The Signal System of the Swedish State Railway

by TURE HÅRD (Member)

Introduction

The methods of safeguarding railway traffic by signals are not the same in all countries, not even at every railway in the same country. The call for signals and the number of indications needed at each signal depends on the amount of traffic, the speed of the trains, and the rules adopted for regulating the traffic. In addition, the methods are greatly influenced by the technical facilities available for signalling. As a matter of fact most signal systems are the result of a successive development at which it has often been a question how to make innovations without losing the continuity of earlier works.

The following paper will try to explain the fundamentals of a signal system that has come into existence on the State Railways in Sweden gradually during the last three decades.

Stress will be laid on describing the purpose of the signals and the method of using them while their design will be mentioned only in passing.

General Principles

The aspects and significations of railway signals are in Sweden defined by rules which are issued by the Railway Administration and printed in a special book called Säkerhetsordningen (Rules of Safety). The signal aspects are produced by means of signal appliances which are divided into fixed signals, signal implements, and signal signs. The signals address themselves primarily to the drivers of engines and motor vehicles but all the personnel taking part in the movement of vehicles or trains are bound to understand, obey, and use signals.

The purpose of a fixed signal is to inform whether a certain track section commencing at the signal may be passed or not. Permission to enter the track section is given by different signal indications, the aspects of which indicate the extent to which the movement at the moment is hampered by conditions prevailing within the track section itself or its continuation. The stop aspect of a fixed signal means that vehicles approaching the signal must be brought to a stand before arriving at the signal.

The precise moment of setting vehicles in motion depends not only on the track being clear to receive the vehicles but also on the vehicles being ready for motion. When this cannot be checked from the locomotive the driver must have an authorization to start before the movement begins. Such a motion signal is given by the person in charge of the vehicles by means of signal implements of different kinds. Signal implements are also used to supplement fixed signals by informing drivers of special conditions governing the use of the tracks. Similar functions have signal signs of different types.

The Swedish Rules of Safety distinguish between Line and Station, and between Train and Shunting. The precise meaning of these words must be carefully considered on applying the signal system to the traffic.

Station and Line

A railway track belongs either to the line or to the stations. The line consists mainly of one or two main tracks on which vehicles are moved from one station to another. Any place where trains that are using the same main track on the line are allowed to meet or pass each other is regarded as a station. The tracks in the stations used by arriving or departing trains are called train tracks. The station ends and the line begins about 200 yards from the outermost of the pair of points where the train tracks converge into the common track that links the station with the line.

Storage tracks connected to the train tracks belong to the station. Storage tracks may also belong to the line and are then connected directly to the main tracks at so-called loading places. Any place where main tracks of different lines run together into a common main track, is a junction situated on the line.

In principle, movements within the limits of a station are safeguarded by inspecting the positions of the points and the unobstructedness of the tracks. This work, according to the rules, is done by station employees just before the arrival or departure of each train, but can also, partly or totally, be replaced by point interlocking and automatic detection of vehicles on the tracks by means of track circuits.

The safeguarding of the traffic on main tracks between stations is based on so-called Train Announcement, the purpose of which is to prevent more than one train at the same time

occupying the main track or each one of the block sections into which the main track may be divided. The departure of a train from a station or a block post is announced by telephone to the next station or block post, from which the arrival of the train is reported back to the first mentioned station or block post. Until this report has come in the next train must be held back. At single lines permission must also be obtained from the next station or block post just before the train is despatched.

Train announcement is not required on lines where the use of the main tracks is governed by automatic block signals.

At junctions, loading places, and other traffic places on the line the movements may be secured by personal inspection of the tracks as at stations, but the manning of such places can be avoided by locking the points either manually from the stations or automatically by means of track circuits. In either case, particularly on principal lines, the proper positions of points must be indicated to the drivers by fixed signals.

Train and Shunting

A train movement is taking place when an engine or motor vehicle, whether alone or with other vehicles coupled with it, is moved from one station to the next one, which takes place after a time table specifying the composition of the train and the necessary brake equipment has previously been approved by the train despatcher. The train movement begins when the train starts from its departing station, and ends when the train comes to a stand in its final station. If the train stops at an intermediate station the train movement becomes for the time interrupted but begins again when the train departs. Train movements chiefly take place on the line. Within stations train movements occur only in connection with the trains' arrival from or departure into adjoining lines.

All other movements with railway vehicles, whether within the limits of a station or on the lines, are regarded as shunting. Shunt movements also are regarded as movements of trains for short stretches after coming to a stand in stations or on the line, as well as any movement in the direction opposite to the one in which the train normally is travelling, regardless of what causes the backward movement. The maximum speed at shunting is limited to about 20 miles an hour.

Train Routes

The stretch of track over which a train has to run on entering a train track at a station is called the entrance route of that train. The route begins at the station limit and ends in the train track at the place to which the train can advance without interfering with any of the entrance routes from the other direction. When the train is allowed to enter without the track being entirely free up to the normal end of the entrance route, the train is said to be using a curtailed entrance route.

The stretch of track over which a train travels on leaving a train track for a line is called the exit route of the train. This commences where the entrance route ends and ceases at the station limit.

A train route may belong to the line and include for instance the main track through a junction, a pair of points at a loading place, a movable bridge, or any other obstacle that can impede the traffic and therefore must be scanned before trains are allowed to pass. At junctions each route is considered as belonging to the line between those stations which get connection over the route in question.

Block Sections

The control of train movements on the line between two adjacent stations is carried out with block sections as units. The block sections include the above mentioned train routes on the line, even though the control of these is accomplished by additional signals and not merely by the signals controlling the use of the block sections.

If a main track between two station limits A and B has only one block section for each direction of traffic, a train, after entering the main track for example at A, must not be followed by another train in the same direction before the last vehicle of the first train has passed B. The time interval between the trains will be equal to the time during which the track between A and B is occupied by the first train, increased with the time it may take for the second train to advance to the station limit A. The stretch to be passed on advancing to A must be reckoned: (*a*) for trains timed to call at the station, from the spot where the train is standing at the departure, and (*b*) for trains not stopping at the station, from the place where a signal allowing the train to

pass the station must be sighted in order to enable the driver to approach A with normal speed.

Shorter time intervals between trains running in the same direction can be obtained by dividing the main track between A and B into two or more block sections, for example Ax, xy, and yB, where x and y are intermediate block posts situated on the line (Line Block Posts). The time interval between trains entering the line at A will then be governed by the time it takes for the first train to travel from A to x increased with the time needed for the second train to advance to A. In like manner the necessary time interval between two trains at x, or y, must be equal to the time required for the first train to run over the section xy, or yB, augmented with the time it takes for the second train to advance to x, or y respectively. The longest time interval obtained in this way is decisive for the density of traffic between the stations A and B.

