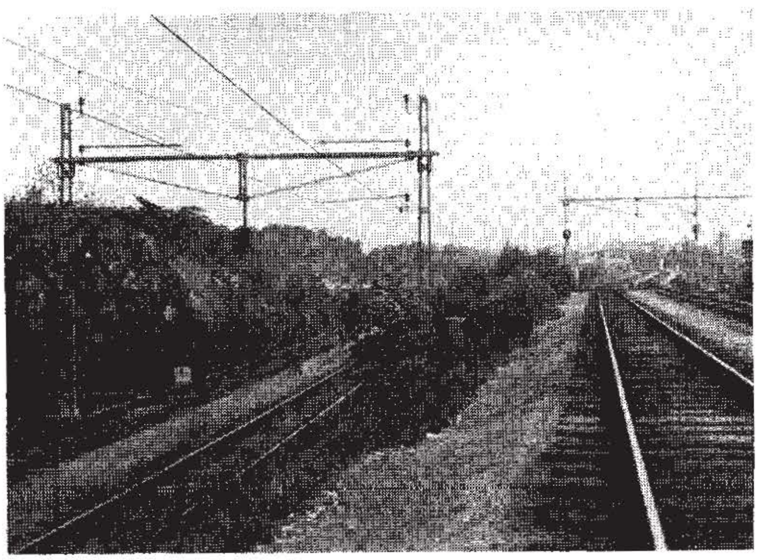
Signalling on the Swedish Railways.*

By T. S. LASCELLES (Hon. Treasurer).

Although railways made their appearance in several European countries within a few years of their introduction for public service in Great Britain, it is of some interest to note that such refinements of working as signalling and interlocking—especially the latter—were much slower in securing adoption there, even where English influence was active. To some degree, no doubt, this was due to the fact that traffic did not grow to anything like the remarkable extent it did during the first half of the last century in England, with the accompanying great increase in industrial activity. These considerations apply to Sweden, where the first railway was opened in 1856, about the period when the earliest practical experiments in interlocking were engaging the attention of Saxby and Chambers in England and Vignier in France. Within 25 years interlocking apparatus was being extensively used in both those countries but was not seen in Sweden until 1888, when the State Railways made an installation. Signals, both disc and semaphore, had made their appearance, the latter being frequently of the type having an arm for each direction at the same level, like the old " main " signal at one time prevalent in India, and constructed on the English model, with left-hand lower quadrant movement. (Both rail and road traffic works left-handed in Sweden ; towards the end of 1940, however, the authorities decided to adopt the right-hand rule of the road on the highway in June, 1943). Such signals were, however, used at important places only, for the most part, and the points long continued to be worked locally on the ground. After 1888 progress with the installation of modern safety devices, but leaning much on German ideas, was gradually made, although much prejudice had to be overcome, and the larger stations were equipped with well-constructed apparatus as opportunity offered. A very serious collision, due to the lack of efficient appliances,

* Reprinted, with additions, from *The Railway Gazette* for November 1, 1940, by kind permission of the Editor, Mr. J. A. Kay.

occurred at Malmslätt on June 16, 1912, and the Government appointed a commission to investigate and report on the whole subject of safe working. The commission reported in August, 1913. More than half the State railway stations then still needed proper interlocking. Most of them had bolting of the points, especially facing points, by the signal transmissions, but the traffic imperatively demanded more than this. The commission made a series of recommendations covering the whole of signalling, traffic working, rules, etc., but the 1914 war and the economic difficulties it created in Sweden prevented improvements being

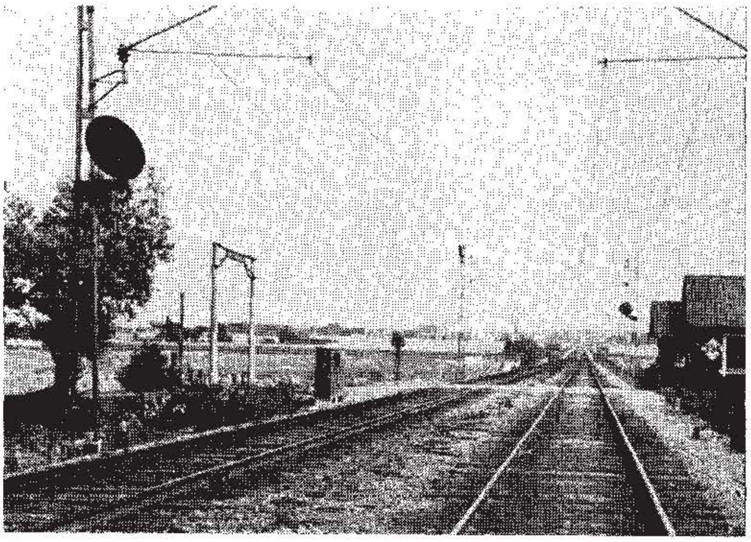


Colour light signals carried on contact wire standards.

carried out. In later years this actually had the effect of securing the adoption of more progressive measures than had been intended, the absolute necessity of considering economy as much as safety leading to a radical change in principles of operation and a breakaway from Central European ideas.

