Centralized Traffic Control on The Stockholm—Saltsjöbaden Railway

H MONTELL, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

U.D.C. 656.257 (487.1)

In recent years systems of the kind described below have found increased employment abroad, especially in USA. In Sweden a plant of this type was delivered in 1938 by L M Ericssons Signalaktiebolag to the Stockholm—Saltsjobaden Railway. The plant which has now been in service for 6 years with good results was developed in consultation and under the supervison of Mr. T. Hård, departmental chief in the Royal Swedish Board of Railways. The account which follows was published in Nordisk Järnbanetidskrift, with whose kind permission it is reproduced.

Since the spring of 1938 there has been in service on the Stockholm—Saltsjöbaden Railway a plant for centralized traffic control on the CTL system. The railway, which connects Saltsjöbaden with Stockholm, has a length of 15.5 km and runs through several densely built up communities, also serving some large industrial centres.

Traffic on the railway is dense, with one train per hour in each direction. In addition there are supplementary trains at certain times of the day, in to Stockholm in the morning and back from Stockholm in the afternoon.

From the graphic timetable shown in Fig. 1 it may be seen that the trains start from the two terminal stations at practically the same time.

The line is single-track except for the sections Saltsjö-Duvnäs—Storängen and Järla—Nacka, which are double-track. Train crossings are for the most part confined to the section between Saltsjö—Duvnäs and Storängen. In certain cases, however, trains cross at Henriksdal station.

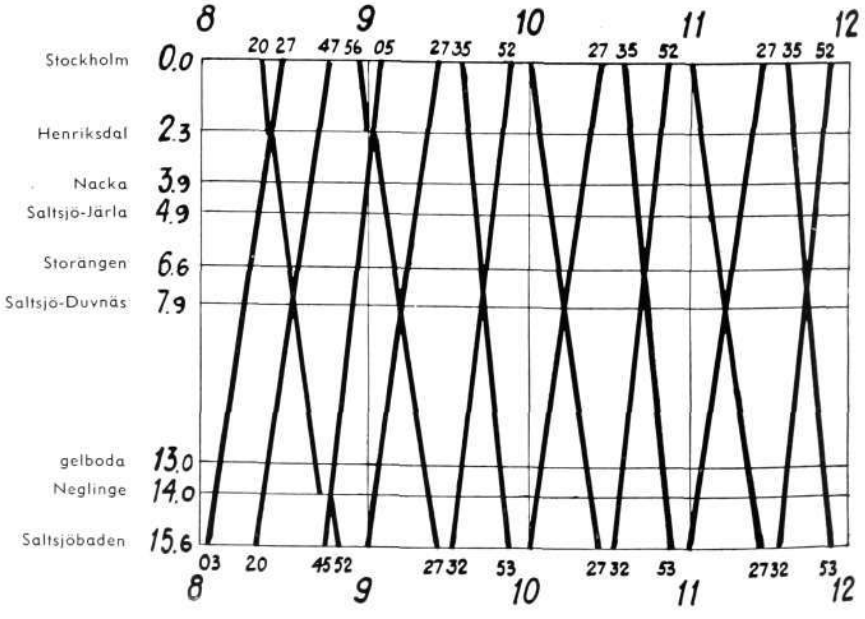


Fig. 1 X 5577
Graphic timetable
for the Stockholm—Saltsjöbaden railway

Fig. 2 X 4361
Illuminated signal

The line is elektrified for D.C. current, with 1300 V operating voltage. The stations had mechanical locking machines.

In the beginning of the 1930s the question became urgent of a thoroughgoing reconstruction and modernising of the interlocking plants at the different stations, with the object of rationalising operation. Various proposals were considered and finally the following decision was reached, which was regarded as the most suitable from all points of view.

The whole line should be furnished with automatic line blocking.

All barriers should be let down automatically by trains approching and be automatically lifted immediately the train had passed the level crossing. In one case existing automatic bell ringing should be retained.

The stations of Saltsjö-Duvnäs, Storängen, Järla, Nacka and Henriksdal should be distance controlled from a control centre located at the depot station Neglinge.

The work of reconstruction at the stations which were to be distance controlled was put in hand in 1937. The existing mechanical locking machines (crank apparatus) were replaced by completely electric locking plants.

Construction

The semaphores and in some cases the existing illuminated signals were replaced by up-to-date illuminated signals; the points on the main tracks were provided with electrical point machines; on the sections between the stations and on the main and meeting tracks at the stations track circuits were arranged. A number of level crossings were supplied with new barriers and all of them were equipped with electric operating devices. Those points and scotch blocks that were not furnished with electric operating devices were equipped either with locks, the keys for which are kept under lock and key at each station, or the points and scotch blocks were locked from existing crank apparatus which are kept locked.

