

MAY 28th, 1914.

Meeting at The Institution of Electrical Engineers,
Victoria Embankment, London.

Mr. J. SAYERS, *President, in the Chair.*

**American Signal Practice as compared with
British Practice.**

BY MR. A. H. RUDD
(HON. MEMBER.)

A PERUSAL of the reports of Colonel Yorke and other Government officials on some of your rather recent railway disasters, as well as a review of the pamphlet on "Railway Signalling" by your Capt. A. Gardiner, read at Leeds in October, 1908, in which he outlines its defects and offers suggestions for removing them (which suggestions you have not apparently put in practice), vividly bring to mind my visit with Messrs. McCarty and Keiser to "the tight little British Isles" in 1904, and the impressions made upon me at that time, not only of your operating conditions, but also of your unbounded hospitality to your "American Cousins," which I have tried (on the unfortunately rare occasions when opportunity offered) to repay in some small measure by courtesies to your countrymen visiting this side of the pond.

My election, July 5th, 1910, as the first foreign honorary member in your Association, and your action in appointing me, on February 3rd, 1913, an honorary member in your re-constructed Association, prompts me to present for your consideration a comparison of your practice and that which I consider to be the best American practice—the best, forsooth, because *my* road has adopted it!

The personal equation can never be entirely eliminated, and the personal note is always present, so I take this

opportunity to express to my friends "beyond the sea" my appreciation of the honour, second to none I have ever received, which you have bestowed upon me, and, although I cannot help but feel that it was given under a misapprehension, I hope to retain it.

My uncle, Alexander L. Holley, one of our pioneer steel engineers, has been held up to me as a model by my family all my life because he was a member of your Associations, so you will appreciate what your action has accomplished in strengthening my position with my family, and so again I thank you.

On looking over the series of articles in the *Railway News*, beginning in the August 23rd issue, 1913, I am impressed with the number of aspects which the driver must learn. We have even more than you, but are striving for "simplified signalling," and are rapidly attaining it.

Until recently we have followed closely in your footsteps—like the Japanese we have been imitators, and have not until recently studied the history of your development of signalling or analysed the reasons for the original installations and subsequent changes. Your conditions differ from ours and, had we made this study when signalling was first introduced here, we should have benefited greatly and done differently some things which it is now too late for us to change.

First: Why do you use the arm in the lower-quadrant? Because when you started signalling the arm was concealed, and you displayed it only when you wished to stop a train; naturally it was biased to drop to clear when not in use. Then you decided that a proceed signal must also be displayed, and you dropped it only part way. Then you counter-weighted it to go to the stop position; you changed the principle of operation, but not the device itself. We imported our first signals from England—then we copied them. What we all should have done then and what we are rapidly doing now is to use the upper-quadrant, doing away with the counter-weight and letting the arm drop to stop by its own weight, *assisted* instead of *retarded* in assuming

this position by any accumulations of ice, sleet, etc., which may form upon it.

Second: Why did you adopt the arm pointing to the left, that is (with your left-hand running) away from the track, and why do we use, with our right-hand running) the arm to the right—still pointing away from the track? I confess I do not know, unless it was to keep the signals low and more in line with the driver's eye.

What is the natural position? Does a man at the side of the road try to stop a train by holding his arms out towards the fields or property adjoining the right-of-way? No; he holds his arm over the track. The arm over the track has its advantages; the mast may be located just as close to the track and, with the light and arm both on the track side, telegraph lines and other structures may be placed nearer the track, in many cases without interfering with the operation of the signal; less right-of-way is, therefore, required. Many of our electric lines are now adopting this arrangement, but, on our steam lines, as with yours, we have gone so far with the old that we cannot change without too much confusion, which, however, does *not* obtain in the substitution of upper *vs.* lower-quadrant signals.

If we started anew, I imagine you would use the upper-right-hand quadrant and we the upper-left-hand—possibly we ought to do so now, and possibly the fear of confusion is not well founded, but so far we have been unable to see our way clear to take the step.

Third: We made one departure from your practice by substituting for your gantrys a single mast for each track governed (in the direction of traffic), the top home arm governed the first route to the right, the second the next to the right, and so on—we had as many as four arms on a mast at interlockings. At some points we had advance block signals, in which case the distant (for high speed only) was controlled by both the home and advance signals, but there was no indication at the home of the position of the advance—that is, the condition might obtain (and still does

on many lines) of a distant at caution, a home at clear, and an advance at stop.

As the number of diverging routes increased, we felt that requiring a driver to remember at which locations the top arm meant straight through and which a divergence was too great a burden, so we "emphasized" the main route by a longer arm or by a mark on the arm (but not by a longer light). Our difficulty was similar to that you have now in showing a fish-tail red light on your distant signal; so that slowly we evolved the principle of the top arm for the through route, which is almost universal to-day, but even then a multiplicity of arms existed, and not more than two years ago we had on the Penna. R.R. two points signalled with four-arm home signals—some roads used two arms with various indicators operated in connection with the bottom arm—later these were discarded and two arms were used on home signals (the practice on many lines to-day), top arm main through *high speed* route, bottom arm *low speed* diverge to all other routes.

The introduction of No. 15 and No. 20 crossovers, radius of curvature respectively 1845.37ft. and 3441.79ft., complicated the problem of route signalling, and our general practice has now developed into what is known as "speed signalling" with either a two or three-arm home signal, the arms, in many cases, operated in three positions.

The two-arm system is simpler but cannot well be used in connection with the home and distant automatic system. The three-arm system may be used with any system. In the former, the top arm, 45° , indicates main route clear next signal at stop, at 90° main route clear next signal at proceed (caution or clear), the bottom arm, 45° , indicates proceed with caution prepared to stop short of any obstruction; and, at 90° , indicates diverge at medium speed, track clear and next signal at proceed.

The development of the three-arm system is shown on the accompanying diagrams. This system gives the greatest elasticity and the maximum of information, and is the one used by the P.R.R.

The ideal system is a two-light system throughout, so that, if only one light is displayed, the signal indicates *per se* that it is improperly displayed. We fall short of this, but the results are satisfactory nevertheless.

