drops out. According to the diagram, they see nothing below the brownish red. As the red has the least number of vibrations on the spectrum, and the brownish red is of a higher order,
it seems that in colour-blind people the retina is capable of
vibrating to its maximum, but not of responding to the
minimum number of vibrations.

This I think is rather interesting, and would indicate
perhaps that it is not so much a defect of the eyes as
a defect of the nerve connected with the red centre or that
portion of the retina which vibrates to the red end of the
spectrum.

The question has been raised as to yellow and blue
when mixed forming white light. Does Mr. Hurst mean
by that that it is white light as we know it from the rays
of the sun, or does it refer to the actual white as on the
paper?

Mr. Hurst: Unfortunately this is not the case, because
the first colour which disappears with every colour-blind
person is the orange. One would naturally expect the
orange to be seen by most people because it is the colour
nearer to the centre of the spectrum than the red, but this
is not the case, and goes to show that it is the failure of the
eye to respond to the vibrations of the orange which causes
the trouble, and the orange is, therefore, not seen by persons
of defective eyesight. I do not, therefore, think that we
could base a fair argument upon Mr. Harradine's suggestion
that because the red and violet are seen in all cases, there-
fore it means that the nerves must necessarily be affected by
colours nearer the middle of the spectrum. The older theory
was that there were three nerves, one sensitive to blue, one
sensitive to yellow, and a third sensitive to red. If this
held good, then for orange not to be seen, two nerves, those
of the red and yellow, would be affected, but we find persons
whose eyesight is perfectly clear in the yellow and red of the
spectrum who cannot see orange. It must also be remem-
bered that the orange of the spectrum is not a compound
of red and yellow, but a distinct colour, and the same applies
to green.

In considering the colours of the spectrum we are inclined
to treat them as pigments and to forget that they are
spectrum colours and, therefore, that as green is a totally different colour to red, they must depend upon their respective vibrations to convey the sense of colour to the eye.

It should be pointed out that the violet in the spectrum is shown to terminate at a certain point in the same way that red is shown, but neither really terminates at that point. It is a well-known fact that heat waves exist in the solar spectrum, and these extend a long way below the red as seen by the eye, and in the same manner we have reason to know (and can prove it very easily by photography) that the actinic (violet) rays continue a long way up the spectrum beyond the last point shown on the screen. It is clear, therefore, that in a normally sighted person the greatest luminosity and most easily distinguished colours lie between the red and the violet, but the colours at the extreme ends of the spectrum—red and violet—may actuate the brain of different persons in a greater or less degree, and consequently some persons can only just see the normal spectrum whilst others see more red or more violet; that is to say, a greater length of spectrum than the normal. This is illustrated in the case of persons having diachromatic vision, who very often see the shortened spectrum in the violet. That in itself is rather against the violet being used as a colour, because people do not always see the same portion of it. Secondly, violet has no penetrating power to speak of, therefore it can only be seen a short distance, and it has still a worse fault, namely, that it is very easily killed by the yellow or the orange-yellow light of the spectrum, which we use so frequently in a lamp as a light. This proves that the violet is open to considerable objection as a light. Then again, there is a difficulty in producing it, which, of course, is fatal. We cannot produce true violet at all; all that we can produce is a purple, which is a compound of red and blue, both of which colours are very much lower on the spectrum than the violet and give vibrations very different to the violet, and their properties must naturally be very different to it. The purple may at first sight appear to match the violet, but it would have more penetrating power,
would be less distinct and very easily confused with red and blue. We see, therefore, that a violet light is quite out of the range of possibilities so far as a signal light is concerned.

Mr. Morgan: I think in connection with the reflection through the glass that if we used the glass with the flashed side next to the lamp that you would not get the reflection of the colour through the glass.

Mr. Hurst: It has been suggested that if the glass was flashed with a colour it would have the effect of stopping the reflection as a coloured light. I think it would not. It must be remembered that when the glass is flashed with a colour on one side there is no reflecting surface between the two colours joined. Assuming the red surface to be at the back of the glass, the light would pass through the white portion of the glass and then the red before being reflected back from the back surface of the glass. It would, therefore, have to pass through colour, whatever the thickness might be, before being reflected from the back surface. If it is reflected from the front surface the colour would be white.

The whole principle of reflection is that a ray of light is reflected from a surface which is more dense than air. This surface may therefore be either the front or the back surface of a piece of glass.

Mr. Powell: Will Mr. Hurst tell us in what way it is demonstrated that yellow and blue produce white?

Mr. Hurst: How can yellow and blue be mixed to form white? This is a very proper question to ask, as clearly you could not handle two lights of the spectrum as you can pigments. You could not mix them with a palette knife, but you can take a light from the spectrum and reflect it and overlay it as it were with a light from another prism, and the two become intermixed in their passage, and in mixing these two colours in their passage from the prism to
Mr. Hurst the screen you will find the colour disappear. It will, of course, be realised that the colours must be proportionate to each other, that is, taken from the same source of light, for if there is a greater proportion of yellow present than when mixed with blue would form white light, the result would be tinted by the residue of yellow, and the same thing would occur with the blue.

Mr. Proctor: On page 38 of Mr. Hurst’s paper he says “and finally by mixing all the colours we obtain a dark grey or black in contra-distinction with the white produced by the mixture of the spectrum colours.” Can Mr. Hurst tell us whether it is possible to mix these in proportion to get a kind of light grey and not dark grey?

Mr. Hurst: The answer to that question depends to a great extent upon the purity of the colours and also the power or density of the colours. There are certain relative proportions both in power and quantity of the colours; so much pure yellow and so much pure blue to so much of pure red, each of given density, which go to form a white light in the spectrum, in addition to the other colours, such as orange, green, violet, and so forth, but the ones we are concerned with are really red, yellow, and blue. If we mix red, yellow, and blue pigments we have a mixture of all the primary colours, and if deep colours these form a dark grey or black; but if you take the same proportion of light colours you get a grey of a lighter shade. You can never get a very light grey, or anything approximating white. Probably one of the greatest reasons why we can never get a very light grey is the absence of the violet. We do not know exactly what violet does in conjunction with other colours, as it must be remembered that it is one of the colours which is not very well seen, or at any rate not seen entirely, but we know that it is actinic in contra-distinction to the live part of the human anatomy. I have no doubt that the absence of the violet from the pigments has a good deal to do with their appearing so dark when mixed together instead of forming a light grey or approximating white.
Mr. J. A. Edwards: Is colour-blindness found common among men who apply for situations on railways?