The newly installed *illuminated signal lights* are of up-to-date construction with double lens system. The entrance signals have 2 green and 1 red light, the exit signals 1 green and 1 red light. The lamps of the entrance and exit signals for the main line tracks are mounted on poles or suspended in the power line suspension bridges, so that the signal lights are about at eye-level for the engine-drivers. Exit signals for side tracks, on the other hand, consist of low illuminated signals mounted direct on concrete foundations alongside the track, see Fig. 2. This placing of the illuminated signals at different heights in relation to the track is due to the desire to distinguish them in a marked way and thus prevent any confusion.

The *point machines* are of Signalbolaget's standard design, equipped with tongue control and built-in point lock, and driven by 220 V three-phase motors.

The *barrier machines* also are provided with 220 V three-phase motors.

The *track circuits* are made as A.C. track circuits and are fed by 50 c/s A.C. For track relays there are used two element two position vane relays. The track feed is done over transformers and the track current is regulated by shift resistance. The relay transformers are connected between the tracks and the relays.

Distance Control System

The operating centre from which the distance controlled stations are controlled and supervised is located at Neglinge. The centre comprises a control apparatus and the control transmitters and indication receivers cooperating with it.

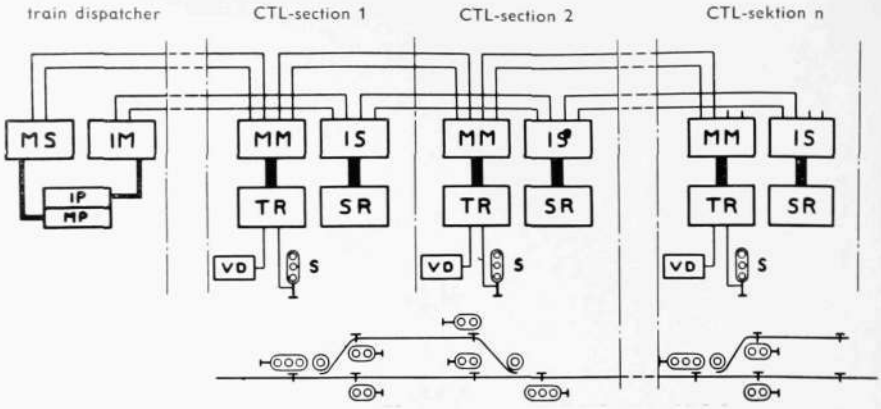


Fig. 3 X 5975

Diagram of the distance control system lay-out

IM indication
IP illuminated diagram
IS indication transmitter
MM contol receiver
MP control panel
S signals
SR track relays, point indication relays
TR train route relays
VD point machine

A telephone cable has been laid along the whole line. Two wire-pairs in this cable are employed for the distance control system, two pairs for telephone purposes and the remaining pairs for the automatic line blocking and other purposes.

The operating centre at Neglinge is connected, via the two wire-pairs employed for the distance control system, with CTL-sections, one at each of the stations Saltsjö-Duvnäs, Storängen, Järla and Nacka. Each such CTL-section comprises a control receiver and an indication transmitter. In addition two CTL-sections have been connected at Henriksdal station to the wire-pairs, as this station is too large to be conveniently served by a single section. Fig. 3 shows the lay-out in diagram of the distance control system.

By means of the operating apparatus the train dispatcher stationed at Neglinge sets and starts orders wanted (train routes and the like) to the different stations, where the orders are received in the control receiver. These in turn actuate special order relays which take care of the execution of the orders. Everything is done completely automatically, so there is no need for any staff at the stations to allow entrance and exit of trains or for regulating the run of the trains between the stations.

Through the indication transmitters communications are transmitted from the different stations to the control centre, when trains enter and later leave the different track circuits, of the positions of points, whether barriers are up or down etc.

In this way the running of the trains is arranged and the situation at the different stations are supervised from the train dispatcher position.

It has not been the intention with the distance control system to provide interlocking in the ordinary sense, i. e., the dependence between points and signals. This has been provided for by the local interlocking plants at the stations and by the automatic line blocking.

The characters of the distance controlled stations on the Stockholm—Saltsjöbaden line are such that it has been possible to make them practically alike as regards control.