Signal Aspects.

The running signals long consisted of the usual Central European distant, home and starting, the advanced starting not being seen, with circular disc, rotating on a horizontal axis for the distant signal and the ball ended semaphore arm for the others. The first interlocking apparatus was of German make and the details of signals were German also, with lattice or steel section posts, metalwork arms and other fittings. The German junction signal, with concealed lower arm, was also adopted, but it is worthy of note that lower quadrant working did not give place to upper quadrant until 1915. Signals with two concealed arms were also used at certain places. The danger that could arise from a light going out caused the Malmslätt commission to recommend the working of the junction signal being reversed—a step actually taken in Norway—but the general adoption of acetylene signal lighting in 1918 was held to make such a radical change unnecessary. Light signals for day and night use first appeared at Södertalje in 1923 and are now the standard. The night aspects adopted were red and green for semaphores and green and white for distant discs, the practice at the time in Germany, the distinction between the green light in a distant " on " and a semaphore " off " being derived from the height above rail level, distant signals all being on very short posts. The Malmslätt report recommended the use of yellow for " caution," but the idea was not favourably received, although a trial was made with it in some special distant signals of semaphore type, having pointed arms, used to indicate at the home signal whether a train might run right through, first put in between Stockholm and Saltskog in 1914. The yellow light was not retained, however, partly from a desire to avoid the difficulties which any transitional period must occasion and because the use of red, green and white did not necessitate such close colour specifications for the signal glasses, especially with acetylene lights, in which the white light is quite distinctive. By making the distant signal lights flashing all difficulty in distinguishing them from others was abolished. The danger of a green glass breaking was considered sufficiently met by using a very strong wired glass, installed everywhere by 1930. The subsequent standardisation of colour light signals has, of course, eliminated the question of broken spectacle glasses altogether. Thus it comes about that the yellow light is not seen in running signals in Sweden. It is seen, however, in a special signal indicating a " flag station " stop. A flashing green light indicates " caution " and a flashing white that the signal ahead is " off." This latter indication is said to be very distinctive, being exceptionally visible in the daytime. Up to 1914 the distant signals had been two-indication and worked simultaneously with the home signal for all routes, as in Germany. In that year, on the Saltskog line, experiments were made with a three-aspect signal, having a fishtailed arm mounted below the disc, and normally in line with the post, but the signal was not adopted. Its construction was a little complicated. About the same time home signals were all moved 200 m. (219 yd.) from the fouling point and distant signals placed much further out than had usually been the case. In 1923 a beginning was made with



Colour light distant signal. Just beyond the crossing is seen a positiou light signal for reversible line working.

installing colour light distants, the first being put in at Gnesta station. This consisted of an acetylene light with special lens combination and internal spectacle worked by a gas mechanism governed by an electrically controlled valve. It proved highly satisfactory and by 1930 some 25 per cent of all distant signals were colour lights, the gas mechanism being used where no power supply was readily available, and ordinary colour light units elsewhere.

With the older semaphore system route aspects were given, as far as the 2 and 3-arm system would allow, supplemented by " directing signals " in advance, as in the then German practice.

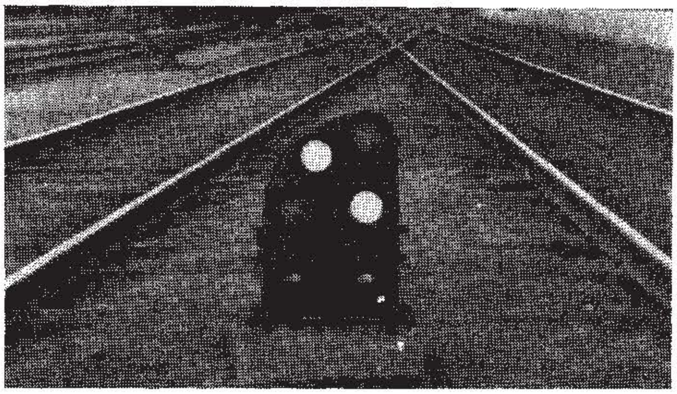
This was followed (except for the " directing " signals) with colour lights, but later practice has been to attach a speed meaning to the signals and restrict the triple green aspect to controlling the entrance to goods and subsidiary lines. All home signal units carry a distant unit, showing flashing green or flashing white when the direct route is signalled, to repeat the starting signal in advance.

