

THE INTERLOCKING SYSTEM AT THE STOCKHOLM CENTRAL STATION¹

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In the Ericsson Review No 2, 1933 it was stated that the new interlocking system at Stockholm Central Station had been put in service on March 25th 1933.

The material for this system was to a great extent supplied by L. M. Ericssons Signalaktiebolag and other factories of the Ericsson group. This was also the case with the interlocking systems already in work at the Gothenburg and Malmö Central Stations, which are very similar to the system at Stockholm.

The first part of a description of this system is published below; it treats chiefly the main technical and economical problems and these will found to be of great interest.

In our next issue a large number of illustrations with text showing the construction of the interlocking machine and the details of the signalling system will be published.

The passenger stations of the Swedish State Railways in the three biggest cities of the country — Stockholm, Gothenburg and Malmö — form a special group with similar traffic conditions and arrangements for controlling the traffic. In respect of safety systems also the three stations have developed along the same lines.

In 1925 a new type of safety system for shunting and signalling was completed at Malmö C station, differing from previous installations of

¹ Summary of a conference given at Oslo in August 1933 before the Northern Railway Officials' Association.



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The Stockholm Central Station, seen from north.

the Swedish State Railways by a higher centralization and automatization of signalling both for the trains and for shunting. For the reason that the staff was not used to the new installation disturbance was caused in the traffic when the system was first put in service; however, the trouble ceased in a short time, after the necessary experience had been gained. Except for this disturbance at the start the Malmö installation proved quite satisfactory from both the economical and technical points of view.

The same principles were therefore applied for the Gothenburg passenger station of the Swedish State Railways when this station was rebuilt in 1929—1930 in order to handle the traffic previously managed by the station of a private railway. The system at Gothenburg was put into service without disturbance of the traffic when only the traffic of the State Railways had to be dealt with at the station. Difficulties, however, occurred a fortnight later, May 15th 1930, when on one day the whole of the traffic of the other station was switched over, representing an increase in volume of about 150 %. In spite of the fact that most of the trouble could not be ascribed to the interlocking system this was made responsible. The inexperience of the staff was this time also though unfairly made the main explanation of the trouble caused on switching over.

As early as 1929 the Royal Board of Railways had decided that the signalling system of the Stockholm C station should be rebuilt in accordance with the Malmö system, and the work was commenced as soon as the Gothenburg installation had been completed. On account of the experience gained at the start with the Malmö and Gothenburg systems, the putting in service of the far greater system of Stockholm C was looked

forward to with a certain apprehension. The installation was completed in the beginning of 1933. Great satisfaction was therefore experienced when on the last and greatest of the three systems being put into service there was no disturbance of traffic.

Arrangement of Tracks.

Fig. 1 shows a map of the railway lines around Stockholm. Stockholm C is situated in the centre, being the main station for express, passenger and mail traffic. The passenger station consists of two parts, the eastern of which is a terminus with 6 platform tracks for northbound traffic and the western a through station with 5 platform tracks for southbound passenger traffic and 1 through track for freight trains.

These are two separate groups of tracks for the shunting of passenger trains: one small group east of the entrance points and one large group west of these points. The tracks for mail and express trains are situated west of the platforms of the Western Yard. Further north in the same part of the yard there are tracks leading to customs depots and provision halls.

The track system of Stockholm C has developed in stages from very small beginnings, and for economical reasons, the arrangements in the densely built parts of the city have been limited to the ground available between the adjoining streets.

The platform tracks are therefore few and short in length; the storage space is relatively restricted and the tracks are so situated that to a great extent the roads for trains and shunting must cross each other.

The yard is laid in narrow curves and at the northern end of the platforms it is crossed by a street bridge, the pillars of which have interfered with the planning of the track system.