Fig. 4 shows in principle how the stations are arranged. In view of the existing double track it has been possible to arrange automatic signals on the sections between Saltsjö-Duvnäs and Storängen and between Järla and Nacka. The automatic signals always show clear if line sections before them which they are to protect are free from traffic and any barriers along them are

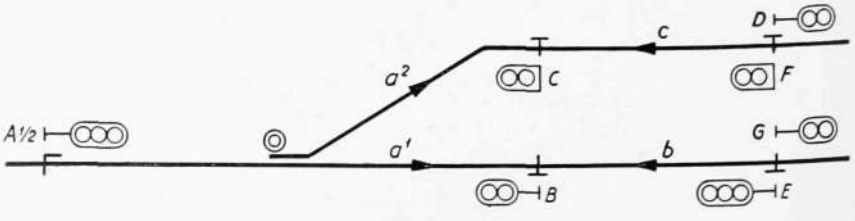


Fig. 4 X 5976

Track lay-out in principle at station

A 1/2 entrance signals
a^1, a^2, b and c train routes
B exit signal for straight track
C exit signal for side track
D, E, F and G automatic signals

down, provided that conflicting train routes have not been set from the control centre at Neglinge. The first thing that happens when an order for a fresh train route from Neglinge comes into a station is that the previous order is cancelled. Then the points comprised in the train route are shifted automatically, if they are not already in correct position, after which the setting of the signal to clear is prepared. If there is no level crossing before the signal along its protection stretch and if the stretch is free the signal goes to clear at once. If there is a level crossing on the section clear signal is not given until the barriers are down. Conflicting train routes cannot obviously be ordered simultaneously.

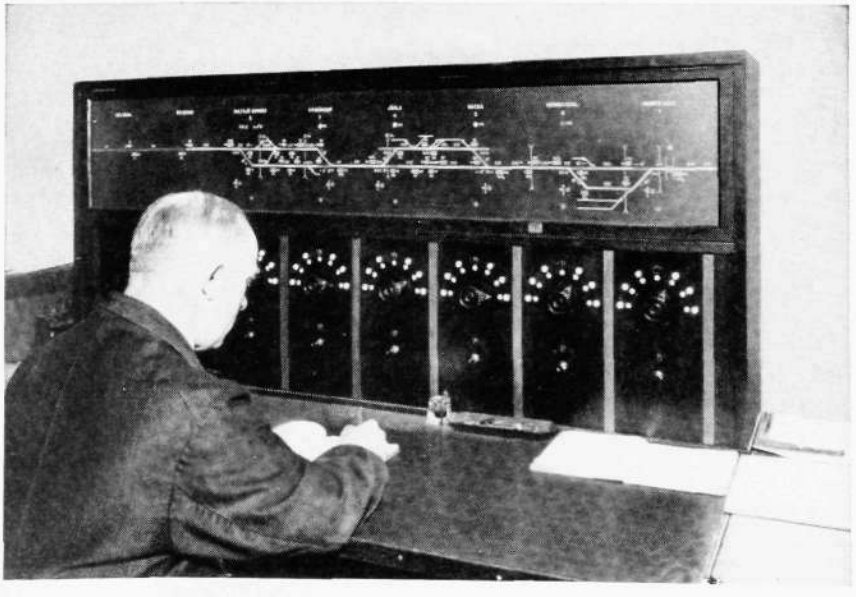
Train route locking has been introduced and makes it impossible to alter a train route laid if a train is approaching. If there is a train on the block section and it is absolutely necessary to re-arrange the train route, this may be done by the sending out from Neglinge of a special order for terminating the train route locking that has been made. The distance operated signals at the station will then show danger. After the lapse of a certain time, regulated by a time relay, the train route locking is released automatically. The new train route can then be arranged. Signals applying to entrance from opposite directions to the same block section cancel each other out.

Control Centre

The control apparatus installed at Neglinge, shown on Fig. 5, comprises a control panel, provided with six fitted control fields and 2 reserve fields, viz: one control field for each CTL-section. The control fields, identical with each other, are fitted with a control knob with necessary order lamps, a starting button and a lamp to show faulty signalling. By means of the control knobs which have 7 setting positions the following order settings can be made:

1 train route a^1: entrance on straight track
2 » » a^2: » » side track
3 » » *b*: exit from straight track
4 » » *c*: » » side track
5 *L*: order permitting local operation of points
6 *A/B/C stop*: order cancelling train route locking introduced
7 *p*: test starting of indication transmitter. The start button is used to start order sending after the control knob has been set.

Above the control panel an illuminated diagram has been arranged. This is made of etched glass sheets on which is shown a miniature of the CTL-operated railway line. The track system with its track circuits is made up of illuminated ribbon.