Our maximum speed is 70 miles per hour. The "authorised" speed may be less than this, depending upon local conditions. Medium speed is not exceeding 30 miles per hour, and low speed not exceeding 15 miles per hour. The signalling of routes is entirely eliminated. We tell the driver to stop or proceed. In the former case we tell him to stop until authorized to proceed from some extraneous source, or to stop and proceed without further orders, and, in the latter case, we tell him to proceed, at either authorized medium or low speed and, in addition, inform him of the position of the next signal, whether the track is occupied or not, or, in certain cases, show by the signal that it tells him nothing about the block.

Our scheme of signalling is shown on plans 241-S3 and 241-S4 herewith, aspects numbered for reference. It will be noted that the interlocking signals, that is, 1 to 8 inclusive, 17, 18 and 19 on sheet S3, are identical with corresponding numbers on sheet S4.

Aspects 1 and 17 indicate stop and stay until authorised by signalman to proceed (rules governing this procedure varying on different roads).

Aspect 2—High speed route is clear and next signal at proceed if there is such a signal within braking distance. It means to the engineman that he may proceed at the highest authorized speed.

Aspect 3—Proceed on high speed route but stop at next signal.

Aspect 4—Medium speed (30 miles per hour) track is clear and next signal is at proceed (similar to 2).

Aspect 5—Is used in rare cases as a distant signal for the next interlocking home which is full braking distance away, and indicates high speed track is clear but next signal shows aspect No. 4.

Aspect 6—Medium speed (30 miles per hour) track is clear but next signal is at stop.

Aspects 4 and 6 are only used for routes made over No. 15 crossovers or turnouts on tangents, or better, such as No. 20 on tangents or on curves up to 1°30.

Aspect 7—Used for movements *with traffic* and over turnouts or crossovers shorter than No. 15's on tangents. Speed under this aspect is limited to 15 miles per hour. It indicates that track is clear over slow speed route and next signal at proceed, similar to 2 and 4.

Aspect 8—This is what we call our "know nothing" signal. It means proceed at very low speed prepared to stop short of any obstruction, and is used for governing movements to a track against traffic, to sidings, yards, spur tracks, or to the high and medium speed tracks when they are occupied (for instance, to attach a coach to rear of train or for other shifting movements, or when the high signals are out of order); in short, it is the catch-all which gives elasticity to the movement, especially needed where the high signals are semi-automatic track-circuit controlled.

Dwarf signals are used for movements from sidings, yards, etc., and against traffic.

Aspect 19 is for movement to a track with traffic and corresponds in all respects to aspect 7, while aspect 18 has the same practical significance as aspect 8. It will be noted that 8 and 18 do not indicate clear block, while all the others do except, of course, 1 and 17.

Aspects 9 to 14 inclusive, sheet S3, are our manual block signals. It is our practice to run passenger trains and certain classes of fast freights under absolute block rules, such freights, for instance, as "perishable" (vegetables, fruits and meats, refrigerator cars, etc.) and "preference" freights of high grade commodities, whose speeds are almost as high as those of our passenger trains, while the slow freights of heavy and bulky commodities are run under "permissive" block—that is, they are permitted to follow each other under a distinctive signal (permissive signal) into an occupied block.

Aspects 9 and 10 have the same significance at No. 1.

Aspects 11 and 12 have the same significance as No. 2.

Aspect 13 is used in absolute block to indicate track clear next signal at stop; similar to No. 3.

Aspect 14 is the "permissive" signal and may only be accepted by certain freight trains.

It will be seen by the notes on plan that, on certain branches where there are no long crossovers and consequently no medium speed route, the medium speed arm and light may be omitted; further, that the "permissive" indication may be given at interlockings under certain conditions, thus doing away at small interlockings with the necessity of providing advance (block) signals.

Aspects 15 and 16—Are used on thin lines where traffic is so light that a block system is not required, and need no explanation.

Aspects 20 to 24—Are distant signals in manual block territory; 20 is the distant signal for No. 1; 21 the distant for No. 2; 22 the distant for No. 4; 23 the distant for 9 and 10, also for No. 1 on branch lines with middle arm omitted and for an outlying switch open; 24 is the distant for 11, 12, 13, 14 or No. 2 with middle arm eliminated or for an outlying switch closed. On account of our permissive operation none of these distant signals give any information as to occupancy of track between them and their home signals, and consequently their least favourable indication is caution; for this reason the fixed light is a caution light while it will be noted that the fixed light on the block signals is red, as stop is their least favourable indication.

Aspects 13, 14 and 15, sheet S4—Are the usual automatic signals. Note the pointed arm and diagonal lights used to differentiate from the manual block signals.

Aspect 13 indicates stop, then proceed (by rule) with caution, looking out for train in block, open switch or broken rail.

Aspect 14—Block clear next signal at proceed—that is, next signal shows 14 or 15.

Aspect 15—Block clear next signal at stop.

Aspects 9, 10 and 12 have exactly the same meaning as aspects 13, 14 and 15, and same night aspect, but the second arm is added so as to provide for aspect 12, which is used as the distant interlocking signal and has the same meaning as aspect 5 or as aspect 22, sheet S3, except that it gives additional information not given by 22 that the block is clear.

The application of aspects 1 to 8 and 9 to 15 is well exhibited on plan of Southwest Junction herewith, this plant having switches and signals controlled at greater distances from a central point than any other of which I have knowledge. Plans of Auburn, McElhattan and Hollidaysburg exhibit the various conditions requiring the different aspects.

It might be interesting for some of you to apply our system to some of your own layouts and decide whether our "simplified signalling" would meet your requirements. Try it at Ditton, for instance, and see whether it might or might not have helped the driver who tipped over on a short turnout—provided, of course, that the same method was used everywhere on the line.

I have before me a signal bridge showing gantry signals near Rugby, L. & N.-W. Ry. As I read them, the bottom level are simply repeaters for the upper level, three tracks are signalled, the one on the right has 5 masts, 8 lights; middle track same; left, 3 masts, 6 lights; total, 13 masts and 22 lights; duplicated below, total, 26 masts and 44 lights. We would use 3 masts and 9 lights at this bridge, and full braking distance in the rear we would put up three two-arm distant signals, depending on these latter to govern the approach to the home signals, and eliminating the upper row of home signals entirely, and yet having 10 masts and 13 less lights than the lower row. Take the track to the right only: you have, with the various positions of the arms, 11 aspects; with our 3-arm signal we would have only six. If I read your signalling correctly, the proceed indications given by the two single-arm signals on the right

would be indicated by aspect 8; those given by the third and fifth masts from the right by aspects 4 and 6; those given by the high mast (fourth from right) by aspects 2 and 3, while the stop indication would be given by aspect 1.