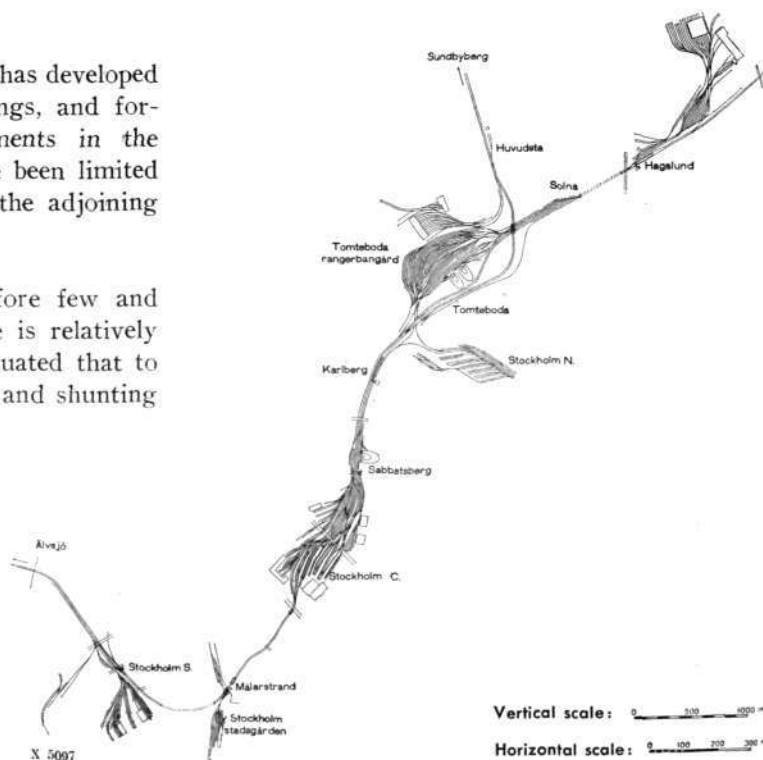
Entrance Lines.

The entrance to Stockholm C from the south consists of a double track which immediately outside the entrance points crosses a street carrying heavy traffic. On the other side of the crossing there is a swing bridge which, however, is seldom opened.

The railway line is carried on bridges over Lake Mälär and, having crossed the street on the southern shore about 1 km from Stockholm C, it enters a tunnel under the southern part of Stockholm. Near the street-crossing a freight-train track to the harbour leaves the double track, and in addition it is crossed by a shunting track for transferring coaches from one part to another of the harbour situated at each side of the double track. There is further near the crossing a swing bridge which is often opened for the passage of ships.

Near the southern end of the tunnel, about 1 km from Mälärstrand, the double track enters

Fig. 1.
Plan of the railway lines around Stockholm.



Stockholm South station, where passenger trains stop. This station is a junction for traffic to and from the southern freight station.

South of Stockholm the double track runs first to Älvsjö where the railway to Nynäshamn on the coast south-east of Stockholm branches off, and thence to Järna where the Malmö and Gothenburg lines divide.

Traffic arriving at Stockholm C from the north is directed partly over a double track and partly over two single tracks, the Eastern and Western side tracks, one on each side of the double track.

About 700 m outside the entrance points of Stockholm C the double track is crossed by a shunting road provided for trains crossing from one side track to the other. In this shunting road there are also points for the double track as well, so that trains may be transferred from the double track to the Western side track and vice versa.

The Karlberg station is situated about 700 m further along, and several passenger trains stop at this station for traffic exchange. A further 700 m along the line, at Tomtebodavägen, the double track divides into two double tracks, one to the line of the private company serving Västerås and the other to the North Main Line of the State Railways.

About 1700 m north of Tomtebodavägen the double track of the North Main Line passes the points at Solna at the northern end of the Tomtebodavägen formation yard and then Hagalund station, from where tracks lead to engine sheds and parking tracks for the long-distance passenger traffic of Stockholm C belonging to the Swedish State Railways. Between Hagalund and Stockholm C a great number of empty trains and single engines are run in addition to the passenger trains of the North Main Line.

On account of the insufficient capacity of the Stockholm C track system Sundbyberg is used as a making-up station for several of the long-distance trains when traffic is heavy; the traffic on the line Huvudsta—Stockholm C is thus increased.

About 1700 m from Tomtebodavägen the double track of the Västerås line passes Huvudsta station, where the railway net of the private Stockholm—Västerås railway begins. Between Huvudsta and Stockholm C runs the passenger traffic of the Västerås line as well as a number of engines to and from the company's engine sheds at Sundbyberg.

The Eastern and Western side tracks are used for freight trains and engines to and from the Tomtebodavägen formation yard. From points in the Eastern side track near the Karlberg station a track leads to the northern freight station of Stockholm. The Western side track leads to Solna from points at Tomtebodavägen and is also used for empty trains when the capacity of the double track is not sufficient.