Mr. Hurst: I do not think it is. I believe that a great many people suffer more or less from partial colour-blindness. Total colour-blindness works out at about two-thirds per cent. Partial colour-blindness is probably some six or seven per cent. Amongst women it is comparatively rare. They have better sight than men, partially due to the fact that men have to work under different conditions. I do not think it is inherent in women, but that men lose their eyesight more owing to the longer hours they sit at work. I am not forgetting that some women have to work in factories and so forth. Many of them have intermittent work, and that may have something to do with it. I do not think altogether it is on the increase.

Mr. A. Aked: Will Mr. Hurst explain what is the reason for the moving appearance of bodies, such as white hand-railing, on a hot day?

Mr. Hurst: This has nothing to do, strictly speaking, with reflection or refraction, but is due to the movement caused by the heat of the sun on the body referred to, which in turn heats the atmosphere next to it, causing it to rise in irregular waves. This would not be seen at all were it not that the atmosphere contains numerous particles of dust, and it is the movement of these, illuminated by the sun, which gives you the idea of movement.

Mr. A. H. Johnson: I am sure we are all indebted to Mr. Hurst for this timely paper on such a vital and difficult subject. I have made a few notes on my journey here, and I am going to take quite a different phase of the subject. Now it might be asked in what respect is the question of coloured lights for signalling more difficult than that of day signals, which depend upon angles and positions. Well, we may say that the day signals are readily gauged by the
Mr. A. H. Johnson

comparatively crude sense of shape, whereas the sense whereby we gauge colours is much finer. The former has to do with quantities, whereas the latter is qualitative. I think we should seize that idea. All physical things, and we have been talking so far of the mere physical attributes of a deep subject, a most elusive thing to grasp for the most intelligent mind. We have been talking of the physical aspect. All physical things correspond with analogous things in the spiritual world, and colours are no exception to this law. But even on the physical side there are vital differences in the effects of various colours or wave lengths of light, and the following is a very interesting point that I came across in a little book I was reading some time ago on the "Science of Correspondences." Plants have been made to grow by red and yellow rays alone, but unless the third primary colour is also present the plant will not produce flowers or fruit. It requires the trinity of red, yellow, and blue to reproduce some forms of life, and that is one of the instances of a very great law which permeates the whole of existence, physical, spiritual, and celestial; the divine law of trinity and unity. You have these three primary colours which are necessary to form the one white, a very fine instance of the law of trines. You have everywhere the same law of trinity. You have length, breadth, and depth, the three attributes of any concrete substance. You will find it in the attributes of the Godhead, despite the scoffs of the Agnostic.

In the practical point of view, the underlying principle which makes certain colours suitable for particular uses may be briefly said to be as follows:—

Red, and this concerns that vexed question of ground signal lights, red affects a man in much the same way as warmth, and so corresponds to the affections, and as the affections are the most potent force in a man, that is probably the cause of the attention being the more arrested by red. Then there is another reason: Red, as I have said in a controversy in the "Railway Gazette," is the blood colour, and that may be another reason for the arrestive
quality of red; as one of the deep underlying causes why we are so much affected by red. We should, therefore, be wise if we continue to use red in all cases where it is important that trains should stop; and I am one of those who consider the use of a white light in ground signals to denote "stop" by some railways recently to be retrograde.

Mr. Hurst, in reply to a question from Mr. Johnson as to the use of lenses for Signal Lights, said the function of the lens is to gather all the light given in the lamp, and to distribute it evenly in the direction required. It might be brought to a focus at any particular point in front of the lens, but that would not do for signalling purposes, as the greatest intensity could only be observed from that point, and there would be a great falling off in brilliancy when seen from other points. Consequently, it has to be distributed in such a way that it illuminates a comparatively large angle and there is comparatively little loss of brilliancy at any distance from the lamp.

Mr. Hurst further suggested that the question of lenses would form a useful subject for some future paper.

Mr. Morris: I should like to ask Mr. Hurst how they can measure the number of waves that are produced by certain rays of light; they seem infinitesimal, these refractions of seconds, and I should like to know how they are calculated.

Mr. Hurst: I am afraid I cannot give you off-hand the information asked for, but I believe you will find a full answer to your question in Ganot's Physics.

Mr. Johnson: I have pleasure in proposing a vote of thanks to Mr. Hurst for his very valuable paper.

Mr. Fleet seconded.

Mr. Hurst: I am very much obliged to you for your vote of thanks. I am very interested in one thing, and I
Mr. Hornbl.

am glad that a fair number of the members present have taken part in the discussion. We usually write papers for the purpose of inducing criticism, and in order to bring out points that have been overlooked. I only hope that many more will come forward and read papers, and that we shall join in criticisms upon them and that we shall learn from them.

It has given me very great pleasure to see you all and to answer the questions to the best of my ability. I am very much obliged to you for the kind way in which you have received the paper and for the discussion which you have taken on it.

In conclusion I should like to propose a vote of thanks to the Chairman. This was carried unanimously, and in reply the Chairman said that he had been amply repaid by the honour.
FIG 1

DIAGRAM 1
SOUNDING REFRACTION

DIAGRAM 2
Illustrating the Colour Interpretation as seen by persons with varying vision.

Note: In the above Diagram, the powers of the separate individuals of the person are indicated by the various bands, but each colour gradually passes into the adjoining one.
MINUTES OF PROCEEDINGS
Of Meeting held at Birmingham, Tuesday,
December 2nd, 1913.

Mr. C. H. Ellison: I regret very much indeed that Mr. Blackall, our President, is not with us to-day. I regret his absence for two reasons: first, because I know he would very much have liked to have occupied his position as President of this Institution for the simple reason that this is our last ordinary meeting this year, and I believe it is the first meeting from which Mr. Blackall has had the misfortune to be absent, and I am sure that for that reason Mr. Blackall will very much regret it, too.

My second feeling of regret is that I should have been called upon to occupy his place. I think there are perhaps others in the room who would have occupied the position with greater credit, and I hope with greater distinction, than I can hope to attain. Anyhow, I have been called upon at very short notice, and quite unexpectedly, and I hope that I shall have your sympathy and support this afternoon.