Of course, to adopt this system you would require some light other than red for caution—a distinctive caution light. While the Penna. R.R. generally uses white for clear, green for caution, and red for stop, it has on some small parts of its line followed the practice in vogue on a majority of the mileage in the States and Canada, viz., green for clear, yellow for caution, red for stop—the basis of the system being that red indicates stop unless qualified by a more favourable colour and corresponds to the horizontal position of the arm, yellow to the diagonal position, and green to the vertical position. Many roads use purple instead of red in the dwarf signals, which has decided advantages in a country where flagging is universally employed, in avoiding confusion between fixed signals and flagmen. We all use red for stop. Our use of white for clear is illogical and almost indefensible; your use of red for caution in your distant signals is equally pernicious, and yet we both are in a quandary for a remedy. Our own management, despite my recommendations and the action of other roads, feel that the yellow is not sufficiently distinctive for a caution indication, especially in the pall of smoke hanging over our Pittsburgh and other steel manufacturing centres, while your fog conditions are certainly as bad and probably worse. Our glass makers are constantly working to develop a better yellow, and some of us have worked unsuccessfully on a combination of lights. Dr. Churchill, of the Corning Glass Works, has produced the “lunar white” which has a limited field, but has not met with approval as a long-distance light. Our spectrum is limited, and here we are with the problem still unsolved. Your use of red in the fish-tail signal has one advantage—with home and distant arms on one mast, you have two reds for stop, we have red over green or red over yellow, as the case may be, and you will readily see the complications involved, but which

are eliminated by the use of the three-position signal. On both sides of the water, men are looking for a better caution colour, and the man who discovers or invents it will be a benefactor.

The promoters of the flashlight are making great claims for it, but it has not met with much favour here. It has been suggested by some of our own people that we might use red for stop, green for caution, and a flashing white for proceed. This is a possible solution.

With sources of electricity so numerous, it may be possible to develop a position signal, for the high running signals, formed of white lights only and available for day and night use. This is another possible solution worth looking into. But, meanwhile, pending the development of these two propositions which will probably take some time and may possibly result in failure, it seems to me that, with all its acknowledged defects, yellow offers the only remedy, and the fact that so many roads are using it with good results goes far to confirm this view.

We are about to electrify our four-track steam line for local travel in the vicinity of Philadelphia. We are to use overhead trolley. We are now developing a light signal for day as well as night use; it takes about 15 watts per lamp, and is so powerful it must be dampened down at night. If we use it, it will probably be arranged so the lights can be turned down in sections of three or four miles between interlocking cabins from each cabin. In case of a fog at night, they can be turned up to the same intensity as daylight. A recent demonstration in the fog in daylight showed lights visible 2,500ft. away, while the signal arm could be only dimly discerned at 1,500ft. This, therefore, has possibilities, but does not solve the colour problem.

We are hearing much nowadays about audible signals and your wonderful developments of them. We may come to them in time, but, as in our automatic system, a distant signal becomes a home as soon as a train passes it, and continues as such until the train passes out of the block, the problem is complicated. Further, as our tracks are not

policed as yours are, and as trespassers are allowed to roam on our lines almost at will, it is necessary for our drivers to watch the track constantly, and I doubt the advisability of substituting an audible for a visible signal with our conditions.

I have noted your recent accidents at Colchester, July 12, 1913, where the signalman overlooked a light engine and forgot or neglected to collar the lever with disastrous results. In busy places we use the track circuit; we instal approach locking, electric switch locking and route locking, and go much farther than your practice in safeguarding the signalman from making mistakes.

A logical sequel is the automatic stop or the train control system. As one of our prominent signal engineers (he has since fallen from grace, and was for a while a Government official, and is now "in trade") remarked, "We try to make our signalling fool-proof, the English eliminate the fool." From recent occurrences, it would appear that our attempts are, in some cases, futile, and that your elimination is incomplete. Perhaps we have gone too far in our efforts; perhaps you have not gone far enough. Probably a middle ground should and will be found where you will be able to apply additional safeguards without weakening your wonderful discipline, and where we, with our safeguards, can improve our discipline so as to give greater value to our efforts. But, as long as trains run on railroads, so long will wrecks occur until the millenium arrives and we are all made perfect. Every time a throttle is opened a dangerous potentiality is introduced, and as long as train movements are made under the direction of fallible humans "even as you and I," so long will the chances of wrecks continue. Our efforts should and must be to reduce them to a minimum.

Interstate Commerce Commissions, Boards of Trade, Congresses and Parliaments may do their best—the fact remains that they can do less than those in authority (if properly supported) who are giving their best expert knowledge (and there is none better) to lessen the risk.

Many of our signal engineers came from England, much of our original apparatus was furnished from the same source. The result is a signal system combining English conservatism with American radicalism, which is standing well the test of time. The combination is a strong one.

I know Henry Thornton, who has recently gone to you as a general manager on one of your trunk lines. He is a splendid fellow. I hope you will meet and know him and receive him as we have received your compatriots who have come over here to help us, and the mutual benefit of such acquaintance will, I am sure, be of the greatest value to the cause of railroading in its broadest and most cosmopolitan scope.

I trust the reception of this screed will not entirely wear you out. My only regret is that I cannot present it personally and answer in person the questions and criticisms I hope it will evoke. If the latter are very severe, I shall be glad to make a later reply, and if there are any points not made clear, I shall esteem it a favour if your Secretary will send me a list of questions to be answered.

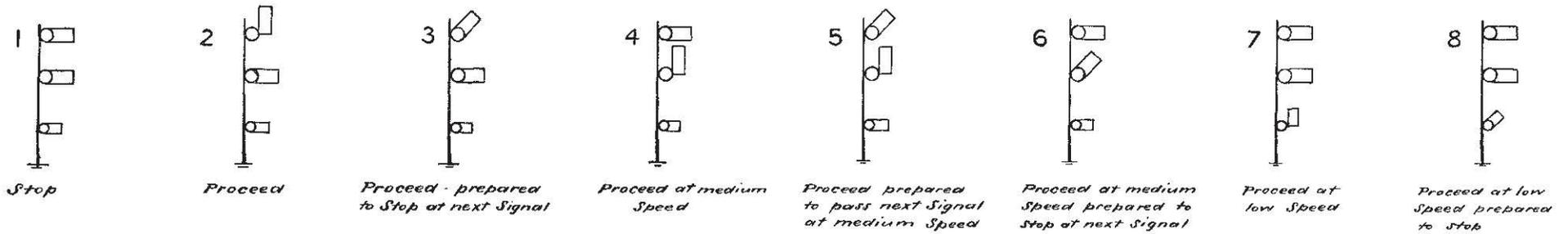
The following was received from Mr. RUDD after his Paper had been printed.