Planning of the New System.

Previously there were three mechanical interlocking machines each about 30 years old, one at Sabbatsberg (Cabin I), one at the eastern part of the yard (Cabin III), and one at the southern entrance points. In addition there was a small provisional signal cabin (Cabin II) at the northern entrance points, built in connection with the extension of the yard when all facilities of the existing interlocking machines were utilized. The points at the northern end of the platform tracks of the Western yard were not interlocking and were operated from a post situated near the points and called »Western Yard Post».

For clearing the roads for arrival and departure there were two blocking apparatus in the train dispatchers' offices, one for the northern and the other for the southern part of the station.

The safety installation had been altered several times and needed thorough reconstruction. In the program for the reconstruction of the system, of which the main points were approved by the Royal Board of Railways in 1929, the intention was to concentrate the 7 interlocking machines of Stockholm C in one main electric system.

The points at Tomtebodavägen and the lines from there to Huvudsta, Hagalund and Sabbatsberg were operated from an electric signal cabin at Tomtebodavägen, which when built in 1916 replaced 3 small signal cabins.

As the project was developed it seemed advantageous to eliminate the Tomtebodavägen signal cabin and concentrate even this operation at Stockholm C. In this way, in addition to considerable reduction of the staff, a far higher traffic capacity of the heavily loaded double track was believed possible.

For the same reason it seemed advantageous to operate the side tracks and their points from

Stockholm C; formerly one of these points had been operated from Tomtebodas Övre and the other from the Karlberg station.

At Mälarstrand there was a 30 years old mechanical signal cabin with section blocking arrangements to Stockholm South and Stockholm C. A separate signal cabin was provided for the operation of the swing-bridge and the street barriers. Although there had to be a certain staff at Mälarstrand to deal with the pivot-bridge and to guard the crossing, the work ought to be performed from one signal cabin which would involve a certain reduction of staff.

In addition the traffic capacity of the double track Stockholm C—Stockholm South with the existing section blocking system had proved insufficient. Difficulties occurred particularly with single-track operation, when running of the trains had to be regulated by means of telephone communication. At Stockholm South an electric interlocking system with automatic section blocking for the line to Älvsjö had been installed a few years before. The advantages of this system could not be utilized to the full until a similar system was installed on the line between Stockholm South and Stockholm C.

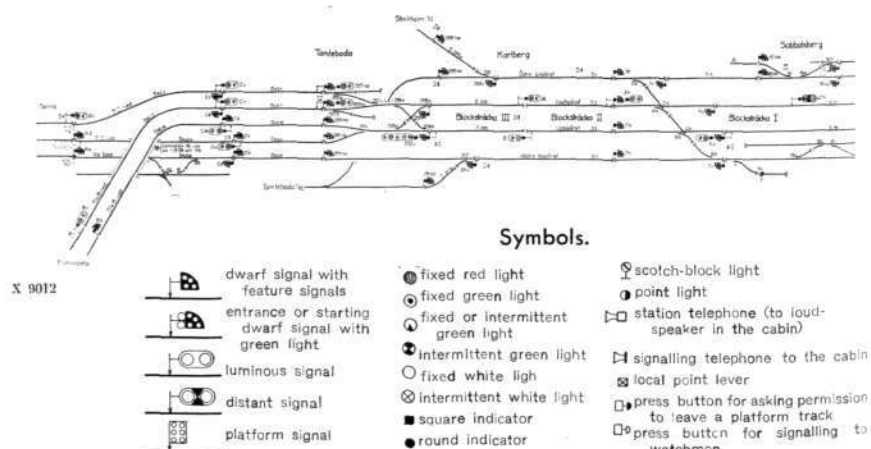
Main Points of the New Installation.