The above mentioned time intervals can be used only for trains running in the same direction. Between trains in opposite directions the time interval, whether there are block posts or not, is equal to the time it takes for the first train to travel from A to B, increased with the time needed: (a) for that train to enter a train track of the station at B, and (b) for the second train to advance to the station limit B.

Signal Sections

When shunting is made in train routes or block sections it is usually not necessary to clear whole routes or block sections for the movements. In most cases shorter track units are sufficient. To meet the special requirements of shunt movements train routes and block sections are divided into signal sections. But the shunting does not always follow the same ways through the track lay-outs as the trains. For this reason, signal sections diverging from the train routes or situated in tracks not belonging to train routes, or block sections are often required.

The dividing of a track lay-out in signal sections depends largely on local conditions and must be carefully considered case by case. Short signal sections facilitate traffic by enabling different movements to be made simultaneously. On the other hand, any increase in the number of signal sections tends to heighten the costs of the signal installation. A thorough examination of the usefulness of each signal section is therefore worth while.

The shunting in the train routes at stations very often starts with pulling vehicles from a train track into an exit route. Whether the exit route should be divided into signal sections depends upon the extent to which other movements would be liberated by opening only some part of the route for such shunt movement as does not require the occupation of the whole route.

In stations where the train tracks are too short to accommodate trains of all occurrent lengths, the inconveniences may be greatly reduced by dividing the exit routes into signal sections, so that long trains can advance beyond the ends of the entrance routes when required in order to expedite train or shunt movements behind the trains.

Shunting in the entrance routes of a station is necessary: (1) when a locomotive or a set of vehicles arriving from the line is to be taken into the station without the movement being treated as a train, or (2) when vehicles have been pulled out from the station and are to be pushed into a train track.

In the first case the control of the shunt movement may require a signal section beginning at the station limit and ending at the outermost pair of points, enabling the movement to be stopped at these points in wait for next signal section leading into the train track to be clear.

Also in the second case the last mentioned signal section, commencing at the outermost points, may be useful. Whether the entrance route ought to be divided somewhere between these points and the train track depends on what advantages can be obtained by enabling the pushing back of the vehicles to begin before the locomotive, pulling the cars out from the station, has passed beyond the outermost points.

The number of signal sections required can often be reduced by utilizing available technical means enabling interlocked points to be liberated for operation behind moving vehicles as soon as the last axle has passed the points. Thereby the route can be prepared and proceed signal shown for a following backward movement before all the vehicles have left the signal section used for the preceding movement.

Several signal sections may commence at the same track and terminate in different tracks. Likewise, several signal sections commencing at different tracks may converge into a track common to all the sections. Each signal section can apply only to one direction of motion. For the control of movements in the opposite

direction other signal sections are used. The reversal of motion after entering a signal section means transferring the vehicles into a new signal section, even though the positions of all points remain unchanged.

The use of Fixed Signals

Dwarf Signal.—Permission to enter a signal section is given by a dwarf signal. This applies as a rule only to the signal section commencing at the signal. However, the dwarf signal of the first signal section of a route or block section, composed of more than one signal section, may be equipped with a special aspect applying to the whole route or block section. Thereby, movements requiring the whole route or block section can be carried out faster than would be the case if proceed signal were to be offered only for one signal section at a time.

A dwarf signal aspect forbidding entrance to a signal section (Stop Signal) concerns all kinds of movements. A dwarf signal whose position has not been intimated to the driver in advance by a preceding signal must be approached so cautiously that the first vehicle can be brought to a stand within the relatively short distance from which the aspects of a dwarf signal can be clearly distinguished.

Colour Light Signal.—A Colour Light Signal (alternatively Semaphore Signal) is put up at the entrance to a route or block section when, for trains approaching the section, braking distances longer that the distance from which a dwarf signal can be seen distinctly, must be reckoned with. Just as in the case of the special dwarf signal aspect mentioned above, a proceed indication of a colour light signal applies to the whole route or block section, and signifies that all the following signal sections are clear and their dwarf signals indicating proceed.

Colour light signals are operated only for the control of train movements and are as a rule passed in stop positions when vehicles enter train routes or block sections by shunting. Such will also be the case when a train must enter a route or block section without the conditions for displaying a proceed indication being fulfilled. On such occasions, when there is but a colour light signal, the movement must be directed merely by hand signals. Only by using dwarf signals applying to all sorts of

movements, the protection afforded by interlocking and track circuits can be fully extended also to shunting and exceptional trains movements.

Distant Signal.—In order to avoid reducing the speed of trains on approaching colour light signals obscured by fog, snow or other objects, advance signals, repeating the indications of the colour light signals, are put up at adequate distances from these signals. The repetition is accomplished either by a special detached distant signal, placed at braking distance from the colour light signal, or by the existing colour light signal at the entrance to the train route or block section preceding the colour light signal to be repeated. The first method is commonly used for entrance signals (Outer Distant Signal), the other one for exit signals (Inner Distant Signal).

Design of Fixed Signals

Position Dwarf Signal.—Dwarf signals are of the position light type displaying two white lights the relative position of which constitutes the character of the aspect. In addition, a white or green additional light may be displayed underneath the two obligatory white lights. The lenses are 4-in. in diameter and situated 9-in. apart which is considered enough for a sighting distance of about 200 yards.

Dwarf signals are usually located close to the ground, immediately to the left of the track they belong to, and are so small that they can be placed practically anywhere between the tracks which, in a complicated lay-out, facilitates the dividing of the tracks in signal sections adequate to the needs of traffic. The signals are as a rule seen by drivers from a relatively short distance, and while the train is standing or travelling with low speed when it is natural for the driver to have his eyes directed downwards on the track next before him. For this reason it is considered an advantage to have these signals located near the ground.

A bigger dwarf signal (Line Dwarf Signal) has its light openings equipped with lenses $5\frac{5}{8}$-in. in diameter and placed about 14-in. apart. This signal which is mounted on a pole ranging 5-ft. above the ground is used especially for the control of movements against the normal direction of traffic on double lines. By avoiding colour light signals for these exceptional train movements not only is

economical saving obtained but also, from the safety point of view, the advantage that signals for reversed traffic on one of the main tracks cannot be mixed up with colour light signals controlling the normal traffic direction on the other main track.

Multi-Unit Colour Light Signal.—A multi-unit colour light signal is composed of two or more lamp units, each unit having a circular opening covered by two combined optical lenses, the outer one being $8\frac{3}{8}$-in. in diameter. The colour of the light is obtained by using coloured inner lenses in such units from which red or green light is to be shown. Flashing light is procured by leading the lamp current over a contact of a flashing relay, or a similar device. Therefore the same lamp unit can be used both for fixed and flashing light. When two or more lights are simultaneously exhibited, the distance between any two lights must not be less than 30-in. The lowest of the lamp units is usually located about 15 feet above the ground.