To make the scheme a little more clear, perhaps it would be well to call attention to points which I apparently omitted.

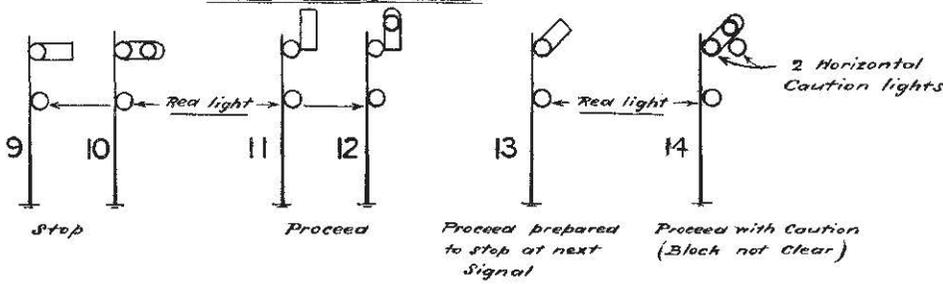
First.—The basis of the scheme is to give an indication at each signal of the position of the signal in advance, that is, advance information, so that a man may properly control his speed on reaching the next signal.

Second.—No attempt is made to indicate the exact speed allowed, that is, 30 or 15 miles per hour, at automatic or manual block signals, the speed being governed by restrictions and unchanging conditions, but the speed signalling so called, applies only where conditions change as at an interlocking; that is, where alternative routes, permitting

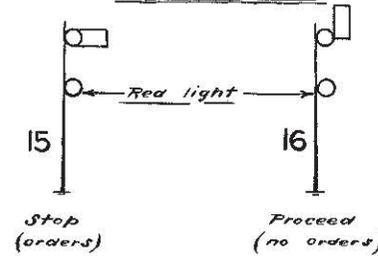
Interlocked Home Signals



Block Signals



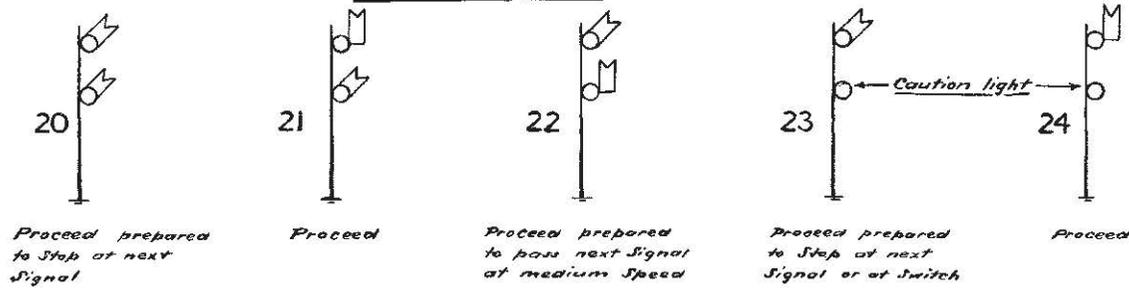
Order Signals



Dwarf Signals



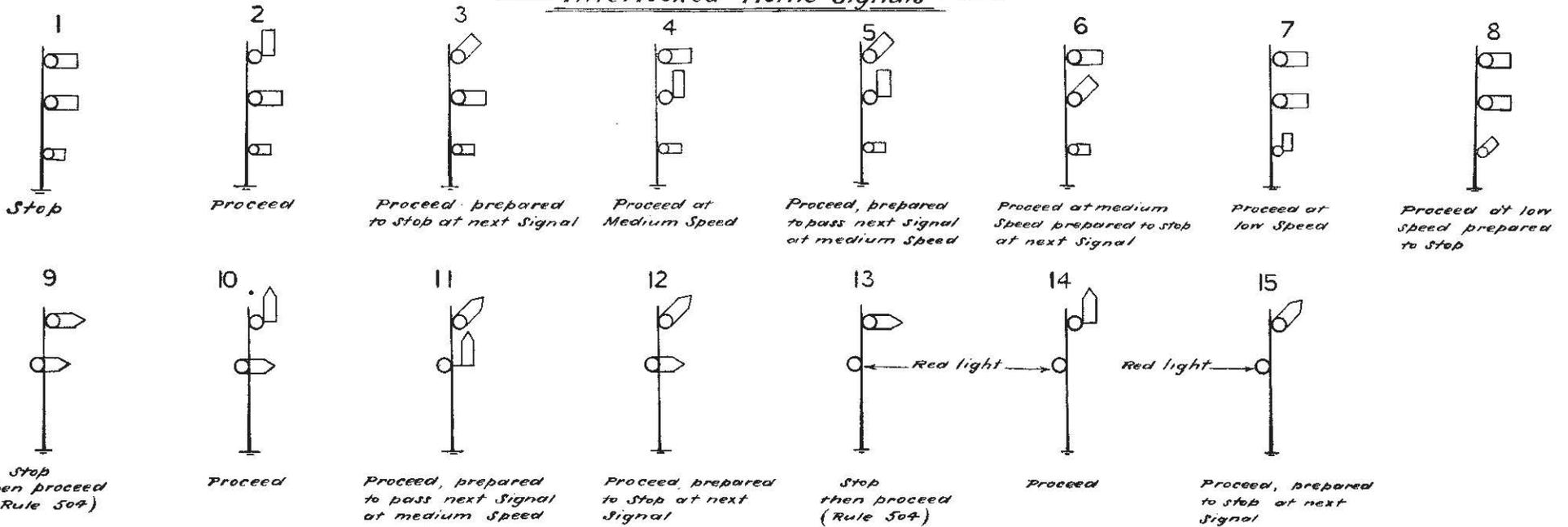
Distant Signals



Notes :

Middle arm and light of home signals and bottom arm of distant signals may be omitted on branch lines
 Round end arm and horizontal lights used only where block is operated permissive; This arm and lights may be applied to top and middle arm of home signal when it is used as a block signal and to bottom arm when used as a block signal provided it does not govern to any other route

Interlocked Home Signals



Automatic Signals

Note: — Middle arm and light of home Signals and bottom arm of automatic Signals may be omitted on branch lines.