Fig. 2 shows the new safety installation in the state in which it was built. In view of traffic conditions the range in question was divided into three main parts, namely Stockholm C and the

northern and southern lines. The points at Sabbatsberg were included in the northern lines, and the limit of Stockholm C was put at a suitable distance from the entrance points of the platform tracks. The points at Mälarstrand and the line between Stockholm C and Stockholm South were included in the southern lines. The limit of Stockholm C in this case was put at such a distance that the tracks outside the entrance points could be used for shunting without the line section being disturbed. The extent of the system is shown in the table below, where all apparatus and arrangements are indicated:

	Northern lines	Central station	Southern line
Main signals ... coloured light	14	3	4
Distant ... signals	—	1	4
Home and starting dwarf signals ... feature light	—	24	—
Other dwarf signals ... signals	40	18	9
Platform signals	—	18	—
Scotch-block lights	5	4	1
Point lights	—	3	—
Centrally operated points and scotch blocks	21	80	7
Other lockable points and scotch blocks	12	3	—
Track circuits	37	94	7
Signal sections with automatic signals	17	—	2
Signal sections with signalling from signal cabin	54	194	13
Roads	—	132	—
Yard telephones	—	9	—
Signalling telephones	13	3	2
	Signal cabin at Stockholm C.		Signal cabin at Mälarstrand
Signal switches	61	3	
Point switches	70	5	
Reserve positions	29	4	

Fig. 2.
The interlocking plant at Stockholm C with adjoining lines.



When working out the project it proved advantageous to complete and alter the arrangement of the points. At the southern end the points 136 a/b and 126 a/b were provided in order to obtain roads from both up and down lines to all platform tracks. By this arrangement it would not be necessary to change the roads in the yard for single-track traffic. In the northern part of the yard the new points 22 a/b, 30 a/b, 56 a/b and 116 a/b were provided, and, further, all single crossing points were replaced by double ones. At Sabbatsberg the shunting road 2a—2b, which had formerly been situated close to the station, was moved further out.

An important problem was the location of the main signal cabin. There were two alternatives: north of the street bridge or south of the bridge at the northern end of the Western Yard. The latter alternative was chosen because in this way the cabin would be nearer to those groups of points where shunting had proved to be far more intensive and more varied than at the points further north. For the street barriers at the southern street a special post was provided, consisting of a small cabin immediately beside the street crossing. At Mälarstrand a separate small signal cabin was provided, placed on poles in the water so near the swing bridge that the opening and closing of the bridge could be carried out by the staff of the cabin.

The tracks were divided into *signal sections* with signals for regulating the traffic on the sections. The sectioning was determined by the position of the points, the necessary traffic intensity and the safety requirements. It was made a main rule, that all movements of vehicles into or out

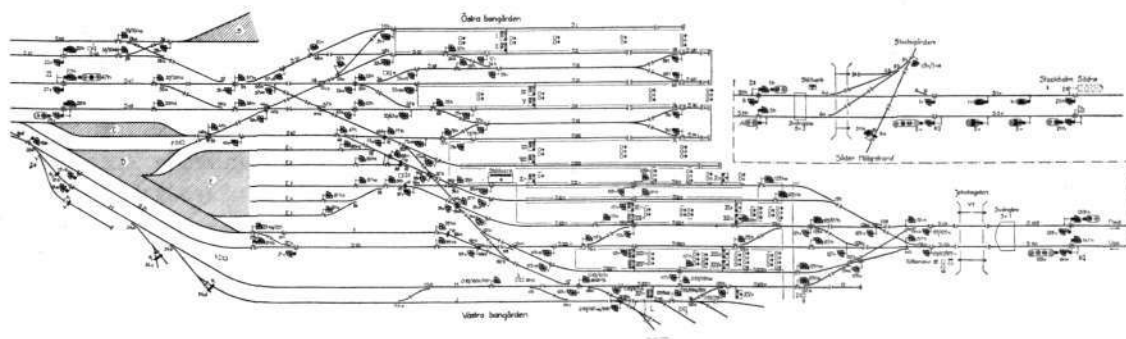
of a section should be controlled by clear signal from a fixed signal. The movement should be protected from dangerous train or shunting operations by points not being thrown to the track in question or by fixed signals in stop position. When the points permit several roads between two places it must be possible to use any one of them.

In order to increase the traffic capacity of the Western Yard the platform tracks at this part were divided into two signal sections, so that two trains of a certain length could be placed behind each other at the same platform.

In the groups of points at the ends of the platform tracks, relatively short signal sections were arranged, whereby the shunting work would be facilitated, as the distances to be traversed would be shorter, and the movements could be carried out at shorter intervals.

In order to facilitate train movements over these groups of points special signal sections were arranged between the lines and the platform tracks, arrival and departure tracks, made up of combinations of several signal sections lying behind each other.