Before we commence the business of the meeting, I should like to say one or two words on points of interest in connection with our Institution, which have just been suggested to me by the Secretary.

In the first place, we as Council (I speak now as a member of Council) have had a very hard and uphill fight in order to firmly establish in a satisfactory way the foundations of this Institution. I think we can claim now that we have just about succeeded. We feel quite satisfied with the success which, as a Council, we have attained, and I think it only now remains for the members of the Institution to back up our efforts and do whatever lies in their power to make the Institution the success which we feel that it ought to be in this country. We have some difficulty
in getting Papers to be read at these meetings—we have had great difficulty in getting one for to-day's meeting, but fortunately one of our members who is in the Malay States kindly came forward at the last moment and supplied us with a Paper to be read to-day. We hope that next year, anyhow, we shall have greater success in that direction, and that our members will feel that there is something to be gained by endeavouring to place before the Council Papers of interest to be read before these meetings.

It may interest you to know how we stand—I will not say financially, we will leave that for a future occasion—but numerically. The strength of the Institution is as follows:—We have 7 Foundation Members, 7 Honorary Members, 91 Members, 51 Associate Members, and 15 Student Members, making a total of 171; and we have already received applications for election from 10 other people who want to become associated with the Institution.

With regard to the Prize Papers, we have now received five Papers, which at the present time are being adjudicated upon, and the successful Papers will be read at our Annual General Meeting, which will be held early in the new year.

We have received apologies this afternoon from Mr. Acland, Mr. Hurst, Mr. Firth, and Mr. Johnson, together with our President, and all I can say is that we are very sorry that these gentlemen have not found it possible to be with us.

I will now call upon the Secretary to read Mr. J. Parsons' Paper on "Sympathetic Numbering and Grouping of Levers."
Sympathetic Numbering and Grouping of Levers.

By J. Parsons

The subject it is proposed to deal with in this brief Paper is the arrangement of levers in a locking frame in the way that facilitates to the greatest extent the operation of them by the signalman in dealing with the traffic.

For some time it has been and still is the recognised practice, at least on many railways, to locate the Up signals at one end of the frame, the Down signals at the other, with all the points and discs in the centre.

It is not easy to say how and when this method originated, possibly from the time when the mechanical difficulties of interlocking had not been mastered as they have now, and this form of arrangement simplified it to some extent: certainly there are points to be noted in its favour.

If the levers operating the signals are always at that end of the box from which the train is expected to approach, the signalman when standing at his distant and possibly home signal levers, ready to replace them when the train has passed, has an uninterrupted view out of the end of the cabin, which aids him in doing this.

There is no doubt also that as a rule the lead off may be more symmetrically arranged when all the points and discs are in the centre. Also, in certain cases, it simplifies the actual mechanical interlocking, but with a properly designed frame this is a matter of small importance, as it will usually only entail an increase in the length of some of the bars.

However, against the good points mentioned above, there are disadvantages to be considered, especially where large frames are concerned, and additional advantages to be thought of, which cannot be attained, and which far
outweigh the benefits obtained by the system already mentioned, but which may be arrived at by adopting an entirely different system.

Now the chief object that should be kept in mind when arranging levers in a frame is the signalman's convenience. Everything should be arranged so that he may be put to the least possible physical and mental labour in the manipulation of the levers and block instruments in order that he may be able to concentrate the whole of his attention on the particular train movement which he is conducting, and carry it out with as little physical inconvenience and walking about as possible.

In this particular detail, as is the case with all signalling, every place must be taken on its individual merits and the traffic conditions carefully considered before the numbering of the levers is done, consequently no hard and fast rules can be stated.

The chief points to be observed may be roughly divided as follows:

1. The Up and Down signals to be grouped close together, usually about the middle of the frame, beneath the block instruments, as the signalman will always require to use these levers in conjunction with the instruments, and has them there all close together with his booking register behind him, thus saving much unnecessary walking up to the ends of the box and back. This will be particularly so where there is a heavy main line traffic and not much shunting.

Cases will occur, however, where all the shunting movements take place at one end of the yard, and in that instance the levers controlling them will all be grouped together at the corresponding end of the frame, whilst the main Up and Down signals will be concentrated at the other.

2. All the levers controlling each separate shunting movement should be arranged in groups as far as possible and placed at that end of the frame which is adjacent to the
siding or crossover concerned, as the signalman when conducting the shunting will frequently wish to walk to the window to observe or give verbal instructions about the movement he is conducting, and this position of the levers will be far the most convenient for doing this.

3. Any group of levers, required for any given train movement, should be so arranged that as nearly as possible they pull in sequence.

Pulls in which the signalman, after reversing a series of levers in sequence, has to return to a lever at the beginning, should be especially avoided, as 7, 8, 9, 4, 12, 13. No lever should ever be left to be pulled over between two other levers already reversed, as 7, 9, 8.

Now, to illustrate the ideas set forth above, the best plan will be to take several instances and work them out on the lines described. Fig. No. 1 illustrates a simple station on double line with sidings and crossovers at both north and south ends. The numbering and grouping is arranged according to the customary method, i.e., the Up signals at one end, the Down signals at the other, and the points and discs in between.

In Fig. 2 this is re-arranged in a manner far more convenient for the signalman.

Now to deal with the grouping, it will be seen that the Up and Down main signals have been concentrated in the middle of the frame and the respective block instruments would be fixed immediately above them. Spare levers Nos. 11 and 12 are inserted between the two groups of main line signals and other spares between the north and south end shunting movements respectively.

The south end shunting movement is at the south end of the frame, and the north end shunting movement at the north end.

The next point to which attention may be drawn is the arrangement of levers in the south end shunt movement group. The pulls are shown below these, and it will be seen that they run consecutively either to the right or left
for all movements. Those at the north end will be arranged in a similar manner. In Fig. No. 3 a simple junction is dealt with.

The block instruments of an uncombined type are shown diagrammatically on the instrument shelf and the levers are represented by the line of figures below them; these are near enough to scale to give an idea of their relative positions. The vertical lines of figures represent the pulls.

It will be seen that all the pulls are in perfect sequence with the exception of the down branch, and this is unavoidable.

By placing the down main starter No. 19 with the homes and distant for the branch and main on the left and right respectively, the pulls are made consecutive and each group is kept quite distinct, and as a result becomes clearly fixed in the signalman's mind almost unconsciously, so that it is scarcely ever necessary for him, having once started on a pull to hesitate and have to hunt for a lever several levers off.