Dwarf Signals



different speeds, exist, and any one of which may be set up for an approaching train. With this speed signalling, the higher the relative location of the arm, the higher the speed; top arm, top speed; low arm, low speed; middle arm, medium speed; and red light means stop unless qualified by some more favourable colour.

Page No. 78.—The coloured light signal referred to takes about 25 watts per lamp instead of 15. In the third paragraph I stated that it might be possible to develop a position signal for the high running signals formed of white lights only and available for day and night signals. We believe we have developed this within the last two or three weeks sufficiently so as to permit of its use, and, if it is adopted, I shall be glad to send you a description of it at an early date. The great advantage beside eliminating the coloured-light problem entirely is the further elimination of all moving parts of the signal itself, the only moving parts being in the relays controlling the lights, thus cutting down in the cost of maintenance and in the number of failures.

DISCUSSION.

Mr. R. J. INSELL: I am sure we are all indebted to Mr. R. J. Insell
Mr. Rudd for the interesting Paper we have before us, and it is worthy of note that one of our first Honorary Members should have taken the trouble to write a Paper for our benefit, and set us such a good example. Mr. Rudd refers to the hospitality he experienced on a visit to this country in 1904, and I can only say that the hospitality that I and my colleagues received in the States last Autumn from all with whom we came in contact was unbounded, and will never be forgotten.

I feel personally indebted to Mr. Rudd from the fact that he has brought to your notice the American three position signal, and if he had not done so I should have felt it my duty to have read a Paper myself on the subject, as

Mr. R. J. Insell I think the three position signal is one of the most important of the many interesting things I saw in the States. The signals we have in use to-day are practically the same as were in use half a century ago, and it must be admitted that they are the least efficient of the many parts which make up the elaborate system of locking and signalling which has been in universal use on the whole of the railways for so many years.

I venture to say that if we were commencing to provide signals to-day, no one would suggest that they should be worked by open wires fixed on stakes in the ground, and in a position to be interefered with by any mischievous person. We should, I feel sure, commence by working them electrically, and at the same time endeavour as far as possible to make them as simple as possible so as to be easily understood by drivers. Our present elaborate signalling is the result of years of expanding traffic, and I am bound to say that, in my opinion, we have not progressed, so far as the signal itself is concerned, in anything like the same way that the other important parts which go to make the railway of to-day. Engines, Rolling Stock, and Permanent Way have all been vastly improved, while the signal has practically speaking been retained in its original form.

I think, therefore, that we as Signal Engineers owe a debt of gratitude to our American cousins for the bold way in which they have dealt with the matter and produced a common form of signal which everyone can understand. I think the diagrams will give you some idea of the manner in which the three position signal is used, and to my mind it is the most simple form of signalling which can be adopted, and is not open to the objection of being misunderstood. The cartoons show clearly the three aspects, and the only rules required in connection with such signals when worked automatically are:—

1. Stop;
2. Proceed with caution;
3. Proceed at ordinary speed.

These rules are a very important feature of the three position signal, and with their introduction into this country we should be able to discard the very elaborate rules and regulations governing the working of signals which are now in force and which experts only can understand. Mr. R. J. Insell

The question of Automatic Signalling so largely in use in the States must sooner or later be taken in hand in this country, and when such time arrives I hope the introduction of the American system will be seriously considered. While in the States I travelled over a distance of about 3,000 miles of railways, practically all of which was automatically signalled, although not entirely with three position signals, which have only recently been adopted, and are being fixed as quickly as possible.

The Americans are in a much more satisfactory position in regard to track circuits than we are, as they have metal wheels on all their stock, which is also very heavy, and this probably is one reason why so much has been done in the way of automatic signalling. We, as you are aware, have had many difficulties to overcome; in fact, it is early days to say we are out of the wood. Mr. Rudd refers to audible signals, and is evidently not familiar with the system now used on the G. W. Railway, which can be used with the three position signals, and leaves the driver perfectly free to watch the line, as there is no visual signal in the cab; there is also full control of the train by means of the brake in the event of the failure of the human element.

I think we should note the fact that our doings, and misdeeds, are carefully noted on the other side, and it should be an incentive to us to take a little more interest in the doings of our American friends.

I hope the subject of three position signals will be well discussed by the members present here to-day.

THE PRESIDENT (Mr. J. SAYERS): Mr. Rudd starts in a very complimentary mood to us for making him the first honorary member of our Institution. He appears to be very pleased with the honour. I think that whatever we Mr. J. Sayers

Mr. J. Sayers have done for Mr. Rudd has been more than compensated by the Paper which we have heard read to-day on the subject, "American Signal Practice as compared with British Practice." So far as I know this is the only Paper dealing with American signalling practice which is really in existence and which has also come to Britain for discussion.

As a rule up to now we have only had the incursion and excursion of various railway officials who have returned, and, to some extent, kept the information somewhat private, but we now have from America itself, and at absolutely first hand, information of the methods which are there adopted.

I ask you to pass a vote of thanks to Mr. Rudd for his singularly able and interesting Paper.

Mr. A. F. Bound Mr. A. F. BOUND: Mr. Chairman, I think we are all under a big debt of gratitude to Mr. Rudd for writing and sending to us a Paper on what ought to be to all of us a most interesting subject. I do not happen to have been one of the fortunate ones who have recently visited America, but I have conversed with friends who have been there on various points, and I will now mention a few that have occurred to me.

In regard to the question of the three position signal: From the study I have been making of it, and what I have heard and read from American periodicals, the system so far as it can be applied to English practice appears to me to be satisfactory. It seems to me that the three position signal is one of the things we want to aim at, and one of the things we badly want is to so arrange the signalling that a driver, who may be strange to a line, may come along and take a train, say, 200 or 300 miles, without any necessity for a pilot. We desire, and should be able to institute a system that makes it unnecessary for a driver to have had previous experience of the road over which he has to run.