Searchlight Signal.—In a searchlight signal the beams emitted by the lamp filament are intensified not only by lenses but also by a mirror placed behind the lamp. The same lamp is used for displaying red, green, or white light. The change of colour is accomplished by a movable spectacle (colour changer) placed in front of the lamp and carrying coloured roundels from which the light gets its character. Flashing is obtained in the same way as at multi-unit signals.

Background shields at colour light signals.—The background shields are painted black at all colour light signals except those used as detached distant signals that have no stop indication. By painting the backgrounds of these signals both black and white it is made possible to distinguish plain distant signals from other colour light signals also when the signal is dark on account of some failure. A dark signal, according to the rules, must always be treated by the driver as exhibiting its most restrictive indication.

Additional yellow lamp.—An additional yellow lantern is sometimes fixed on the signal post about 5 feet underneath the colour light signal. The diameter of the outer lens in this lantern is 5-in.

Indications conveyed by Fixed Signals

Dwarf signal without additional light (Table 1).—The fundamental indications conveyed by a dwarf signal are shown in Table 1.

" Stop " means that vehicles must not be brought beyond the location of the dwarf signal.

" Proceed " means that the signal section starting at the signal is clear, e.g. all points locked in their proper positions, the track free from vehicles, and conflicting movements held back by stop signals or diverting points. All movements that may interfere with, or endanger the use of the signal section, are regarded as conflicting.

When " proceed cautiously " is shown all points within the signal section are locked properly and conflicting movements held back but the use of the signal section may be restricted, for example : by railway vehicles on the track, by a highway, grade crossing not closed for road traffic, or, as for comparatively short signal sections, by the exit signal into next section indicating stop.

When shunting under local control is allowed by the fourth aspect, the display of " proceed " or " proceed cautiously " for any conflicting movement is excluded but the points are not locked and must, when necessary, be put in their proper positions by the shunters themselves by means of local point levers located on the ground close to the points (Local Point Control).

The third and fourth indications always imply that the movement over the signal section must be performed so carefully as to prevent collision with eventual obstructions in the track. For train movements those indications are used only occasionally when full " proceed " indication for some reason or other cannot be displayed.

Dwarf Signal with additional white light (Table 2).—The position of a pair of points can be indicated at the entrance to a signal section by a third white light which is shown : (*a*) right under the lower light in the aspects " proceed " or " proceed cautiously," when the points are in their normal positions, and (*b*) diagonally under that light, when the points are reversed.

Dwarf Signal with additional green light (Table 3).—In order to indicate at the entrance to a signal section that the following sections within the same route are also clear, a green additional

light may be displayed simultaneously with the proceed aspect. The green light appears for a principal route or line right under, and for a secondary route diagonally under the " proceed " aspect.

Flashing green light may be substituted for steady green light. At an exit dwarf signal, i.e. at the entrance to an exit route, this is done in order to indicate that the block section commencing at the end of the exit route is not yet clear. The additional light functions as a distant signal to the block signal at the station limit. By allowing trains to leave the train track before the preceding train has left the first block section of the line, time may be saved when the exit route is long.

At an entrance dwarf signal flashing green light is used to indicate that the train is entering a curtailed train route, i.e. a train track partly occupied by vehicles. When the route is clear, all up to the end of the train track the additional light is always steady.

Colour Light Signal with route indication (Table 4).—At the entrance to a station or junction " stop " for trains is shown by red light and " proceed " by green steady light. If the colour light signal governs more than one route these can be distinguished from each other in so far that a single green light appears for the principal route, and two or three green lights for secondary routes. If there are more than two secondary routes, the same proceed indication may be used for a group of similar routes.

As a rule, the maximum speed allowed over a route after " proceed " indication has been given through a single steady green light is equal to the maximum speed permitted on the main track on which the train approaches the signal. But a lower maximum speed may in certain cases be prescribed in the time-table.

When " proceed " signal is shown by two or three steady green lights, the speed as a rule is to be limited to 25 miles an hour, but even then higher speed may be used if allowed in the timetable, for instance because of a greater radius than the usual one being used in the curved tracks of the points at some stations or junctions.

The timetable always specifies for each train which " proceed " aspect is to be expected at every one of the colour light signals to be passed by the train. Should any other proceed

indication appear against the train the driver is obliged to stop at the signal and inquire about the reason by telephone before he proceeds. But the driver may also be authorized by the time-table or by special order to proceed with the train on any other proceed aspect than the usual one. Under all circumstances he is expected to observe the change of signal aspect and to conform to the speed reduction or the special precautions that may be required in connection with the new one.

A proceed indication is not supposed directly to specify the maximum speed, but rather to give the driver such guidance as will enable him to follow the speed regulations specified in the Rules of Safety and the Timetable Book.

By enabling drivers to check the choice of routes at the stations, an accident may be prevented in case of a wrong route being set up by mistake to a train track already occupied. This reason for using different proceed aspects may be set aside if track circuits are installed which prevent proceed indication from being shown to an occupied train track. Then, if a wrong route is chosen, it must at least be free from vehicles and so far safe to travel over.

In spite of track circuits it might be necessary to indicate the route to the driver on account of differences in the speeds allowed over the various routes. Most decided is this difference between a straight and a diverging route, but even diverging routes must sometimes be distinguished from each other, for instance, on account of some routes being much shorter than others. For this reason the aspect three green lights has been retained as a means to differentiate between diverging routes. At exit colour light signals, the three proceed indications are retained as a means to indicate the lines into which the routes are leading.

Exit Distant Signal (Table 5).—Green or white flashing light may be displayed under the green proceed aspect of a station entrance signal when the driver has to be informed of the position of the exit signal at the end of the entrance route. Green flashing light prepares for stop, whereas white flashing light indicates that the exit signal is showing proceed.

Similarly a multi-unit colour light signal at the entrance to a junction may be used for repeating the colour light block signals at the exits from the block sections diverging from a common main track at the junction.

Searchlight Block Signal (Table 6).—At the entrance to a block section that does not emanate from the common main track at a junction, a searchlight signal showing red light for stop and a single steady or flashing green light for proceed may be used instead of multi-unit signal. The flashing aspect is used only when two or more block sections are situated between the block signal and the entrance signal to next station or junction. Flashing " proceed " appears when the first of these block sections is clear but the second one still occupied, and enables the driver to moderate the speed over the first block section so that the next block section may be clear in time to avoid stopping the train on the line.