Sparcs are inserted between the various groups in order to accentuate the divisions between them.

Another point worthy of notice is the locking on the fouling bars. It may be safely assumed that the traffic on the branch is less than the traffic on the main, and so by making 14 and 15 release 10 and 15 lock 20 and 6, the fouling bars are only operated for the branch, but attain the same results as if they were made to release the homes, 6, 10, and 20, thus saving a considerable amount of labour.

It may be mentioned here that all the arguments in favour of this form of numbering and grouping apply in an exaggerated degree to a relief signalman, as it enables him to grasp the lay-out very much more easily and quickly.

The author is well aware of the argument that is frequently brought forward that it is better for the signalman to move in the direction from which the train is approaching when pulling over levers, but this does not appear to him to be of much importance, as it can equally well be argued that the man should move in the same direction that the
train is going; in fact, the relative direction of movement of the train and the lever sequence is immaterial.

In Fig. 4 is illustrated a method of numbering an ordinary crossover and through road with discs. The ground signal No. 3 applies to go on to both the down main and both sidings and is released by points 8 and locks points 4 and 5 in either position.

Certain gaps in the sequence are unavoidable, but it will be noticed that they all pull consecutively, and in no case has the signalman to return in his tracks to complete the movements, as is the case when the numbering is done in the usual method, as shown in Fig. 5, as, for instance, 2, 4, 6, 1.

Fig. 6 represents an important block post, controlling a junction between fast and slow lines, a station and several shunting movements.

Now in the first instance let it be assumed for the sake of argument that there is a very heavy through fast line traffic, a considerable number of trains use the junction, and nearly all slow trains stop at the station.

Obviously, then, the most important work which the signalman has to do is the management of the fast line traffic, and in order that he may carry out this with a minimum of physical labour and loss of time, the fast line block instruments and signals for both Up and Down lines are kept close together in the centre of the frame. The Up and Down fast signal levers are separated by a spare to avoid any chance of confusion.

The shunt movement is inserted between the Up fast to slow and Up fast groups because if carried out to the end it would be such a bad pull, and as placed it serves as a useful gap to emphasise the above groups.

It will be seen that the Up fast to slow movement runs in excellent sequence.

There is a gap in the Up slow pull caused by the starter having to be in advance of the Up fast to slow signals, but as this signal will usually be pulled off separately, owing to slow line trains stopping at the station, it is immaterial. The Down slow to fast pull cannot be made perfect, but is
quite a reasonably easy one, and in order to avoid a lever having to be pulled over between two other levers already reversed, the spare No. 37 is inserted.

The other shunting movements are arranged on the lines mentioned elsewhere, and are placed at their respective ends of the frame.

The type of block instrument illustrated is the uncombined type as used on the Midland Railway, and it will be seen that by the grouping shown, the various bells—all of which have to be used in conjunction with one another—are practically within arm's reach of the signalman, so that he can accept, say, a down slow train for the South with his left hand, and with a minimum of movement ask line clear for it from the north with his right. In Fig. 7 a different arrangement is shown.

The traffic in this case is assumed to be very heavy on the fast and slow lines, while that using the junction is very small. To group the levers most conveniently for these conditions, the Up and Down slow are placed together, similarly the Up and Down fast and the pulls for these are kept in perfect sequence.

Something, of course, has to be sacrificed, and the pull for the Up fast to slow is not so good as in Fig. 6, but then in this case this movement is of minor importance.

By inserting points Nos. 37 and 38 between the Up and Down fast the requisite division is made between the groups, and also the pull for the Down slow to Down fast is kept fairly good. The shunt movements remain practically the same as in Fig. 6.

It may be of interest to mention here that the author has had actual experience of a case where, by adopting the methods herein set forth, the signalman could be saved a walk of approximately a mile every eight hour shift.

He does not lay claim to any originality for most of the ideas described, but hopes that placing them in a concrete form on paper may lead to a useful discussion.
DISCUSSION.

Mr. C. H. Ellison: I hope the concluding remarks of Mr. Parsons will be realised this afternoon, and that his Paper may lead to a useful discussion. I do not think that I can say anything myself (I do not profess to be a Mechanical Signalling Engineer), but I do think that Mr. Parsons has thrown down the gauntlet, so to speak, to some of you Signalling Engineers, and has thrown out a challenge on the method of laying out a signal box frame which he in his own judgment ventures to claim as superior to present day practice. That is what I seem to gather from the reading of his Paper, and I think if this is his intention it may lead some of you gentlemen to say something interesting this afternoon, and I hope we shall have the pleasure of hearing you.

Mr. R. J. Insell: The first thing which strikes me on hearing what you said just now is this: we had to go to the Malay States to get this Paper, and another Paper we are promised is from America. The foreign members of this Institution are certainly in a minority, and I think some of the English members will have to make an effort to send Papers also.

Now as to the Paper itself. This sympathetic numbering and grouping of levers is a very important feature of signalling. There is a lot to be said for Mr. Parsons' methods; in fact, these methods have been generally adopted, and although it seems to me that the numbering and arrangement of levers is quite as important as the layout of the yard, or the arrangement of signals, there are a good many things which have to be considered. In a small signal box it does not very much matter where you put the points and signals so long as you get a good view, but you must bear in mind that Rule 40 comes in on this question as to where levers should be placed. A man in working his Home signals is supposed to see that a train is under control; therefore you must be sure that he has a good sight of the line, and if you put these levers in the middle of
the box it is just possible that he will not be able to comply with this Rule.

Mr. Parsons is very anxious to put spare levers in between the different groups. That is a very easy way of getting over it, but spare levers take up space, and if, as is apparently the case, they cannot be used and are simply there to make a space, and that means that a signal box has to be very much larger. He ought to try and avoid so many spare levers—that is one point.

Another point is that in numbering a box of any size, where there are more than one or two men, you want to consider how that box is going to be worked. It is just possible that there will be a director, or chief signalman, who will have lever men under him to work the different levers, he working the block. All these points have to be taken into consideration in numbering a big frame.

It may interest you to know that in America recently I found the practice there in a big Yard was that instead of numbering each box separately, they number all the points and signals consecutively, and if you give the number of a particular point or signal that is sufficient to locate the box from which it is worked. This arrangement rather appealed to me—you simply describe the levers and that tells you which box they are worked from, thus saving a good deal of clerical work in some cases.