Each of the side tracks between Stockholm C and Tomtebodavägen was divided into three signal sections for each traffic direction. The same sectioning was carried out for the two tracks of the double track, while the number of sections for the opposite direction was limited to two for these tracks. The tracks between Tomtebodavägen and Hagalund and Solna respectively were each divided into two sections, except for the abnormal traffic direction on the double tracks; for this case only one signal section is



provided. The two tracks between Stockholm C and Stockholm South were divided into two signal sections each for the normal direction and one each for the opposite.

Automatic signalling was arranged for the signal section on the line where there were no points. The intention was to reduce the work of the staff and make possible shorter intervals between trains by means of a more rapid clearing of the signal sections for the following trains. Even the automatic signal sections were, however, placed under the supervision of the signalling staff, as a change of the traffic direction on a track would have to be arranged by the staff.

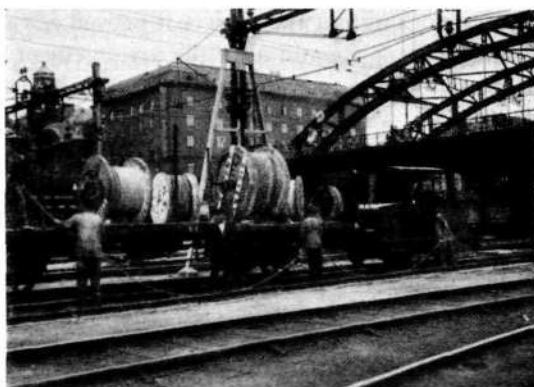
Signalling Systems.

Entrance to the signal sections both on the lines and in the range of Stockholm C is regulated by *dwarf signals*, which show two uncoloured lights arranged in different positions in relation to each other. »Stop» is indicated by two lights side by side, »caution» by the left light being situated somewhat higher than the right one and »clear» by one light above the other.

For the entrance roads to Stockholm C special signalling was arranged on the dwarf signals at the station limits (*home dwarf signals*) consisting of a green light below the uncoloured lights. A continuous green light on a home dwarf signal shown at the same time as »clear» by the uncoloured lights means that all signal sections of the entrance road are clear. Intermittent green light is used instead of fixed for *shortened road*, i.e., all signal sections except the last section of the platform track.

Corresponding signals for departing trains have been arranged on the dwarf signals regulating the traffic from the platform tracks (*starting dwarf signals*). Intermittent light is used when the signal sections of the road are clear only to the station limit and fixed green light when the first signal section of the line is also clear.

The position of dwarf signals can be clearly seen at a distance of 200 m, which is considered sufficient for a speed of 30 to 40 km/h. Where greater speed is used or where the signals are required to be visible at a greater distance, the dwarf signals are combined with *main signals* showing a green or a red light placed above the dwarf signals, and which can be made out at a great distance.



X 1256

Fig. 3. Cable laying.

In this system the main signals are thus regarded as supplementary to or repeating signals for the dwarf signals which are the fundamental means of signalling. When the dwarf signal indicates »stop» the main signal shows a red light. When the dwarf signal is switched over to »clear» the main signal shows a green light, if the clear signal does not belong to a signal section where a reduction of speed or special attention is necessary. In such cases the dwarf signal only indicates »clear», while the main signal continues showing a red light. Red light is always shown on the main signal when »caution» is shown on the dwarf signal.

»Clear» on a dwarf signal or green light on a main signal means that all points in the signal section are in the right positions, that danger signals indicate »stop» and that the section is free from vehicles.

»Caution» on a dwarf signal means that the points are in the right positions and danger signals in »stop» position, but that there may be vehicles in the section or close to it.

The feature »caution» is of great importance for shunting work during which movements have to be carried on near sections occupied by vehicles. As a rule only the feature »clear» is used for train movements. »Caution» may be used also for trains when faults occur or when trains have to be directed to tracks already occupied by vehicles.

In the range of Stockholm C it was arranged with regard to the shunting work that »caution» should always be shown on dwarf signals when the signal lever is switched over, if »clear» signal cannot be indicated immediately. If the latter is the case, »clear» is automatically indicated instead of »caution».

For the signals on the lines where the traffic as a rule consists of trains, it was arranged so that the feature »caution» cannot be shown if the section is occupied, unless a locking button on the signal lever is kept pressed.