Will Mr. Rudd please tell me what benefit is to be derived from the middle arm shewn in examples 1 to 8 on sheet 4, especially as regards the aspects exhibited by it in

examples 4, 5, and 6. It appears to me that the three positions of the top arm gives all the information necessary when combined with the bottom arm in certain cases such as terminals or large stations where in English practice we provide what is known as a calling-on arm. Mr. A. F. Bound

It is a very valuable feature in this system of position signalling that every signal can be made to act as a distant to the next signal ahead. It changes to a home signal as soon as a train passes it, and continues as such until the train passes out of the block. Take, for instance, an ordinary junction with the starting signals on the diverging lines 700 yards ahead of the fouling points, as is now frequently the case. With our present system, before the junction distants can be lowered, the starters must be "off," which means a clear road right through the next section, but with the system under review the distant signals would only repeat the home signals, and the latter would act as distant signals for the starting signals, so that a train would run one half-mile farther than at present speed, and this would have the effect of considerably speeding up the traffic.

On sheet 3 we have aspects 20 to 24, three of them with two arms, and 23 and 24 with one arm each and a lower light. I should be glad if Mr. Rudd or anyone could give us a little further elucidation hereon as to the necessity for the same, as it appears to me that the two aspects 23 and 24 are all that are necessary, at least so far as English practice is concerned.

Another point which I think should be brought out is the question of the lights.

I believe the yellow light has been tried in England, but I am not sure it was a success.

I have been told that the difficulty of distinguishing between three different types of light is not so great when you recollect that in looking at the yellow you always have the red to compare with it. I think that is often overlooked.

The second marker light underneath the arm of a one arm signal, therefore, certainly appears to me to be

Mr. A. F. Bound desirable. In addition it enables the driver to distinguish a stop signal as compared with an automatic signal due to the lights on the latter being staggered, and also if one of the lights have gone out the signal is treated as a "danger" signal there is not the likelihood of it being overrun in the stop position as in our practice.

I think that is all I have to say about the subject at present, and I only hope we shall have a good discussion, and that before many months have gone by we shall have something of the sort under trial in England. I am sure we shall all benefit from such a system.

Mr. E. C. Irving Mr. E. C. IRVING : In connection with the three position signal, referring to Mr. Bound's remarks : In the States it is usual where the distances between interlockings are considerable, to have automatic signals, in which case the automatic signal acts as the distant signal for the interlockings. I believe the maximum distance between automatic three position signals is about $1\frac{1}{2}$ miles (with regard to the limit of distance between the automatic signals, Mr. Insell could give us a little more information), this distance being considered quite long enough for the driver to carry in his mind the last indication received.

As the three positions are common to both the permissive and the absolute stop signals, a distinction is made in the case of the permissive signal by fixing a marker light (usually red) on the opposite side of the post from the signal light. The daylight distinction is a pointed arm. The absolute stop signal at interlockings usually has three arms, one above the other, and the lights are fixed in a vertical line. The signal arms are square ended.

The upper arm governs the high speed route, the second arm the medium speed route in either direction, right or left, and the lower arm, which is shorter than the others, is used for calling on, shunting into a dead end, or, in fact, for the purpose of any low speed movement and where track circuits are used the traffic can be kept moving by the use of this signal in the event of their derangement.

I should like to add that the great benefit derived from the three position signal is that you have a distinctive position for the Caution indication, which we do not get in the two position system. We have also the benefit of two signals with one signal mechanism.

Mr. E. C. Irving

Mr. J. SAYERS: The automatic signals are placed about a mile apart. The three mile block mentioned by Mr. Bound does not arise. The interlocking signals and towers may be many more miles apart. One case I know of, where there is a 65-mile section of automatic signalling between interlocking.

Mr. J. Sayers

Unfortunately, I have to go. Before doing so I should like to suggest that this discussion be adjourned, and another paper be written by someone qualified to parallel American practice with British Traffic working.

I have a question to ask Mr. Rudd. In the last paragraph of page 74 he distinguishes between running passenger trains under absolute block rules and running trains under permissive block. I have never understood that this was so. I was not aware that trains could run under permissive block at one time and under absolute block at other times, through the same section of line.

[The President then vacated the Chair, and Mr. C. H. ELLISON took charge of the meeting.]

Mr. C. M. JACOBS: Mr. Chairman, I think what we might consider is not how to apply the American system of signalling, but whether we could not with advantage make use of the three position signal. There appears to be a good deal in the American signalling aspect, and its adoption in this country might enable us to simplify our Rules and Regulations.

Mr. C. M. Jacobs

Mr. Rudd has given us an example showing how he gives the same amount of information with three masts and nine lights as we give with 26 masts and 44 lights, and he gives the information, I think, in a more intelligent manner

Mr. C. M. Jacobs than we do. It is time we considered whether our signalling aspects should not be altered.

The idea of the "know nothing" signal seems good and better than our practice of trying to give the driver all sorts of information, as to routes at terminal stations, for instance.

With regard to lights, if the yellow light is mistaken for anything at all I think it can only be mistaken for red, and this is on the side of safety.

Mr. R. G. Berry Mr. R. G. BERRY: Mr. Chairman, I endorse what the previous speakers have said in thanking Mr. Rudd for his Paper.

It has been very interesting to listen to the remarks of Mr. Insell and Mr. Jacobs, for these gentlemen have had the opportunity of studying the practical side of the three position signal in America. I must confess that it is quite a new thing to me, and it is very difficult to express an opinion on anything unless one has studied the question more than I have been able to. Mr. Rudd states in his Paper that by means of this signalling the maximum of information is given. When I looked at the diagram I tried to look at it from a driver's point of view. There is no doubt that what this system is trying to achieve is good and ideal, but on sheet 3 there are eight signals, each with three arms, giving eight different combinations of signals. It would appear at first sight that, rather than simplify matters for the driver, it would tend to complicate them. I am speaking now without having had any experience. I should like to know Mr. Insell's opinion, for he has actually seen the three position signal in operation on the road, as to whether he thinks the system presents any complicated features to a driver.

There is one other point which is interesting to note. Mr. Rudd mentions the flash-light signal, and gives their opinion thereon. It has been tried over here, and it is rather interesting to see that they have considered the question over in America.

Mr. B. H. PETER: Mr. Chairman, the discussion so far seems to have been practically limited to the three position signal. I would like to refer to the use of the upper quadrant.

Mr. B. H. Peter

It is in use in England, and it has proved very successful from the engineering point of view, only leaving the traffic side of the question to consider. When it was first installed the majority of the drivers were very much against it, but after experience they welcomed it and, I believe, petitioned for the extension of the upper quadrant.