This method is adequate if the block section to which entrance is offered by flashing green light is at least as long as the necessary advance signal distance, e.g. the stretch of line that is needed for a train running at full speed to be brought to a stand. Should the block section be essentially shorter than that distance, the speed must be reduced even before the train enters the block section. To remind the driver of such a speed reduction flashing green light is displayed at the preceding block signal but with a steady yellow light underneath it. This reduces the delaying effect of the flashing green aspect that otherwise prepares for stop.

Detached Distant Signal (Table 7).—At stations or junctions the routes are habitually set up after the train has entered the preceding block section. For this reason block signals cannot be used as distant signals to colour light entrance signals which, therefore, are repeated by detached distant signals located at adequate braking distances from the colour light signals.

Stop aspect is repeated at the distant signal through green flashing light, and full proceed aspect by white flashing light.

Proceed on a diverging route is shown at the distant signal by a single steady yellow light displayed from a separate lantern under the green flashing light. The yellow light indicates to the driver that speed reduction is required instead of stop at the next colour light signal. When flashing white light is shown from the distant signal the yellow lantern is always dark.

Distant Signal with red light.—When the distance between the detached distant signal and the colour light signal at the entrance to a station or junction coincides in length with the block section

ending at the entrance signal, the distant signal is converted into a block signal by substituting a red light for green or white flashing light while the block section between the advance and the colour light signals is occupied by vehicles. As soon as the block section becomes unoccupied the block signal automatically resumes its distant indications and shows : a single flashing green light when the colour light signal is at stop, a green flashing light above a yellow light when the colour light signal indicates " proceed on diverging route," and a single white flashing light when the colour light signal indicates " proceed on the principal route."

Warning to the driver as to the red aspect of the distant signal is given as shown in Table 6 by green flashing light at the preceding block signal.

Independent of whether there are block signals or not, red aspect may be used on a distant signal to protect a loading place, or a highway level crossing located between the distant and the colour light signals. Red aspect is displayed while shunting is going on at the loading place, or the gates are open for road traffic.

The indications of the distant signal may be repeated by a separate distant signal in order to avoid the slowing down of approaching trains.

Occasionally, red aspect is used on distant signals to emphasize the stop aspect of a following colour light signal when there is some important obstruction immediately behind the colour light signal, for instance a movable bridge that ought to be locked, but may happen to be open when a train approaches.

Signalling with dwarf and colour light signals in co-operation (Tables 8, 9 and 10).—Table 8 gives a survey of the indications that can be displayed by combining a colour light signal and a dwarf signal at the entrance to a station. In the cases *e*, *f*, *g*, and *j* the colour light signal simply repeats the proceed indication of the dwarf signal and, in addition, informs the driver (1) whether he is entering the principal or a diverging route, and (2) whether the signal at the exit of the route is " on " or " off."

In the cases *b*, *c*, *d*, *h*, and *k* permission to proceed is given with the dwarf signal alone but by aspects different from those used in the first mentioned cases. The signals are co-operating in such a manner that the dwarf signal gives the necessary short range

indication while the colour light signal supplies the long distance indication for movements approaching with high speed.

In Table 9 the co-operating signals are controlling the exit from a train track at a station. Permission to proceed is given with the dwarf signal alone except when the route is set to a line whose first block signal is indicating proceed. In case *c*) and, eventually, in case *g*) the colour light signal repeats the proceed indication of the dwarf signal. In all the other cases the colour light signal retains its stop aspect enforcing the driver to moderate the speed on approaching the exit signal until the indication of the dwarf signal can be seen clearly.

Colour light signal as in Table 9 is usually supplied only at exits from train tracks belonging to principal entrance routes used by passing trains. At train tracks where all trains stop before departure dwarf exit signals are used alone.

Table 10 shows a combination of searchlight signal and dwarf signal at the entrance to a block section.

If vehicles are brought into a block section by shunting only occasionally, the necessary security against collisions with such vehicles may be obtained by special precautions adopted for such cases, without the use of a dwarf signal. The increase in safety obtained by placing a signal valid also for shunt movements at the entrance to block sections may, however, justify a wider use of dwarf signals for that purpose, particularly at distant controlled stations and junctions.

The aspects displayed by line dwarf signals at the entrances to block sections used for motions against the normal direction of traffic on double lines (Right Hand Traffic) are the same as are shown by the dwarf signals in Table 10.

Supplementary Hand Signals.—In the foregoing it has been mentioned that supplementary signals are being used: (1) as motion signal to authorize the driver to start; (2) as supplement to fixed signals supplying additional informations as to certain conditions.

Usual devices for given motion signal are: the signalmen's arms, a green or white hand lantern, a hand disc signal, a red or green flag, or a whistle. Signals must be given in such a way that they can be readily seen or heard by the driver, and must be obeyed by him as long as they are given by a person authorized to direct the movement, and are not opposed to the Rules of

Safety or to the indications of any fixed signal controlling the movement.

Motion signal to a train (Departure Signal) must be given by the Train Clearer, i.e. the person responsible for the train movements in the station. As implement is used: by day the hand disc signal, and by night the green hand lantern, but departure signal may also be given with a distant operated fixed light signal, valid either for a single train track or for a group of adjacent train tracks. The signal shows the letter A and is therefore called A-signal.

Signal to vehicles to cease moving, or to reduce speed may be given with the arms, a flag, or a lantern. For informing trains when to stop on entering stations or other traffic places, distant operated fixed light signals, displaying red light, are sometimes used.

Signal to a train to call at a traffic place where the train is bound to stop only when travellers wish to ascend, may be given by Ascending Signal which is located on the platform and operated, when required, by the travellers themselves.

Signal implements supplementing fixed signals are divided into movable ones and fixed ones. To the movable group belong such disc signals and signal lanterns as are used to stop or warn trains when the track is defective, or under repair, or when a main track is occasionally occupied either by vehicles left on the line without engine, or by a defective train incapable of proceeding. The signals are put up at braking distance from the hindrance. Detonators are placed on the rails opposite the signals to attract the driver's attention should the signal be disregarded.

To the movable implements also belong such temporary signals consisting of discs and lanterns that are hung up at the posts of colour light signals while defective in such a way that a proper stop signal cannot be exhibited.

The following signal implements belong to the fixed ones:—

(*a*) Point Indicator used at certain pairs of points to make their positions visible at some distance. A new aspect appears directly on changing the position of the points.

(*b*) Track Blocking Signal used in connection with scotch blocks, derailing points, dead stops, etc., to warn drivers approaching the obstacle. The same signal is also used alone to simulate the existence of a scotch block.

(*c*) Gate Signal is used to stop movements on railway tracks

over a highway level crossing until the gates, or bars, have been properly operated to stop road traffic.

(*d*) Water Crane Signal connected to the movable arm of a water supply crane in order to stop movements on the track under the arm when it is swung out over the track.