Another interesting feature was that they did not provide lead numbers—the signalmen have to learn the frame; they do not get any assistance from lead numbers, that is considered quite unnecessary.

Mr. E. F. Fleet: As Mr. Insell has said, this system of numbering has been used oft-times, and it is used to-day wherever it is found that this can be done with advantage according to the lay-out, but I think the Paper is very valuable practically—it teaches what is sometimes forgotten in the Drawing Office, that is, the consecutive pull of the levers.

As regards the arrangement of the levers, I do not think
that this is the best system—it lands you into difficulties. In Figure 2, for instance, you get Nos. 4 and 5 levers to give signals in opposite directions—that is not good; signalmen very often go to the wrong lever and are only prevented from pulling it because of the locking on it.

Then again in the larger diagrams (they are very simple—extremely so). Figure 6 has only two facing points apparently, and Figure 7 likewise, and the bars have been left off the diagrams in these cases. If you take a big station you will find bars on nearly all the points, and this would upset this sort of numbering. On the whole I think the geographical numbering is the better, but this does not put this Paper out of court, because all the circumstances of each case have to be considered in arranging and numbering the points and signals.

I think if we had a diagram of the box referred to where a man would be saved a mile a day or shift, so that we could make a comparison, we should have known better how to deal with it.

I think the Paper is valuable because we can use it in everyday practice, but as regards using it as a system I think we can only use it as a partial system, that is where the local conditions are such that it could be applied with advantage.

Mr. J. R. Downes: There is one point in the previous speaker's remarks which has been brought rather closely home to the Midland Railway Company, and that is where the author refers to a case in which a signalman could be saved a walk of a mile a day. It is true that the instance was on the Midland, but in defence of that I should like to say that it was a locking frame built up in sections as the line became extended from time to time and was not a new frame. We had under consideration the improving of the numbering in order to save the signalman, but I do not wish it to be understood that this is a common occurrence. With regard to the locking bars which are missing on the author's diagrams, we do not omit them from our
diagrams, but as the bars work with the lever operating the points on the Midland, possibly the author may have thought that the numbering, without showing the bars, carried his point.

I quite agree with what has already been said in reference to the Paper, but it is rather based on some obsolete Midland installations. What we have adopted is rather the idea of bringing things into a more satisfactory form for the signalman, but I quite agree that we cannot do it in every case, and I hope therefore that Mr. Parsons' views will not be attributed to the present practice of the Midland Railway. We had, I know, some old-fashioned lay-outs, with No. 1 Distant, No. 2 Home, No. 3 Starter, and No. 4 Advanced Starter; then 20 or 30 levers in between, finishing up with 41, 42, 43, 44 for the main signals in the opposite direction. It was not the best possible system of laying the thing out, and under Mr. Acland we have been encouraged in arriving at a much better and more economical way of numbering off lever frames.

I should also like to say that the idea of putting spares in between the Up and Down main signals is not that they should never be used; we should have some little thought to the possibility of using them in the future. We should probably be able to see some possible place where another connection might be wanted and at the same time take advantage of it to form the division, particularly, say, between an Up and Down starting signal, because they are most undesirable levers to have together, as a man might pull the wrong signal off when he had a train standing at it.

Mr. A. F. Bound: Taking the subject as a whole, I think it is one where we can hardly lay down any general definite rule. As regards ordinary cases like simple junctions, the practice can be in nearly all respects identical, but when we get into the larger installations with which this Paper is intended to deal, practically every arrangement is different, and that, I think, throughout the whole system of
signalling, is where the thing calls for special thought and care as to what advantages are to be gained; many questions of sight, traffic, etc., have to be considered.

In the Paper, on page 58, paragraph 1, the author says: "Now the chief object that should be kept in mind when arranging levers in a frame is the signalman's convenience." I take issue with Mr. Parsons there. I take it that one of the chief objects is not so much the signalman's convenience as to give the signalman the very best sight you can over the line which he controls, and in working the signals the chief point is that when he is standing at his frame and putting his levers back he ought to be able to see that the arm obeys the lever. As regards the points and other connections of that sort, one very often sees a signalman squinting over the tops of the levers and underneath the telegraph instrument shelf in order to get a view of what is going on in front of the box. Lately we have been trying putting the signalman with his back to the line, and so far the results have justified the alteration, but it has not been adopted as a general practice as there is an amount of prejudice against it in some quarters. Take a box that is in the fork of a junction: there you cannot help having the line behind or to one side of the signalman, but I have yet to learn there is any inconvenience caused, as a man can easily turn round if necessary. One can group the various points and signals for the altered working as desired, and when a man wants to make any communication with anyone outside he has simply to walk from his frame to the windows behind him in order to do this. There is also another slight advantage, and that is that he gets the direct light through the windows on to his block instruments.

I notice farther on, on page 60, the author states that he is "well aware of the argument that it is better for the signalman to move in the direction from which the train is approaching, but this does not appear to him to be of much importance, as it can equally well be argued that the man should move in the same direction that the train is going." Surely not; in the former case the train has to be dealt with,
and you are moving him to the best position to effectually do this; in the latter it would mean you are taking him from the train, and I cannot see there is any question as to which is the best principle. It must not be forgotten that a signalman has to be continually thinking of what is going on around him due to his agency, and the ordered sequence of lever movements on a definite principle is a big help to a man in realising the position of affairs at any instant.

The lever movements should follow in the same sort of sequence so that in reversing a number of levers in a sequence the last to be pulled should be at the end from which the train is approaching; this saves a man walking many yards for observation purposes. In figure 3 for the Down Main line you pull 19, 20, and 21, which is correct; whereas if you had a train off the Branch your sequence would be in the opposite direction and you would pull 19, 18, and 17. This seems confusing in my opinion, and is bad practice. In figure 4 you also have a somewhat similar case, and I think it would be much better if No. 7 were altered to No. 3 and vice versa. You would then have your signals 1, 2, and 3, all leading in the same direction, which would be far better than 1 and 2 in one direction, and 3 controlling an absolutely conflicting movement.

Turning back again to figure 2, you will notice there (whether an error or not I do not know) at No. 19 points from the Sidings to Down Main line the author shows No. 20 from Down Main Line to Siding and 18 from Siding to Down Main line. Nos. 18 and 20 should change places.