Mr. A. F. BOUND: There is another point I would like to mention—the question of fogmen. In English practice we generally have a fogman posted at the distant signal, and if we adopted the three position signalling I can easily see trouble from a traffic point of view in not having sufficient men to go round, providing the present arrangements were kept in vogue.

Mr. A. F. Bound

In connection with Mr. Peter's remarks, I think there is not much question in the minds of Signalling Engineers that the upper quadrant is the right aspect for the signal to take, and I should like to see it adopted generally; unfortunately, it is rather a big order to change all the old signals.

Mr. J. A. SILVER: Mr. Chairman, I should like to say a word or two on this Paper, *i.e.*, the diagram illustrates views of signals which may be read in eight different ways. This to many English drivers would appear detrimental, and be some excuse should an accident occur, but I have no doubt it would soon be got used to. Against this the English method of only having two positions (Danger and All Right) (Off or On) seems to simplify matters from a driver's point of view, but to equalise things we have many kinds of signals such as Distant, Home, Starter, and Advanced Starter (the three last being of the same form). In addition we have Siding, Backing, Shunting, Calling-on, which are all distinctive by rings or letters.

Mr. J. A. Silver

I do not know the practice the Americans adopt in

Mr. J. A. Silver working mechanical signals, but I would like to know what methods they adopt in order to ensure the arms go to the 45° or 90° position, as the case may be (this is quite understood as regards the automatically-worked signals), and what means they adopt to get over the difficulty of expansion or contraction. I see on page 71 Mr. Rudd speaks of the American system in regard to the position of a man on the track when indicating the stoppage of a train, as holding his arms out over the track. Is this right, please? The English practice is for the man to hold both of his arms over his head, not across the track, to stop a train; but to hold his right arm out towards the track for "All Right" or Go Ahead.

Aspects Nos. 13, 14 and 15 shewn on sheet 4 and described on page 75 as automatic signals with pointed arms and diagonal lights used to differentiate from the manual block signals, I fail to see any diagonal lights illustrated in this diagram. However, it would seem to be a possible solution of the three position arm if the lights were split, or the red and green to be placed side by side, or red and white, whichever combination would be most distinctive; or the lights might be re-arranged as double or triple in combination for a distinctive signal, either to be used for a distant or a home, in place of the flash-light, which, if I heard correctly, the American people have adopted.

Mr. F. Downes Mr. F. DOWNES: I join in thanking Mr. Rudd for sending his splendid Paper.

There are one or two matters I would like elucidating. One point still remains in my mind, and that is the difficulty with regard to the driver. Sometimes there is disagreement between the Traffic and Loco' Departments in deciding whether a signal has been read correctly. Whilst the Electric Repeaters have shown a midway position indicating to Signalman "Signal out of order," drivers have read signals incorrectly, sometimes assuming them off when in the midway position. That difficulty seems to me to be one

of the greatest objections from an English point of view to the three position signalling. Mr. F. Downes

It occurred to me that the upper quadrant could be utilised for the caution position, the horizontal position as we have it now for Stop, and when the arm is dropped into the lower quadrant to be an indication for Proceed. I should like to have the opinion of Mr. Insell on that question.

I am very pleased to hear that we shall have a further discussion, and also how the practice will apply to English railway working.

Mr. C. CARSLAKE: Mr. Chairman, I would like a little further information as to the actual use of aspect 5 on sheet 3. Mr. C. Carslake

Mr. F. R. ADDIS: Mr. Chairman, I would like to put a question. How do the Americans deal with slotted signals on this system, mechanically? Mr. F. R. Addis

Mr. A. F. BOUND: With regard to Mr. Downes' remarks, I think the trouble he refers to is what we all experience with mechanically-worked signals due to contraction and expansion of the signal wire. It would be exceedingly difficult, if not impossible, to give the three aspects with a mechanical signal, and I think Mr. Downes can take it for granted the signal would be worked electrically, in which case he will realise it is quite easy to work the arm to the exact angles, and I do not think there would be much doubt in a driver's mind as to the indications displayed. Mr. A. F. Bound

Mr. S. L. GLENN: Mr. Chairman, the practice of three position signalling is, to my mind, good, because it gives full information to the driver as to the condition of the road ahead of him, and it gives him that information early. Mr. S. L. Glenn

For instance, aspects 3 or 6 give early information that the next signal ahead is as shown in aspect 1; similarly, aspect 2 tells the driver the next signal will be either 3 or 5;

Mr. S. L. Glenn while aspect 5 gives the driver information in advance that the next signal will be as 4.

But I do not see what aspects would be given to lead a train up to 7 or 8. I suppose either 3 or 6 would be used.

Referring to Mr. Bound's remarks about signals 20, 21, 22, 23, 24, I take it these would be used in cases where the traffic is so thin that the use of automatic signals is not warranted. In such cases these signals would be used as Distant signals, and as they do not drop below the 45° or Caution position, as shown in 20 or 23, the use of such signals is logical, and fits in well with three position signalling.

Mr. Rudd refers to the difficulty of obtaining three distinct coloured lights, and mentions the "lunar white." I have seen this light in use; it is something like bright moonlight, quite a distinctive light, but not a powerful one.

Mr. H. E.
Morgan

Mr. H. E. MORGAN: Mr. Chairman, I should like to ask if the three position arm is not more suitable for main lines with fairly long block sections than for suburban lines where we have short sections.

(Mr. Morgan drew the blackboard diagram shewn below.

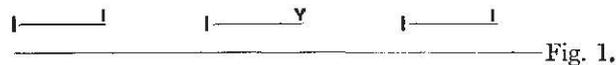


Fig. 1.



Fig. 2.

Fig. 1 represents present British practice, where it is possible to get the distant signal its full distance from the home signal without placing it under the rear section starting signal.

Fig. 2 illustrates a three position arm fixed on the site of the rear section starting signal, and which takes the place of the separate starting and distant signals shewn in Fig. 1. (This is the equivalent of our practice of plain starting and distant signal arms on the same post).

Now, in the first example, a frequent train service would often mean that a driver would pass the starting signal at the Box in the rear with the distant signal for the next Box at danger, but it would probably be lowered before he reached it, and no delay would be caused. If, however, the three position signal shewn in Fig. 2 was in use, the driver would get a caution signal when entering the section and would proceed cautiously at low speed until within sight of his home signal, and this would cause frequent delays to traffic.