(*e*) Weigh Bridge Signal used at weighing-machines to indicate whether the bridge is in position for weighing or is resting on its fixed supports.

(*f*) Stop Lantern exhibiting a single red light is used in the following cases :—

(1) On either side of highway grade crossings equipped with semi-automatic road traffic signals, to stop movements on railway tracks over the highway after the automatic control has temporarily been put out of action, until the road signals are actuated by hand.

(2) At the end of entrance routes directed *from* the train track, to forbid shunting into the train track against the entrance route while a train is approaching on this route.

(3) At the end of entrance routes directed *against* the train track, to mark the end of routes which continue into another train track that may be occupied by vehicles. Proceed indication for an entrance route ending in this way is usually given by three green lights. The Stop Lantern remains lighted until the train has come to a stand.

To the fixed signal implements are also reckoned Exit Repeater Signals that are put up at train tracks in some stations in order to facilitate for the Train-Clearer in charge of train movements to check the exit route set up from the signal cabin, before trains are allowed to start.

Fixed signal implements of kinds are finally Signal Telephones provided at the entrance to train routes and block sections to enable drivers to speak with stations and signal cabins to get the necessary information should a proper proceed indication fail to appear at the signal.

Signal Signs.—The purpose of Signal Signs is to guide the drivers while running over the line. Contrary to signal implements a signal sign is constantly exhibiting the same indication. The following are the most common signal signs :—

(*a*) Locating Sign, triangular shaped, with reflecting prisms at the three corners but without special marking sign, is used at

main tracks to remind the driver that he is approaching a traffic place that has no entrance signal of its own.

(*b*) Locating Sign of the same type but equipped with " distant signal mark " is used at main tracks on secondary lines to inform drivers of the train's approaching an entrance signal that is not repeated by detached distant signal. The sign is put up at braking distance from the signal. On principal lines the same sign is put up at braking distance from such block signals as are repeated by the preceding block signal.

(*c*) Locating Sign of the same type as before but marked with " warning disc " is used before such main track stretches on which the speed must be reduced more than 25 miles an hour under the line's normal maximum speed. The sign is placed 900 yards from where the reduced speed is to be used.

(*d*) Speed Limit Sign, with figures, denoting the maximum rate of speed in kilometres an hour, is put up at the entrance to any stretch of track on which a lower speed than the normal maximum speed must be used. The place where normal speed can be retaken is marked by a speed limit board without figures.

(*e*) Marker Plates are put up at the poles of fixed signals to enable the driver to identify the signals. The figure, or letter, shown on the plate must be mentioned by the driver when speaking with stations or signal cabins from the telephone at the signal. The plate is circular at automatic signals controlling only the sequence of trains on the line, and rectangular at manually controlled signals and at automatic signals securing the passage of trains over obstacles such as points or movable bridges. The form of the plate reminds the driver of the special precautions that must be taken after having passed a signal without getting a complete proceed indication.

(*f*) Route Limit Sign, a rectangular plate carrying the letter S, is used to mark the end of entrance routes when so required on account of local conditions.

(*g*) Station Stop Sign, circular and equipped with the letter U, is put up at train tracks to indicate where an incoming train shall stop as a rule. Several U-signs may be placed at regular intervals at the same track. Each sign is equipped with a figure, denoting the number of axles that can be housed between the sign and some place in the track that the last vehicle of the train ought to have passed before the train comes to a stand. The

locomotive will advance to the sign whose figure is nearest to the number of axles in the train.

(*h*) Whistle Signs are put up at the main track where the steam or air whistle ought to be blown from the locomotive to warn workers in tunnels or deep cuts, or road-farers approaching level crossings. The shape of the Whistle Sign indicates whether warning signal shall be given always, or only in foggy or snowy weather.

(*i*) A sign consisting of two pieces of wood nailed over each other in the form of a cross is hung up on every new fixed signal until it can be brought into use.

(*j*) On electrified lines a special sign is used to indicate the limits of such short sections of the overhead contact line as are normally disconnected from the power supply.

Conclusion

The signal system that has been described has included signals needed for checking the position of points and conflicting signals, and the withdrawal of vehicles from the tracks for all sorts of movements whether they are made under the rules for train movements or merely as shunting.

When a stop signal is exhibited vehicles may drive up to the fixed signal but not past it.

The aspect of the proceed indication depends upon the length of the track section to which access is opened through the signal, upon the limitation as to speed that must be observed on running over the section, and, in addition, upon the extent to which the movement can be secured through the signals. If some part of the automatic detection must be omitted on account of the character of the movement, or fails to function, this fact must be conveyed to the driver by the appearance of a signal aspect imposing low speed and increased attention to be used on running over the section.

The fundamental signal is the dwarf signal which is applied to all sorts of movements. Colour light signal is required to supplement the dwarf signal at entrances to such routes and block sections that must be approached with high speed. The long range colour light signal repeats not only the short range dwarf signal at the foot of it but also the dwarf signals at the following signal sections in the route or block section. Nevertheless, while running over a train route or block section, the driver is expected

to pay due attention to the dwarf signals and to stop the train as quickly as possible should any of the dwarf signals have resumed stop position. Therefore, on running through a complicated track lay-out, the dwarf signals continue to guide the driver after he has passed the colour light signal, by showing him where the route is leading. If, for some reason, a whole route or block section cannot be offered to a train, the train must be run with reduced speed on proceed indications from the dwarf signals alone, in the same way as at shunting.

It is important that the driver acts in accordance with the signal situated in front of the first vehicle in the direction of motion, i.e. the locomotive when the locomotive pulls a set of vehicles, and the vehicle farthest from the locomotive when this pushes a set of vehicles. If, in the latter case, there are so many vehicles that the signals cannot be seen from the locomotive in due time, the onus of observation of fixed signals must be transferred to a shunter who repeats the indications to the driver by means of hand signals.

A signal may be approached though stop aspect is displayed, provided that the movement stops before the first axle has passed the signal. Stop from a dwarf signal must be understood as stop for all vehicles that have not yet passed the signal. Therefore, a set of vehicles occupying two neighbouring signal sections must not be set in motion unless the dwarf at the limit between the sections is in the " off " position.

The full use of all available indications necessitates an extensive use of interlocking and track circuiting to bring about automatic control of the aspects. To what extent signals are necessary for the securing of the traffic, or may be justified from the economical point of view depends upon the amount and type of traffic. The practical application of the signal system at a railway like the Swedish State Railway with its many different types of lines must take place with due consideration of the real traffic conditions on each line, and taking into account all the possibilities of omitting in certain cases such signal indications as can be dispensed with or would require too expensive installations.