Then again, turning to figure 6. As has been mentioned by one of the other speakers, the bars have been left out, but where you have on a complicated junction separate bars it makes a very big difference. You probably have to pull those bars, and therefore that might destroy the sequence. Also, in this particular case, I should have expected that there would have been some releasing between 19, 38, and 39 (that is, the facing points) to protect an overshoot—that would rather upset his lever sequence.

Speaking generally, I think the principle is a very good
one where it can be adopted, but I am afraid, as I said, that it is impossible to lay down any hard and fast rule, and each case must be arranged according to its special requirements.

I think the author is to be congratulated on his Paper.

Mr. W. H. Powell: Mr. Bound referred to No. 20 shunt signal on Figure 2, and I think suggested that the number of this signal and No. 18 might be reversed, but as No. 20 also applies to No. 21 crossover, I think this would make the numbering not read quite as well. I had intended calling attention to one point which has been mentioned about the bars. Mr. Fleet described Figures 6 and 7 as being simple junctions to number. The simplicity is made even greater by the bars working on the same levers as the points, and this would apply in a greater degree to the numbering of a large terminal or through station, as in what I believe is the practice on most railways, when the bar has to be pulled for the roads for which the points lie normal, as well as reversed. There is always a difficulty in arranging the various series of pulls in close sequence.

Mr. H. E. Cox: With reference to Figures 6 and 7, it seems to me that the arrangement of the spare levers is not in the best manner. Instead of grouping them in two groups, perhaps one at each end of the frame, we have one or two dotted all along the frame; so that in the event of any alteration you would have to obtain levers by upsetting the numbering altogether, taking one out or perhaps three out as necessary.

Mr. H. E. Morgan: Nobody seems to have mentioned the position of the block instruments in relation to the levers. In Figures 6 and 7 there are two different arrangements shown. In Figure 6 the first two block instruments and bell apply to the Slow lines; the second and the bell to the Fast lines; the next bell and two instruments to the Fast lines; and the next bell and two instruments to the Slow lines. In Figure 7 all the Slow line bells and instruments are on the left, and all the Fast on the right.
Mr. H. E. Morgan

In Figure 6 the bell applying to No. 18 Starting signal comes over No. 38 lever, and in the case of No. 41 Starter the bell comes over Nos. 23 and 24 levers, so that there is a long walk for the signalman between the Starting signal lever and the bell applying to it.

Now I do not see myself why the block instruments should not be grouped according to the position of the signal levers and not to any fixed rule as is at present the case. Then again we generally place the bells between the two block instruments; for instance, the Slow bell should be between the Slow receiver and transmitter, and the Fast bell between the Fast receiver and transmitter, and, where lock and block is installed, the bell should be as nearly as possible over the Starting signal lever. Especially lock and block such as we use, where the instrument when pegged to the "Line Clear" position the lock on the starter in the rear is held out, but when pegged to the "Train on Line" position the lock drops in. Therefore, if a man has a train standing at his Starter and offers it to a Box in advance, and when accepted puts it "On Line" before pulling off the Starter, the man in advance then pegs up to the "Train on Line" position, and the lock drops in, with the result that he cannot then get his Starter off.

If it is not possible to place the bells over the Starting signal levers, I think the ringing keys should be duplicated or separate bells provided on a board above and the plunger keys placed underneath on the front board of the shelf. This would save space on the shelf, and the block instruments could then be put in a better position. Nowadays a lot of room is taken up with such things as Track Circuit Indicators, Repeaters, Light Indicators, etc., that space on the instrument shelf is very valuable.

Mr. R. G. Berry

Mr. R. G. Berry: I do not know whether I have anything to say beyond endorsing what others have said. I may perhaps suggest what I consider would be a better sequence of pulls on No. 6 diagram. Take the pull from the Down Slow to the Down Fast; the pull as given in the
figure is 39 and 38, then going back to 34, 35, and 36. Mr. R. G. Bury

Well, I would suggest that a better sequence would be this
(of course we should make 38 pull before 39; that is, the
facing points would release the trailing points). A better
numbering would be:—The facing points in the Down
Slow 32; the trailing points in the Down Fast 33; Down
Fast Starter 34; Down Fast Home that is shown to be 33
to be 35; and the Down Fast Distant to be 36; the Down
Slow to Down Fast Home Signal, which is shown to be 35,
to be 37; and the Distant following that to be 38. Then we
get the following sequence of pulls:—

Down Fast (through running) 34, 35 and 36.
Down Slow to Down Fast - - 32, 33, 34, 37 and 38.

There would certainly be a gap between 34 and 37, but the
pull would be all in sequence.

Similarly in Figure 7. The pull from the Up Fast to the
Up Slow as shown is 20, 21, 22 and 23; then back to 19,
18 and 17. That numbering should be: 20 to be 17; 21
points to be 18; 22 points to be 19; the Up Slow Starter
to be 20; Up Slow Home to be 21; Up Slow Inner Distant
22; Outer Distant 23; then going back to the Up Fast to
Slow the Home should be 24; Inner Distant 25; Outer
Distant 26. We should then get the following pulls:—

For through running on
the Up Slow - - - 20, 21, 22 and 23.
Across from the Up
Fast to the Up Slow - 17, 18, 19, 20, 24, 25 and 26.

There again we should have a gap of three levers between
20 and 24, but still the pull would all be in the straight run.
I think that would be a better arrangement for the signal-
man.

Mr. J. R. Downes: I should like to say that Mr. Parsons
seems to have given us food for discussion, and that he is to
be congratulated on his Paper. As I know him personally,
and as he is not present, I should like to say in his defence
that he has apparently made one or two accidental slips
Mr. J. R. Downes

which I do not think he intended. For instance, the bad sequence of pulls on Figure 6—on the Down Slow to Fast line he gives the Fast Starter 34; Home to Fast 35; and the Distant 36. Then when you come to the Slow line he gives his Distant 32, and Home 33. I think he meant the Home to be 32 and the Distant 33. Then again in Figure 7 he has got 20, 21, 22 and 23; then 19, 18 and 17; going up the frame instead of down. I think these are little slips on his part, and that as he is so far away we should not be too hard on him.