All points of the signal sections in Stockholm C and the northern lines are operated from the signal cabin of Stockholm C with the exception of a few points in the Western side track leading to parking tracks which are only provided with point locks, and the points of the southern line which are operated from Mälarstrand.

A number of points in the through track of the Western Yard are operated both from the signal cabin and at the points themselves by means of levers. Permission must, however, be obtained from the signal cabin before these levers can be used. The dwarf signals of the signal sections in which the points are situated then indicate »out of service», which means that shunting may be carried on without intervention of the signal cabin. This signalling feature consists of lights of different colours, of which the right one is situated higher than the left.

Track Circuits and Their Application.

The supervision of the extensive interlocking range is carried out by means of *track circuits*. These circuits are used for three different purposes:

- to operate a track diagram, which shows the staff where trains and vehicles are situated;

- to ensure automatically that the entrance signals of the signal sections do not indicate »clear» when the sections are occupied by vehicles;

- to prevent the points being thrown over too soon;

- the division of the track into track circuits, *i.e.* electrically insulated sections, through which the track current passes to the track relays, must take account of all these points of view.

The indications on the track diagram are by means of lamps which light up and go out as the track relays change position.

The signals are operated by the first track circuit of the signal section. A signal in »clear» position will therefore change when the first axle of a train has passed. The signals on the line are

changed to »stop» and the signals in Stockholm C to »caution», according to the different methods applied for the operation of signals on the line and in the yard.

In order to prevent points being thrown over too soon the principle is applied for signal sections on the lines that a signal lever switched over must not be put back until the expected train has arrived and the engine has passed the signal. The release occurs when the train enters the first track circuit of the signal section. The signal lever can then be put back but the points of the section are still locked by the influence of the train and are not released until this can be permitted from a safety point of view.

A similar system is used for the entrance and starting roads over the points of Stockholm C, *i. e.*, when signalling is made with green light on the entrance and starting dwarf signals.

For practical reasons it was necessary to avoid the locking of the signal switches in thrown position (track locking) for movements in connection with shunting work. The locking of the points by individual locking of the point switch was, however, arranged in all cases where the signal is passed by vehicles when the switch has been thrown. If a signal switch is thrown back before the signal has been passed there is of course a certain risk if immediately afterwards the points are thrown over from the signal cabin without the staff having ascertained whether the stop signal has been obeyed or not. For the groups of points situated far from the signal cabin special time relays have been provided in connection with the signal switches. These time relays will hold the points of the signal section locked for a certain time after the signal switch has been thrown back.



X 1255 Fig. 4. Welding of the connections at the rail joints.

In the group near the signal cabin, where there was a great need for liberty of motion, this delay was not introduced. The suitable time for throwing back the signal switches when shunting is determined by the shunting staff in accordance with general orders.

Communication Arrangements.

The Stockholm C interlocking system is of the master type. The operation of the signals is thus commanded by the interlocking system. For the information of the platform staff, particularly the train dispatcher, special platform signals have been installed, which indicate when a train is arriving or when the road is clear for departing trains. Arrivals are indicated by a red light towards the platform and departures by a green light; the latter indicates by its position in the signal to which track the road is leading.

In order to call the attention of the signal cabin when a train is ready to start there are press-buttons on the platforms connected with signal lamps in the track diagram in the signal cabin. The signalling staff need therefore not clear the roads earlier than is absolutely necessary.

Communication between the signal cabin and the train dispatcher is carried on by the telephone. For information between the signal cabin and the staff in the yard there is a special telephone system with loud-speakers and microphones in the signal cabin, so that calls can be exchanged without interruption of the work at the interlocking switchboard. There is also a special signalling telephone system for giving orders to the engine crews on trains that have been stopped at the fix signals on the line.

Connecting-up the Interlocking System.

The interlocking system was put in service in three stages. On the night of March 16th to 17th all devices on the lines north of Stockholm C were switched on, by which 21 machine driven points, 12 locking devices, 54 signals with 37 track circuits were put into service. The work had been prepared during the four previous days, and during this time the old section-blocking system and

the signal cabin at Tomtebodav were put out of service and replaced by telephone information and personal inspection of the roads.