The Book of Rules distinguishes between normal and narrow gauge railways, and between principal and secondary railways with widely different demands on signals for promoting security and expediting traffic. But also in each category variations in

the application of the signal system may be desired on account of local circumstances at individual stations and lines. As a merit of the signal system may be reckoned the fact that the necessary modifications have proved to be possible without violating the line of thought on which the system is grounded.

The completion of the signal system by automatic train control has been considered and tests have so far been made with the Swiss intermittent inductive system. In the trial installation track coils have been placed 200 yards before all entrance and distant signals at stations, junctions, and block sections. Visible and audible indications are transmitted to the driver's cab unless the fixed signals are exhibiting their least restrictive proceed aspect. If the driver fails to respond to the signal in the next few seconds by pressing a button, the brakes are automatically applied.

The purpose of a train control of this kind is to prevent the driver from overlooking such signal indications as require precautionary steps to be taken from his side. The driver is informed of what steps are to be taken in each case through the aspect of the fixed signal.

A special indication in the cab also when the signal is indicating unlimited proceed might be useful by enabling the driver to check the function of the train control at each passage Another special indication might also be desirable when the signal 200 yards ahead is virtually showing stop, as this would arouse the driver should he have forgotten the advance warning previously obtained, or the signal have been restored to stop after the train had passed the advance signal. Extension of the train control in these respects might need to be considered in further installations.

To remind drivers of such track sections as are marked by signal implements or signal signs implying reduced speed, a permanent magnet may be fixed to the track at adequate distance from each stretch. Permanent magnets are also proposed to be installed instead of coils before the line dwarf signals protecting the entrance to block sections for reversed traffic on double lines.

From an economical point of view train control may be justified as a supplement to fixed signals because of the fact that it helps the driver to follow the signals and makes the aid of a second man in the cab for this purpose dispensable on high speed trains.

APPENDIX

Note—In the following tables the colours of the lights are indicated thus :—

⊖ lamp with red fixed light

◐ ,, ,, green ,, ,,

⊘ ,, ,, yellow ,, ,,

○ ,, ,, white ,, ,,

◍ ,, ,, green flashing light (70 flashes a minute)

◎ ,, ,, white ,, ,, ,, ,, ,, ,,

● ,, not lighted

TABLE I—**Dwarf Signal**

(*a*) Stop for trains and shunting ... ... 

(*b*) Proceed over signal section ... ... 

(*c*) Proceed over signal section with caution, prepared to stop at any hindrance ... ... 

(*d*) Shunting allowed in signal section with points free for operation on the ground ... ... 

TABLE 2—**Dwarf Signal** as in table 1 equipped with additional *white* lights indicating position of points. With indications 1*a* or 1*d* the additional lights are out.

(*a*) Proceed as in 1*b* with points in normal position ... 

(*b*) Proceed as in 1*c* with points in normal position ... 

(*c*) Proceed as in 1*b* with points reversed ... ... 

(*d*) Proceed as in 1*c* with points reversed ... ... 

TABLE 3—**Dwarf Signal** as in table 1 equipped with additional *green* lights for route indication. With indications 1*a*, 1*c*, and 1*d* the additional lights are out.

(*a*) Proceed on principal *entrance* route, *or* on *exit* route into principal line ... ...

(*b*) Proceed on curtailed principal *entrance* route, *or* on *exit* route leading into principal line, the first block signal of which is still at stop ...

(*c*) Proceed on diverging *entrance* route, *or* on *exit* route into secondary line ... ...

(*d*) Proceed on curtailed diverging *entrance* route, *or* on *exit* route leading into secondary line, the first block signal of which is still at stop ... ...

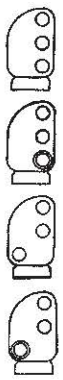


TABLE 4—**Multi Unit Colour Light Signal** with route indication.

	Lighted lamps in aspect Lamp	
(*a*) Stop for train movements	No. 2	⊖
(*b*) Proceed on principal *entrance* route, *or* on *exit* route into principal line	No. 1	◐
(*c*) Proceed on diverging *entrance* route type 1, *or* on *exit* route into secondary type 1	No. 1	◐
	No. 3	◐
(*d*) Proceed on diverging *entrance* route type 2, *or* on *exit* route into secondary type 2 ...	No. 1	◐
	No. 3	◐
	No. 4	◐

Sketch of signal at stop

TABLE 5—**Multi Unit Colour Light Signal** as in table 4 but equipped with advance signal aspects showing position of next colour light signal. Lamp No. 6 on the signal post is required only when reduction of speed at next signal is to be indicated in advance. Advance indications may also be used in connection with proceed for secondary route.

	Lighted lamps in aspect Lamp	
(*a*) Proceed on principal route, the exit colour light signal of which is displaying red ...	No. 1	
	No. 5	
(*b*) Proceed on principal route, the exit colour light signal of which is displaying aspect 4*c* or 4*d*, or flashing green for short block section (see table 6*c*) ...	No. 1	
	No. 5	
	No. 6	
(*c*) Proceed on principal route, the exit colour light signal of which is displaying aspect 4*b*, or proceed for block section of normal length.	No. 1	
	No. 4	

Sketch of signal at stop

TABLE 6—**Searchlight Signal** at entrance to block section. Lamp No. 2 at the signal post is required only when the block section that follows after the one commencing at the signal is shorter than full braking distance of trains.

	Lighted lamps in aspect Lamp	
(*a*) Stop for all trains, block section occupied ...	No. 1	
(*b*) Proceed over the block section, the exit signal of which is displaying red	No. 1	
(*c*) Proceed over the block section but reduce speed *before* arriving at next block signal, which is displaying flashing green or short block section ...	No. 1	
	No. 2	
(*d*) Proceed over the block section, the exit signal of which is either a signal displaying proceed for block section of normal length, or a signal repeated by detached advance signal as in table 7 ...	No. 1	

Sketch of signal at stop

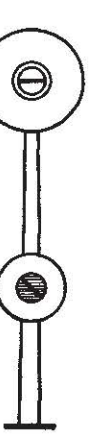


TABLE 7—**Searchlight Signal** used as advance signal to station or junction entrance signal. Lamp No. 2 at the signal post is required only when the entrance signal governs diverging routes.

	Lighted lamps in aspect Lamp	
(*a*) Proceed cautiously, entrance signal indicates stop	No. 1	
(*b*) Proceed and reduce speed on account of the entrance signal's indicating proceed for diverging route	No. 1 No. 2	
(*c*) Proceed, entrance signal indicates proceed for principal route. ...	No. 1	

Sketch of signal at caution

TABLE 8—**Dwarf Signal** as in table 3 combined with colour light signal as in table 5 at entrance to station or junction.