Signals for Shunting.

For many years all points had point indicators, on the Central European system, and a few semaphores were used as " stop shunting " signals, but eventually a special signal was introduced for this purpose. After a study had been made of the signalling practice in other countries, especially Great Britain and America, it was decided to adopt the principle of signalling all shunt movements and the position light dwarf signal was selected for the purpose, with 3-aspect working. The dwarf signals are now used for governing all movements within station limits, being shown in the third position for a running train. Colour light starting signals are not provided for each converging outlet road, the dwarf signals sufficing, a single colour light advanced starting or block section signal being placed beyond the last pair of points, restricting colour lights to the absolute minimum. Certain dwarf signals have a fourth aspect called " neutral," which authorises movements under the orders of a shunter on the ground. Point indicators remain in use, however, at many places, double slips having one indicator displaying four distinct signs.

Mechanical Signalling.

This has for very many years been exclusively of the double wire type, using German designs and often in earlier years purchased from German firms. At the smaller stations the frames are worked by the station supervisors who, even when this is not the case, control any signal boxes in their station limits. Points located at some distance from the supervisor frequently have a " dual " mechanism, enabling them to be worked locally with his permission. The peculiar " crank handle " type of frame has found much favour, being very suitable for working out of doors. Its original disadvantage of not allowing such long transmissions to be used as the ordinary double wire lever has been overcome by installing closer pulleys and ball bearing fittings. Standardisation of mechanical signal equipment was begun in 1912 and completed in four years. Signals are invariably operated by cam plate mechanisms. On many single line sections there is little traffic at night and stations are closed, special locking arrangements being used to enable signals to be cleared for opposite



Position light signal with additional green fixed and flashing light units below repeating advanced starting (block) signal.

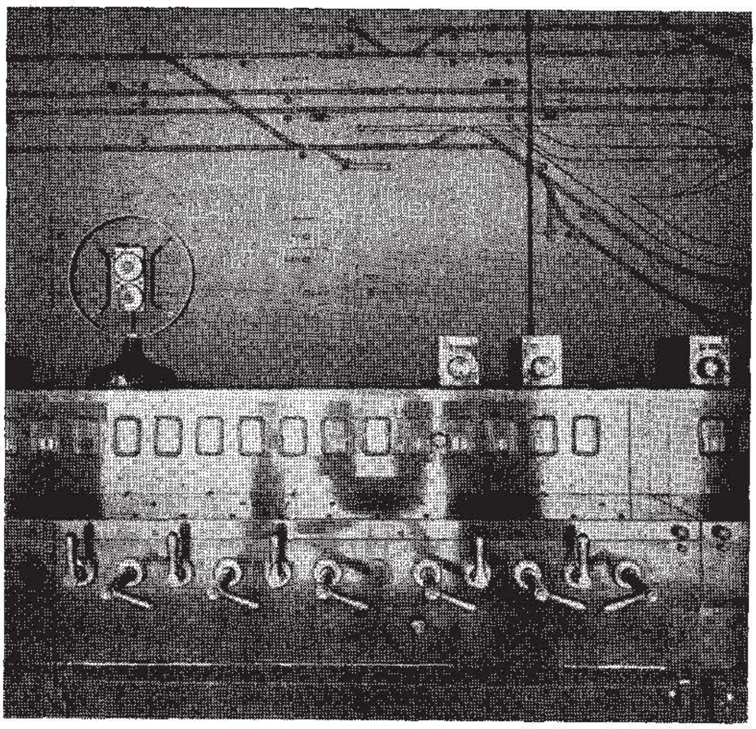
directions simultaneously. Some stations have key locking. There is the usual route holding locking, so general in Central Europe, and much use is made of track locking sections in place of lock-bars. In course of time the manufacture of mechanical signalling was taken up in the country, but general principles remained unchanged.

Block Working and Track Circuits.

In the beginning trains were worked by time table rule and later by the telegraph message system, which was in effect block working. In 1906 the Siemens a.c. lock-and-block apparatus was introduced between Malmö and Arlöv and subsequently was much extended to both double and single lines, it being decided in 1912 to work all important routes in this manner. It was found however that the apparatus did not lend itself readily to the switching out of stations during hours of light traffic, rendered increasingly necessary by the economic position, especially on single lines, while to put the equipment temporarily out of use and work by telegraph, as was sometimes done, was decidedly unsatisfactory. Automatic signalling was therefore resorted to and two short double line sections between Norsholm and Kimstad and Gothenburg and Olskroken equipped in 1925. The former section had ordinary type signals, the latter light signals of the acetylene type. Soon afterwards the Malmö-Arlöv line was converted to automatic working. Track circuiting—except for short rail lengths acting in conjunction with electric treadles—was late in finding favour in Sweden, but experiments were begun with the intermittent feed type at Tomteboda in 1918, and gradually track circuits were applied on the ordinary principles, at a number of signal boxes. Both a.c. and d.c. apparatus was used, depending on local circumstances. It is found that, with suitable arrangements, d.c. track circuits can be efficiently worked where the single-phase a.c. traction is in service. The first illuminated diagram was installed at Flen in 1925. In recent years there has been a large increase in track circuiting and automatic signalling and in many installations both tracks of the double lines have been fitted for both way operation, movements in the right direction being controlled by colour lights and in the wrong direction by position lights. These improvements have been applied to most of the new work undertaken in recent years. The Siemens block was also applied to enable the station supervisor to control the signalmen in the area under his orders, this method of working having been recommended by the commission, but other apparatus has also been used for the same purpose.