Mr. H. E.
Morgan

Communicated by Mr. H. E. MORGAN: As no one has referred to the statement made by Mr. Rudd in the second paragraph on page 79, I think it only right to point out that the morals of such accidents as Colchester, to which he refers, are not quite overlooked by the Railway Companies. He points out that track circuit, approach locking, electric switch locking, etc., is used in America, and that they go much further than we do in safeguarding the signalman from making mistakes.

Communicated
by Mr. H. E.
Morgan

To some extent this statement is correct, but, judging from Colonel Yorke's report dated December 6th, 1902, after his visit to America, it would appear that their efforts are confined to the busy sections of the lines near to the large cities, and that by far the greater mileage of the lines are neglected. To quote his words: "Signalling in America is in an inchoate condition, there being no uniformity of practice throughout the country. Some portions of the principal railroads are fully signalled, but on many others hardly any signals are used. . . . Similarly, with block working, only about 25,000 miles out of a total mileage (measured as single track) of 200,000 are at present worked in America on the block system, but its use is being gradually extended. Single lines, which form the bulk of the railroads of America, are operated almost entirely on the 'train order' system, no train staff or tablet being used as in England, there being no less than 13 standard forms of 'train orders' in use. The train order system was tried

Communicated
by Mr. H. E.
Morgan

in England, and has long ago been abandoned as troublesome and dangerous, and I believe that the American train service would be probably conducted with greater punctuality and economy, and certainly with greater safety, if the electric staff or tablet system were introduced on the single lines."

I fully recognise that this report was made some years ago, but I understand that practically the same state of affairs exists to-day.

Nor can I agree that we do not go as far as they in the installation of safeguards for preventing signalmen's mistakes. In most of our English railways some form of reminder is in use to warn the signalman of a train standing at a signal—either electrical or mechanical in design, and very often automatic in action. Amongst the first to introduce these appliances were the London and South-Western, London and North-Western, Great Western, Great Eastern, Great Northern, Midland, Lancashire and Yorkshire, South-Eastern and Chatham, and London, Brighton and South Coast Railways.

We have in use on the Midland Railway alone over 550 track circuits for the protection of standing trains, exclusive of those for controlling automatic signals.

Most of our busy railways are worked on the lock and block system, or "Controlled Manual," as our American cousins term it, and pronounced by the Commission appointed by the United States Government to enquire into the various systems in use in that country in their report of February 23rd, 1907, as "the best in the world."

Amongst the Companies using this system may be mentioned the London and South-Western, Midland, Great Central, Great Eastern, South-Eastern and Chatham, London, Brighton and South Coast, North British, Glasgow and South-Western, etc., and there is not the slightest doubt that a combination of lock and block with replacers (or their equivalent) on the starting signals and track circuits within yard limits makes a system which is as safe as it is possible

to devise, and yet gives that elasticity of working which is a *sine qua non* on a busy railway.

Communicated
by Mr. H. E.
Morgan

Mr. S. L. GLENN: It seems to me that the point raised by the last speaker has not so much bearing on the use of three position signals, as on the positions in which the signals employed shall be placed.

Mr. S. L. Glenn

If the traffic is such that the distant indication given by the inner signal is useful, a signal should be placed at that spot—no matter what type of signal he employed.

Mr. C. H. ELLISON: You heard what the President said this afternoon before he left the Chair, that it was the intention to adjourn this discussion to-day and continue it at some future meeting, at which he undertook to have a Paper prepared on somewhat similar lines to the one we have heard read to-day.

Mr. C. H. Ellison

We have thanked Mr. Rudd, I hope, sufficiently for the Paper which he has sent us, but there are one or two remarks which I should like to make before the meeting closes, on one or two points which he has raised, and points which are not of a technical character but more of a social character.

On page 70 of the Paper he speaks of the honour which has been done to him by this Institution of conferring upon him an honorary membership, and he goes on to say that he cannot help but feel that it was given to him under a misapprehension, but he hopes to retain it. I must say, and I can assure Mr. Rudd on behalf of the Council of this Institution, that the honour was not conferred under a misapprehension. If we could only get more honorary members of the same status and the same ability and ambition, who will take an interest in the Institution as Mr. Rudd is doing, it would augur well for the future of our institution. We should try to add to our list of honorary members men who are prepared to do what, apparently, Mr. Rudd is prepared to do.

On page 78 of the Paper he says "We are about to

Mr. C. H. Ellison electrify our four-track steam line for local travel in the vicinity of Philadelphia. We are to use overhead trolley." I do not know whether he means that this is the first instance in America of the overhead trolley being used. I have not had the privilege, as some of our members here to-day have had, of visiting America. I think I have told you before that we cannot afford such luxuries on the little Company with its small monopoly in the North of England from which I happen to come. If this is the first instance of the overhead trolley being used in America for railway traction, then it becomes a very interesting problem, and it occurs to me that I might here mention that we on the North-Eastern Railway are electrifying now a mineral branch which carries, I believe I am right in saying, the largest mineral traffic in Great Britain with the overhead trolley system, and I invite you Railway Signal Engineers to watch this experiment of ours. I think it is a thing which is full of interest to the future of railway traction, and one which, if successful on this very heavily worked and very heavily loaded line, will prove of great use to railways in the future.

On page 79 Mr. Rudd makes a remark to which I should like to refer. I do not quite understand what Mr. Rudd means, and, like many others, am seeking information this afternoon. He says "We try to make our signalling fool-proof, the English eliminate the fool." I am afraid this is not quite correct. I think the fool on an English railway is the most obstinate beast and the most difficult problem we are called upon to deal with, and I never knew that we had the character of being able to eliminate him. I think, as an electrical engineer, and electrical engineers, I am sure, will agree with me, that our greatest anxiety and our greatest endeavour to-day is to do, as they are apparently doing in America in connection with manual and electrical signalling, that is, to make signalling absolutely fool-proof, and we are doing it with one purpose in view, which is the safety of railway servants and the general travelling public.

There is just another point I should like to refer to, and

that is the concluding remarks of Mr. Rudd's Paper, where he refers to Mr. Henry Thornton, whom, he says, America is sending to us as a General Manager, and he hopes that we shall receive him as Englishmen generally receive their American cousins, and by so doing we should, of course, only be maintaining a reputation which we have had for so long. I am sure it will be a source of gratification to Mr. Rudd to learn, if he has not already learnt, that the General Managers of the English Railway Companies have extended a very cordial welcome to Mr. Thornton.