On the night from March 20th to 21st the signal cabin at Mälarstrand and the lines south of Stockholm C were switched on, by which 7 more points operated from the central signal cabin, the interlocking of the pivot-bridge and 17 signals were put in service. The old safety system was kept in service all the time and was not disconnected until after the last train of the 20th. The work was rather difficult as the electric circuits at Stockholm South had to be rearranged in a few hours of the night.

At this time there remained at Stockholm C 80 point-machines, 127 signals and 94 track circuits to be switched on. The signals and the track circuits had been completed previously as well as about 20 points which were not in use at this time or which could be thrown over by hand-levers. The remaining 60 points were connected in four hours of the night from March 24th to 25th. The complete system was in service for the first train of the 25th. Fifty-seven men took part in the connecting work, and these were divided in two gangs with written instructions regarding what each man had to do.

The signalling staff had previously received careful tuition and had been trained in practice for a few weeks. During the training the signalling with the dwarf signals was carried on as if the system was already in service but the points were still operated in the old manner. The shunting and engine staff were ordered to respect also the new signals. Two signalling systems were thus in service during the training time.

As a result of this training the switching-over from the old to the new system was done without any sudden change and the work went on as usual. The only difference was that the old signals and signal cabins were put out of service from March 25th, when also the operation of the points was taken over by the interlocking system.

Cost of the System and Reduction of Staff.

A summary of the cost of installation of the point and safety signalling system at Stockholm C with lines to Huvudsta, Solna and Stockholm South is given below.

Material.

1. Interlocking machine, track diagram, relays, signals, operating machines for points and street barriers, transformers, condensers, rotary converters and rectifiers, switchboards, telephones and installation material	505 000	
2. Underground cables, cable fittings and connecting wire	155 000	
3. Tools and parts for provisional arrangements	16 000	676 000

Wages.

4. Fitting, excluding work on cables (80 000 hours at Sw. Kr. 1:80)	144 000	
5. Laying and fitting of cables (44 000 hours at Sw. Kr. 1:75)	77 000	
6. Supervision of the work, watchmen, stores, provisional arrangements, holidays, illness, etc. (50 000 hours at Sw. Kr. 1:70)	85 000	306 000

Buildings.

7. Signal cabins	60 000	
Total Sw. Kr.	1 042 000	

Two thirds of the total cost, Sw. Kr. 1 042 000, is represented by material and about one third by wages paid by the Swedish State Railways direct to fitters and workers. The average wages have been Sw. Kr. 1:75 per hour; this average includes piece-work, over-time and night work as well as the wages of fitters with special qualifications.

If each point, scotch block, signal, operating machine for street barriers and interlocking device for swing bridge is considered as a unit there are 464 units in the whole system, and the installation cost per unit was Sw. Kr. 2 250. For purposes of comparison it may be mentioned that the Gothenburg system with 216 units cost Sw. Kr. 464 000 or Sw. Kr. 2 150 per unit.

The changes in staff due to new safety system are shown in the table below.

	Staff for train dispatching, signalling, engine shunting and maintenance			
	Before	Now	Reduction	Increase
<i>Traffic department:</i>				
Tomtebodavägen Övre	7	3	4	—
Karlberg	4	3	1	—
<i>Stockholm C:</i>				
Signal cabin I (Sabbatsberg)	5	—	5	—
Signal cabin II	3	—	3	—
Signal cabin III	10	—	10	—
Signal cabin IV	4	3 watchmen	1	—
Eastern Yard	4	3	1	—
Western Yard	13	8	5	—
New signal cabin	—	17	—	17
Southern end of the yard	3	3	—	—
Northern train dispatcher's room	6	6	—	—
Southern train dispatcher's room	5	5	—	—
Mälarsstrand	7	3	4	—
Stockholm South	6	3	3	—
<i>Line Department:</i>				
Repair staff	8	8	—	—
	85	65		

The saving of staff thus amounted to 20 men on August 1st 1933, which corresponds to about Sw. Kr. 80 000 per annum. A calculation of interest regarding this saving is given below.

It should be observed that the staff is to work to the time table of May 15th which was introduced only about a month after the system had been put into service. On account of the uncertainty as to what influence the system would have on the work the staff will probably be too large rather than too small. When the staff is fully trained it will probably not be necessary to have 17 men in the new signal cabin, which means 6 or 5 men per gang. This staff can then probably be reduced by 4.