Power Interlocking.

Power signalling first made its appearance in 1910, when an all-electric installation was provided at Nyboda. (The all-electric system has ever since been used exclusively). This equipment was of German make, with mechanical locking and circuits on the Central European style. There was no track circuiting and several signal boxes were therefore required in some layouts, of which Hagalund, Uppsala, Järna and Luleå-Svartön were typical. Further work was interrupted by the 1914 war and in 1916 installations of similar type, but made in Sweden, were put in at Eslöv and Åby, followed by several more during the next 6 or 7 years. There was little or no saving in staff costs with this system. The difficulties of working mechanical signalling in the severe weather conditions obtaining on the Lapland line led to electric working, using a.c. point motors, being substituted, the frames being in the stationmasters' offices. (The Norwegian Railways fitted the Narvik terminus with power working in 1930). In 1925 a decisive step forward was taken when the important station at Malmö was power signalled. A great deal of shunting took place there and the three mechanical signal boxes were supplemented by



Part of a modern power frame with all-electric locking.

observation posts for the better supervision of the movements. The disadvantage of the point indicator system was apparent and it was decided to break away from it and adopt a complete equipment of independent shunt signals of the position light type, with one central signal box and automatic signalling on the adjacent block sections, resulting in a saving of 22 men and greatly speeding up the working. The locking frame in this instance was of a well known English type with indication locking and signal selection. Trailable points were retained and are still standard, with practically no locking between point levers, as in previous work. This is considered better for Swedish conditions, as otherwise the inability to operate one pair of points, due to frost or snow, may unduly interfere with the emergency use of others. Internal locking mechanism has superseded the hook and other outside forms of point lock. The platform starting signals were colour lights at Malmö: the use of ground signals for all movements inside station limits came later. The excellent results obtained soon led to other installations being made, but of Swedish design. At Hässleholm in 1927 mechanical locking was given up in favour of electric, and this has been done in most of the work since. Further work followed at Lund in 1929, Gothenburg in 1930 and then Stockholm Central. Electric locking was later adopted for a number of small installations, such as Abisko, Kiruna, Bodens and Jönköping, while the point indicator system gave way to the ground signal system at a number of places where the older type of power working was in use, such as Luleå. Track circuits became more and more general. In recent years C.T.C. apparatus has made its appearance.

Power Supply.

In all the early power work accumulators were invariably provided for point operation. The costs were not low and trickle charging was introduced to enable the reserve cell equipment to be reduced. Where two sources of power were available direct working through rectifiers was used, with the accumulators as final standby, but later they were dispensed with at many places. Where, however, much of the equipment was a.c. operated accumulators could not, of course, serve as standby, when one was considered essential, and reserve petrol generator sets, were used, but at many small stations no standby was thought necessary.

Swing Bridges and Level Crossings.

Both swing and lift bridges—the latter type now the usual—are worked electrically, with electrically operated safety siding points, light signals and approach locking control by track circuit. Many flashlight warning signals have been installed at level crossings, principally at the unattended ones, and where barrier gates exist these have been adapted for power operation, hand working being kept as a reserve. At some places, such as Halmstad, there is a number of crossings in a short distance and by concentrating the working in the hands of the station supervisor the gatemen originally employed have been dispensed with. The barriers are set across the road from the station when a train is about to approach but clear up automatically in turn as it passes them, reducing delay to road traffic to a minimum. Power control of barriers has been included in the recent resignalling at Uppsala.

Although what has been said above chiefly relates to the State Railway system some of the most up-to-date equipment, including C.T.C., is to be seen on the privately owned lines. The progress made in signalling in Sweden during the last 15 years or so has been due in great measure to the ability and foresight of Mr. T. Hård, Member, Signal Engineer of the State Railways, who contributed a most comprehensive study of the question to the railway commemorative volume issued by the Swedish Government in 1931, from which the above particulars are chiefly taken.