		Aspect at	
		Dwarf signal	Colour light signal
(*a*)	Stop for trains and shunting	1 (a)	4 (a)
(*b*)	Proceed on next signal section	1 (b)	4 (a)
(*c*)	Proceed with caution over next signal section against eventual hindrance	1 (c)	4 (a)
(*d*)	Shunting allowed in next signal section with points free for local operation	1 (d)	4 (a)
(*e*)	Proceed on principal route, exit signal red ...	3 (a)	5 (a)
(*f*)	Proceed on principal route, exit signal green but speed reduction required at the exit... ...	3 (a)	5 (b)
(*g*)	Proceed on principal route, exit signal green for full speed	3 (a)	5 (c)
(*h*)	Proceed on curtailed principal route ...	3 (b)	4 (a)
(*i*)	Proceed on diverging route type 1	3 (c)	4 (c)
(*j*)	Proceed on diverging route type 2	3 (c)	4 (d)
(*k*)	Proceed on curtailed diverging route	3 (d)	4 (a)

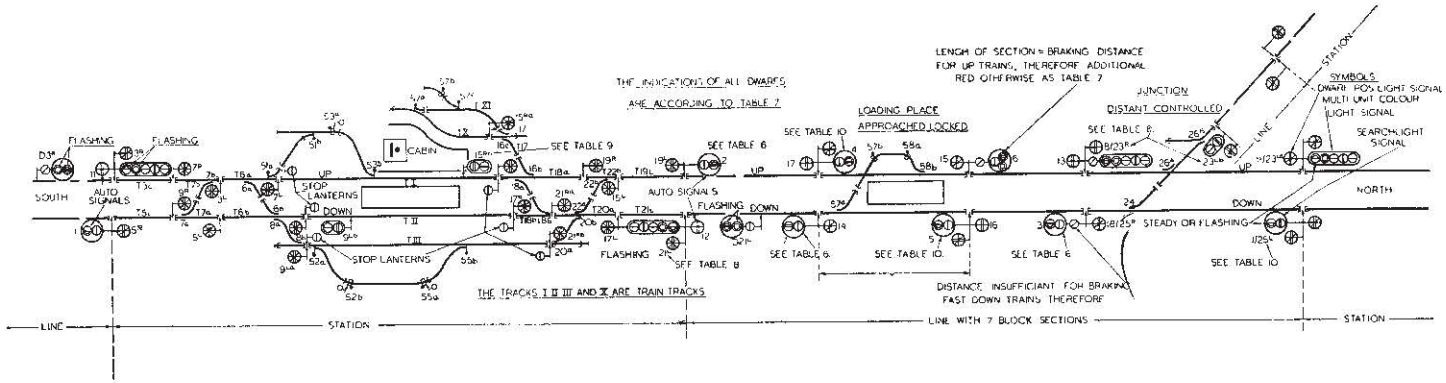
TABLE 9—**Dwarf Signal** as in table 3 combined with Colour Light Signal as in table 4 at the exit from train track used by trains that pass the station without being brought to a stand. At train tracks not used by passing trains, colour light signal is usually omitted.

		Aspect at	
		Dwarf Signal	Colour light signal
(*a*)	Stop for trains and shunting	1 (a)	4 (a)
(*b*)	Proceed on next signal section	1 (b)	4 (a)
(*c*)	Proceed with caution into next signal section against hindrance	1 (c)	4 (a)
(*d*)	Shunting allowed in next signal section with points free for local operation	1 (d)	4 (a)
(*e*)	Proceed on exit route into principal line ...	3 (a)	4 (b)
(*f*)	Proceed on exit route against principal line, block signal red	3 (b)	4 (a)
(*g*)	Proceed on exit route into secondary line ...	3 (c)	4c, 4d, or 4a
(*h*)	Proceed on exit route against secondary line, block signal red	3 (d)	4 (a)

TABLE 10—**Dwarf Signal** as in table 1 combined with Searchlight Signal as in table 6 at entrance to block section.

		Aspect at	
		Dwarf signal	Colour light signal
(*a*)	Stop for trains and shunting	1 (a)	6 (a)
(*b*)	Proceed with caution into next signal section against hindrance	1 (c)	6 (a)
(*c*)	Shunting allowed in next signal section with points free for local operation	1 (d)	6 (a)
(*d*)	Proceed over block section, exit signal red ...	1 (b)	6 (b)
(*e*)	Proceed over block section, exit signal green but speed reduction required at the exit ...	1 (b)	6 (c)
(*f*)	Proceed over block section, exit signal green for full speed	1 (b)	6 (d)

SWEDISH STATE RAILWAY—SIGNAL SYSTEM



DISCUSSION

Mr. E. G. Brentnall, in opening the discussion, said that he found the paper particularly interesting as he had had the pleasure of seeing Swedish signalling in actual use. The author mentioned that the system was the result of a series of developments made to preserve continuity, and although it might be thought that the various aspects and signal readings appear to be somewhat involved, in actual practice they fit in very logically and have proved to be satisfactory. He had been impressed by the excellence of the installation and maintenance of the signalling in Sweden, and they were a great credit to Mr. Hård. Swedish signalling was comparable with British practice in some respects, but one important distinction was that they used a different type of signal in station limits to that used on the line between stations ; namely, colour-lights on the line and position lights in the stations. In Britain it was the practice to have the same type of signals through the stations for main movements, and outside in the block sections. He thought perhaps the principle of using different signals might have developed because at one time station limits were almost completely under the control of the station master and his staff, who had to make sure that everything was safe. Interlocking was now being used more and more.

Another difference was that of shunting under local control, where signals in the station were put to the caution position and were free of interlocking, the movements being under the control of the staff. In regard to the use of telephones for train movements, he enquired if such messages were booked or if reliance was placed on verbal messages alone.

Reference had been made to the use of background shields to colour-light signals—black ones for signals with stop aspects, and black and white for distant signals. He asked if these had proved of any great value and if any difficulty was experienced at night in distinguishing them.

Mention was made of an additional white light at the dwarf signal to show whether the points were normal or reverse. If there were more than one set of points, or more than two routes, he asked if it were usual to have a route indicator. Regarding the use of a second and third green light for less important moves, which was a form of speed signalling ; he enquired whether, if there were several secondary movements of the same

value, the one aspect was shown for each of them. Also, if there were some third rate move, as distinct from the main and the next fastest route, would it be indicated by three green lights, or would there be a route indicator to show over which route the driver had to proceed. He mentioned that because it had been stated that drivers were able to check the route at the stations and accidents might be prevented in the case of a wrong setting.

He had noted with interest that drivers were supposed to know from the time-table which " proceed " aspect was to be shown at every signal. This would seem to be a severe tax on the driver's memory on a long distance train.

When in Sweden recently, he had remarked on the use of searchlight signals and multi-unit signals and had wondered why, if a signal was only required to show two aspects, in some cases a searchlight signal was used, and in others, a multi-unit signal.