	Annual cost	
	Increase	Decrease
4.24 % interest on Sw. Kr. 1 042 000	44 200	—
Consumption of electric power	5 800	—
Cost of material for maintenance	—	—
Cost of staff for operation and maintenance	—	80 000
Total Sw. Kr.	50 000	80 000

The annual profit with the reduction of staff by 20 men already made is Sw. Kr. 30 000 and in addition an increase has been obtained in traffic capacity and safety.

Eight men remain of the 13 men at the Western Yard; of the work carried out previously there is only left the coupling of the engines when shunting, while all inspection of roads, throwing-over of points and signalling has been eliminated. In the Eastern Yard and at the southern starting points there are 6 men in all for the same kind of work with the shunting of the engines; the effective work of this staff during an 8 hours' shift can probably be counted in minutes. By a better organisation of the work and by spreading more widely over the yards, the whole staff for shunting engines can probably be reduced by at least 6 men more. This reduction is relatively small in view of the fact that there are 3 shunting engines with corresponding shunting gangs working in the yard, costing about Sw. Kr. 360 000 a year. Also for these shunting groups the improved arrangements for the operation of points and signals will have brought about a higher efficiency which after some time should make further savings possible.

Other figures in the table that are worthy of note are those relating to train dispatchers. According to the table the same number of staff as before is used though the work connected with the station-blocking apparatus has been eliminated and the responsibility for keeping the lines clear

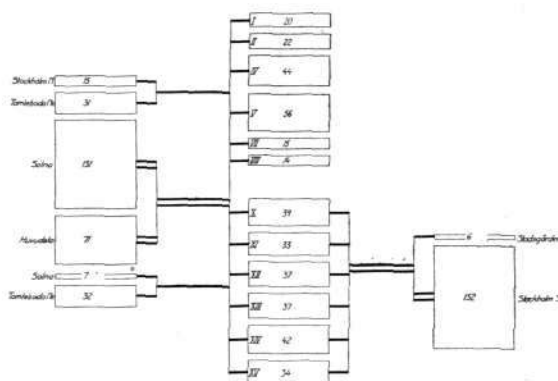
has been transferred to the automatic equipment. By combining the two train dispatcher's offices in one, two assistants will be saved. By relieving the train dispatchers of certain kinds of routine work such as giving starting signals to local and empty trains, it should be possible to reduce the number of train dispatchers from 7 to 4.

Even at Stockholm South, Tomtebodavägen and Karlberg it will be possible to make certain reductions. In addition to the reduction of 20 men already made, as stated in the table, a further reduction of 14 to 15 men will be possible when all facilities for rationalizing the work are utilized. The savings for amortization of the installation cost, which is Sw. Kr. 31 000 at a reduction of 20 men, will increase to three times this amount with a reduction of 15 men more.

Amount of Traffic.

Fig. 5 gives in graph an indication of the train frequency on the train tracks and the adjoining lines of Stockholm C. The diagram gives the ordinary traffic on the day of the week when traffic is at its heaviest. The number of arriving and departing trains on the adjoining lines is 445 in all, of which 270 are passenger trains and the remainder consists of freight trains, empty trains and single engines.

In addition to these trains there are a great number of shunting movements, which are carried



X 1258 Train frequency on the tracks and adjoining lines at Stockholm C.

out on the train tracks of Stockholm C without reaching the lines. The number of such shunting movements is about 825 per day, according to the shunting plan of Stockholm C. A new shunting movement is counted after each change of direction or road, so that for instance a shunting movement requiring one drawing-out and one reverse movement is counted as 2 movements in the above figure. Shuntings on the parking lines are not included in the above figure, which refers only to movements on the tracks operated from the signal cabin.

Fig. 6 shows a plan of the utilization of the platform tracks during the day. From the plan it may be seen that practically all traffic is carried on between 4 a.m. and midnight. During this time there are thus more than 1 200 train and shunting movements in the interlocking range, i.e. an average of one movement a minute.



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Fig. 6. Plan of the utilization of the platform tracks at Stockholm C.

The tracks are represented by horizontal lines and the hours by vertical lines. The presence of a train or an engine on the platform tracks is indicated by heavy black lines, the ends of which indicate the time of arrival or departure of the vehicle from the track. The figures at the ends of these lines indicate the time of arrival and departure in case the movement is made as train.