Mr. V. H. Openshaw

Mr. V. H. Openshaw: I should like to mention one point, and that is where the main line signals are grouped under the block instruments I think there is less likelihood of a signalman making a mistake. Take a large frame where the signal levers are a long way from the block instruments. Many times a signalman walks to his Home signal lever waiting acceptance of the train, and it would be possible while in this position for him to mistake the block instrument, but if the levers were grouped under the block instruments applying to them I think there would be less likelihood of his making a mistake.

Mr. R. J. Insell

Mr. R. J. Insell: I should like to propose a vote of thanks to Mr. Parsons for his Paper, and for the very interesting discussion which we have had this afternoon.

Mr. J. R. Downes

Mr. J. R. Downes: I have great pleasure in seconding the vote of thanks. It is very nice to think that although one is so far away he has not forgotten those he left behind in this country nor the members of this Institution.

Mr. C. H. Ellison

Mr. C. H. Ellison: Before I put the resolution which has been kindly proposed by Mr. Insell and seconded by Mr. Downes, I should like to give an opportunity to any member who wishes to say anything more. There is no reason why we should close in such a hurry. I was scarcely anticipating for the moment that we were coming to an end;
we were going along very happily and the discussion was going on admirably, and we were learning something from that discussion. I think a reply has been given to Mr. Parsons, and I am quite certain that he will very kindly receive the criticisms which have been made on his Paper this afternoon. They will be sent to him in due course, and I hope that we can tell him at the same time that his Paper has given us some pleasure and interest, and certainly, as some member has just mentioned, has provided food for reflection. It only goes to prove what I said a short time ago when you asked me to take the chair to-day: that some of these short Papers are capable of promoting perhaps the best discussion, and I think it ought to be an encouragement to the members here and that they should go away with this on their minds, that an effort like this of Mr. Parsons, which I trust and believe has not caused him the time, pains, and anxiety which the writing of some Papers causes our members, will be some inducement to us to feel that a short Paper is always capable and may succeed in bringing forward a very excellent and useful discussion.

I can only say that I have learned something myself to-day out of this discussion, as I have had emphasized to me over and over again the necessity of a signalman having the best possible advantages given to him of doing his work in the interests of the Company and the safety of the travelling public; and one thing which has been impressed very forcibly upon my mind is the question of sight—that the Signal Superintendent and the Traffic Superintendent, in considering the site of a signal box, should always have in view that one of the most important matters for their consideration is the matter of sight for the signalman. I will tell you how that has been impressed upon my mind. I am always getting into trouble on the North-Eastern Railway for a telegraph pole getting in the way and obstructing the sight of a signalman. I do not know how the telegraph pole gets there unless it is the fault of the Signal Engineer, because he goes and sticks the signal up in such a position that a telegraph pole which has probably been there for...
Mr. C. H. Ellison years obstructs the view. However, I do get into trouble, and it has been very interesting to me to-day to hear so much said about the importance of observing the rule that nothing should come in the way of the sight of the signalman, with which of course we all entirely agree.

I am sure, gentlemen, we have benefited by coming here to-day, and I hope we shall have very many other useful and profitable meetings in the coming year. I have explained to you previously the difficulties which the Council have had to contend with, and I am quite sure that if you knew of the disappointments we have met with and the uphill fight which we have had for some years past in trying to put this Institution on a sure and a permanent basis you would sympathise with us, and you would try and help us by taking a great interest in the Institution and by making a point of supporting us with your presence at these meetings.

I am quite sure that everybody will agree that to-day we have had a most successful meeting, small though it may be, and that the discussion has been an admirable one.

The vote of thanks was then put to the meeting and carried unanimously.

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Communicated by Mr. A. H. Johnson—

I am in accord with Mr. Parsons as regards his main thesis. A considerable amount of signal work has been done in a half measure in the direction he advocates, especially in connection with power signalling.

Distant No. 36, Figure 6, should not be higher than 43. It should be lower than 43, because it answers for a reverse curve that might be risky at high speed.

If 38—39 is too sharp to be safely run at a medium speed, I would omit 36.

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Communicated by Mr. F. R. Addis—

In Figures 1 and 2, I think there might be another shunt provided at each end for shunting from Up to Down South end and Down to Up at North end, as there is no indication
to show which road is set when the disc is "off" by applying to two different roads (Main and Siding), and not only is that all, but it means extra work for selectors outside, and special locking in the box frame, and there appears to be spare levers enough for these, otherwise the numbering in Figure 2 is far preferable, not only for pulling but also for the connections.

I do not think Figure 3 is quite satisfactory working, firstly, that the locking bar to No. 12 points should be worked by a separate lever, unless, of course, this works in conjunction with fouling bar 14; then, again, with regard to the pulling of the Down signals (no doubt the author has his opinions for both arguments as to the placing of levers, as explained in paragraphs on page 60), I certainly think that the Down signals could be arranged better by placing them thus:—17 Down Starting, 18 Down Main Home, 19 Down Main Distant, 20 Down Branch Home, 21 Down Branch Distant; this way of placing would then be better for the leading off of the wire connections, they would read according to how they were placed on the ground and would show more distinctly when compared with the box diagram. What I mean is, that the author's method 19 would be on the left of diagram and right on frame, and 17 would be right on diagram and left on frame, and it is more natural to read from left to right under any condition.

In Figures 4, 5, 6 and 7, I maintain that separate discs should be provided for shunting from the Main to Main, and from Main to Sidings, as it is no indication to have half a movement.

In Figures 6 and 7, Nos. 4, 5, 6 and 7 might be arranged a little different so as not to have two opposite signals next to each other. No signals are provided for shunting in the Middle Siding from Up Fast, and in this case probably the schemes would be upset by bringing in a new lever for this movement.

In Figure 6 the pulling of the Down signals seems somewhat out of order, 32, 33, 34 being from right to left, and 34, 35, 36 left to right, and I certainly think that it would be
Mr. F. H. Reddix 

very beneficial to arrange all things to gain one end, and that is simplicity and do away with cross working as the author has done in Figure 7 with 39, 40, 41, 42, 43. Nos. 45, 46, 47 might be re-arranged to read from left to right, the same as the connections lead off from the box and prevent crossing of wires.

I certainly think there might be some control from North to South in Figures 6 and 7, to protect anything standing at the Down Platforms, even in the case of another box (which is not shown) he should have some control over the Down Homes for the Platforms, which would necessitate revising the numbering.
Sympathetic Numbering and Grouping of Levers.

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 5
List of Names and Addresses of Members.