Mr. J. F. H. Tyler said that as the author's paper stressed, signal engineering had developed in several countries; in the sparsely populated areas the idea of the station being separate from the line had influenced the signalling system to a greater extent than in Britain, which being more densely populated, signal boxes had to be closer together. In Sweden and other continental countries, there were different signals at different places whereas in Britain an endeavour was made to have the same kind of aspect given by automatic signals, by " stop " signals, or any other signal except a shunt signal. There were different regulations too; for instance, a block overlap existed in Britain but not in Sweden. The overlap of $\frac{1}{4}$ of a mile, he supposed, was in the early days intended to be the emergency braking distance; it was nothing like it any longer, but the overlap remained. It was very interesting to note that in Britain the tendency was to use colour-light distant signals to make them distinctive, while in Sweden they made them distinctive by making them flashing signals.

He was not quite clear why the author had adopted a flashing white light as a " proceed " aspect.

With regard to the telephone block working, he did not think this could be claimed as perfectly safe. He also asked if consideration had been given to token working on single lines.

Mr. Tyler added that when he was in Sweden in 1949, and

travelled from Stockholm to Malmo, he had seen the signalling of the intermediate stations referred to by the author. The semaphore signals were also very interesting, and had bands of yellow and red—the red presumably as a contrast against snow and the yellow a contrast against summer green.

He had noticed that one of the duties of the station master at each station seemed to be to salute the driver as a train went past. He believed it was to tell the driver that everything was all right and that it was therefore part of the system.

Mr. F. Horler said that the author had given an excellent survey of the development of signalling in Sweden and it would be interesting for members to compare it with their own experiences in dealing with similar problems in their own country. He considered that it was of great value to have in the proceedings information as to the way in which problems had been met under different conditions. In regard to the use of the fourth aspect on the dwarf signal, as he understood it the movement of the train was handed over to local control, and it seemed that the points which had been operated from the signal box were handed over for operation by the man on the ground. He enquired if that were the correct interpretation of the system. Another question referred to the blocks on the line. In the case of three or four blocks as shown in the diagram in the paper, what record had the signalman who was receiving the trains and had to deal with them ?

Mr. A. Moss referred to the large number of aspects displayed in the system described in the paper. On British railways the trend in signalling had always been towards simplification of aspects, in order to make them easily understood by the drivers and he asked if drivers in Sweden experienced any difficulty in remembering so many. It had been stated that the fundamental signal was the dwarf signal and he had counted twelve different aspects given by these which seemed a great many for the drivers to learn and memorise. Reference had been made to the development of signalling based on the continuity of earlier work. In Britain, the introduction of colour-light signalling had been a departure from earlier works, and he could see no reason against such a departure if it had advantages. He assumed that the importance given to shunt signals or dwarf signals emanated from Germany.

He also asked if the height of colour-light signals, the lowest

aspect being 15-ft., was the driver's eye level. In Britain it was round about 10-ft. 6-in.

He had also noted the various signs which were used ; the triangles with reflecting lights, rectangles with the letter " S " in them, and a number of others and assumed that the head-lights carried by the locomotives were sufficiently powerful to distinguish them at night.

In reply to *Mr. Brentnall*, the **Author** said that every time a telephone message was sent or received, it had to be written in a book. They did not use a red light in a dwarf signal, because it was used for other purposes, as described in the paper. He thought that the drivers liked the aspect and it was very seldom that they did not obey a stop signal from a dwarf. In regard to the use of background shields to differentiate between a distant signal and a main signal, although it might be difficult to distinguish them when it was dark, many locomotives carried powerful head lamps which enabled the driver to see quite clearly which signal he was approaching. Under complicated conditions, it might be necessary to provide a greater distinction.

The additional white light on dwarf signals to indicate the position of points was only used in special cases, and was not favoured.

When there were more than two secondary routes, they used a track circuit to prevent the station master from routeing the train in an occupied track. The third aspect could be dispensed with, but it was used when there was need for special precaution, for example when one route was much shorter than the other secondary routes.

Searchlight signals had come into use for block signals from a practical point of view, as they took very little power and could never give a false indication through a reflected light. At junctions or entrances to stations, however, they could not be used, because they could not give two or three green indications simultaneously.

In regard to taxing the driver's memory, each driver had a time-table book and for each place he passed, the signal was indicated so that he could follow the time-table. Conditions were rather more simple than in Britain and it was quite easy for a driver to get to know the line.

In reply to *Mr. Tyler*, the author said that they did not use tokens of any kind. Announcements were made by telephone

and written down in a book. Regarding the use of both a track circuit and a train announcement, that was not the case. When there were track circuits, no train announcements were made for safeguarding trains ; but, in some cases, it was announced which train came in first. They had never had overlaps in Sweden and expected drivers to stop at the signal and gave them a pre-warning by using a distant signal.

In reply to *Mr. Horler.* The local control of points was used only for shunting movements, and not for running trains. At many stations traffic came in busy periods but with intervals of several hours without a train. Shunting, however, went on and it might be economical to close the cabin and let the shunters carry out the moving of the points. The practice was not used in big stations where traffic was going through all the time.

Regarding the block section, the signalmen followed the time-table. At important places such as Stockholm, there was a system so that the order of the trains could be changed by the cabin master, who pressed a button for one kind of train and other buttons for other kinds. This informed the receiving station as to what train was coming. In some cases the train might be announced by telephone.

In reply to *Mr. Moss.* The indications may seem more complicated than they really are and in the case of the dwarf signal, it gave in reality all the necessary indications, although the colour-light and the long range signals supplemented it. The dwarf signal indications for " proceed " were never used alone ; when there was a colour-light signal they were both used at the same time. Over a long distance, one had only to follow a high signal and when getting nearer one could follow the dwarf.

In regard to the height of the colour-light signals, they were on a level with the eyes of the driver or slightly above ; and were always under the overhead trolley structure. The origin of the dwarf signal was Pennsylvania. The colour-light signal was of the German type, first they had a semaphore signal, and the colour-light was a translation of it, with a red light for " stop " and one, two or three green lights for " proceed."

The **President** remarked that the Swedish State Railways used three green lights for the most restricted route two for a less restricted route, and one for the high speed route which, according to British practice, seemed fundamentally wrong.

They seemed to have aspects for every type and kind of movement they wanted to make, and although it may appear somewhat complicated, no doubt it was quite simple to those who were accustomed to it. He felt sure that everyone had enjoyed the paper very much indeed, and wished to express to the Author their admiration for the way in which he had delivered it and the way he had answered questions, and proposed a very hearty vote of thanks, which was carried with acclamation.

The **President** announced that that was the last Technical Meeting before the autumn and he thanked everyone for the encouragement and support they had given him.