FOUNDATION MEMBERS.

NAME.  
Acfield, Wilfred Cosens ... Signal Supt., Midland Railway, Derby  
Blackall, Alfred Thomas ... Signal Engineer, Great Western Railway, Reading  
Dutton, Charles (Member of Council) ... Signal Supt., L.B. & S.C. Railway, New Cross, London  
Firth, Harold William (Member of Council) ... Electrical Engineer, G.E. Railway, Liverpool Street Station, London  
Insell, Robert J. S. (Treasurer) ... Chief Assistant Signal Engineer, G.W. Railway, Reading  
Johnson, Arthur Henry (Member of Council) ... Signal and Telegraph Engineer, L. & S.W. Railway, Wimbledon Station, London  
Sayers, Josiah (Vice-President) ... Telegraph Supt., Midland Railway, Derby

ADDRESS.  

HONORARY MEMBERS.

Denney, C. E. ... Signal Engineer, L.S. & M.S. Railway, Cleveland, Ohio, U.S.A.  
Jacomb-Hood, J. W. ... Chief Resident Engineer, L. & S.W. Railway, Waterloo Station, London  
Rosenberg, C. C. ... Secretary-Treasurer, Railway Signal Association (America), Times Buildings, Bethlehem, Pennsylvania, U.S.A.  
Rudd, A. H. ... President, Railway Signal Assoc. (America), Broad St. Station, Philadelphia, U.S.A.  
Siemens, Alexander ... Managing Director, Messrs. Siemens Bros. and Co. Ltd., Caxton House, Westminster, London  
Wood, Sydney P. ... Managing Director, Messrs. McKenzie and Holland Ltd., 58, Victoria Street, Westminster, London  
Yorke, Lieut.-Col. Sir H. A., C.B., R.E. ... Chief Inspecting Officer of Railways, Board of Trade, 6, Richmond Terrace, Whitehall, London

MEMBERS.

Acfield, Wilfred Cosens (Member of Council) ... Signal Superintendent, Midland Railway, Derby  
Anderson, Percy ... Assistant Superintendent (Signal) South African Railways, Cape Town  
Arnott, Peter Ashcroft ... Chief Assistant, Engineer's Department, R. & C.D. Railway, Belfast
<table>
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<td>Assistant Electrical Engineer, New South</td>
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<td>Bennet, W. R. R. M.</td>
<td>Senior Assistant Signal Engineer, L.S.</td>
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<td>Attorney and General Manager for Australia, Messrs. McKenzie &amp; Holland, Ltd., Newport, Victoria, Australia</td>
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<td>Larcombe, Albert Edward</td>
<td>Assistant, Mechanical Section, L. &amp; S.W. Railway, Wimbledon, London</td>
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<td>Leech, Sydney George</td>
<td>Joint Managing Director, J. B. Saunders and Co. Ltd., 91, York Street, Westminster, S.W.</td>
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<td>Liley, Walter Henning</td>
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<td>Principal Assistant Electrical Engineer and Telegraph Superintendent, B. F. &amp; C. I. Railway, Bulcher Station, Bombay</td>
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<td>Neale, George</td>
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<td>Nicholson, John H.</td>
<td>Signal and Telegraph Superintendent, G.S. and W. Railway (Ireland), Dublin</td>
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<td>O'Donnell, John P.</td>
<td>Civil Engineer, Palace Chambers, Westminster, S.W.</td>
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<td>Oldham, Alfred</td>
<td>Assistant to Signal Superintendent, L. and N.W. Railway, Crewe</td>
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<td>Openshaw, Vincent H.</td>
<td>Assistant Signal Superintendent, L. &amp; Y. Railway, Huntis, Bank, Manchester</td>
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<td>Page, Harold F. D.</td>
<td>Interlocking Surveyor, G.W.R., Reading</td>
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<td>Parsons, Isaac Hardy</td>
<td>Electrical Engineer and Director, Messrs. Gent &amp; Co., Farady Works, Leicester</td>
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<td>Parsons, Joshua</td>
<td>Assistant Signal Engineer, Federated Malay State Railways</td>
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<td>Parsons, Chas. Wulstan</td>
<td>Acting Signal Engineer, East India Railway, 108, Clive Street, Calcutta, India</td>
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<td>Patenall, Frank P. J.</td>
<td>Signal Engineer, B. &amp; O. Railway, Baltimore, U.S.A.</td>
</tr>
</tbody>
</table>
MEMBERS.

NAME.  ADDRESS.

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Thorowgood, W. J. ... ... Chief Assistant, Signal and Telegraph Department, L. & S.W. Railway, Wimbledon Station, London
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<td>Wheatley, William George</td>
<td>Manager and Engineer, Messrs. Saxby and Farmer, Ltd., 12, Cornwall St., Calcutta</td>
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<td>Signal Engineer, B. B. &amp; C. I. Railway, Bombay, India</td>
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<td>Signal Engineer, District Railway, Earls Court, London</td>
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<td>Williams, Llewellyn W.</td>
<td>Managing Director, Henry Williams Ltd., Railway Appliance Works, Darlington</td>
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<td>Wynne, Henry J.</td>
<td>Signal and Electrical Engineer, Government Railways, Wellington, New Zealand</td>
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ASSOCIATE MEMBERS

Addis, Fredk. R.           | 59, Complin Street, New Cross, London            |
Bottorff, Octavius S.      | "Langdale," Blenheim Road, Caversham, Reading   |
Bourne, Fredk.             | 21, Chalcroft Road, Loz, London, S.E.           |
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Dyer, Herbert H.           | 52, Sala Street, Derby                           |
Edwards, John Allen        | 12, Sutherland Street, York                      |
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<td>Smith, O. F.</td>
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<td>Signal Department, Midland Railway, Derby</td>
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<td>68, Otter Street, Derby</td>
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<td>Wardall, H. B.</td>
<td>&quot;Gillygate,&quot; York</td>
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<td>White, Douglas Rendell</td>
<td>9, Renals Street, Derby</td>
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<td>W. R., Sykes Interlocking Signal Co. Ltd., 28, Voltaire Road, Clapham, London</td>
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<td>Routh, Claude Isham</td>
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<td>Signalling Draughtsman, Henry Williams, Ltd., Signal Engineers, Darlington</td>
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<td>Thorne, W. L.</td>
<td>114, Wyldes Street, Worcester</td>
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