X 5977

Fig. 5
Control apparatus

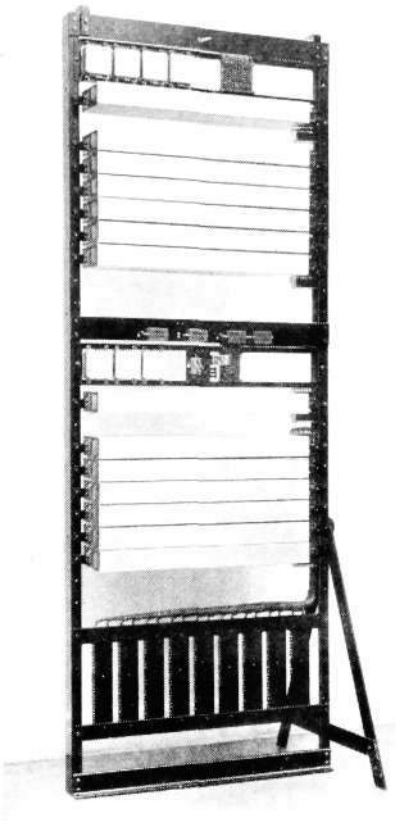


Fig. 6 X 4262
Relay and selector rack at Neglinge

In addition to the track circuits there are indicated the positions of the distance controlled points, the raised positions of the barriers, if the distance controlled signals A, B and C at the stations concerned show danger and if the master locks mentioned above as at each station and which lock the central lock or the crank apparatus respectively are really locked. Fig. 6 shows the rack with relay and selector equipment for the control transmitter and the indication receiver at Neglinge.

The control transmitter is equipped with relay devices for 6 CTL-sections, but the rack is cabled for 2 further sections, to allow of later enlargement to 8 CTL-sections, should that prove necessary. In the same way the indication receiver is constructed for receiving indications from 8 CTL-sections, though at present only fitted with relays for indication receiving from 6 CTL-sections. From each CTL-section indication can be given respecting the two positions of 10 devices.

The relays are mounted on bars. Each bar is provided with a fixed connecting plug, enabling the bar to be easily loosened and taken out of the rack for inspection or replacement. This is done without the necessity of loosening any connection. All connections of wires to the rack are made on a number of terminal blocks, mounted on the lower part of the rack.

Control Receivers and Indication Transmitters

As stated above, at each CTL-section there are control receivers and indication transmitters. These apparatus consist of a base-plate on which is fitted a relay grid. Relays and selectors are fitted on the relay grid, which can be swung out. The relay grid is connected to the base-plate by means of flexible connecting cords provided with plugs which are plugged into jacks on the base-plate. It is a simple matter to take the connecting cords out of the jacks after which the relay grid can be lifted and taken out for examination and if necessary for replacement by a reserve grid.

Fig. 7 shows a control receiver. The components comprised in the distance control system, such as relays and selectors, are parts wellknown in automatic telephony and to be found in the different automatic systems.

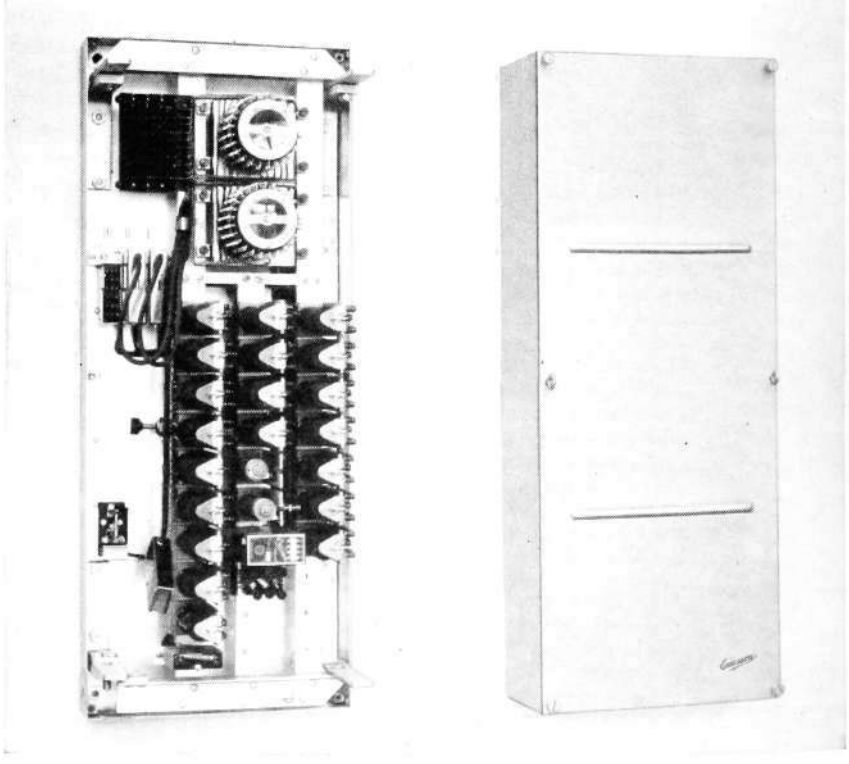


Fig. 7 X 5978
Control receiver

left, without cover: top, selectors, below, relay sets; rigth, with cover

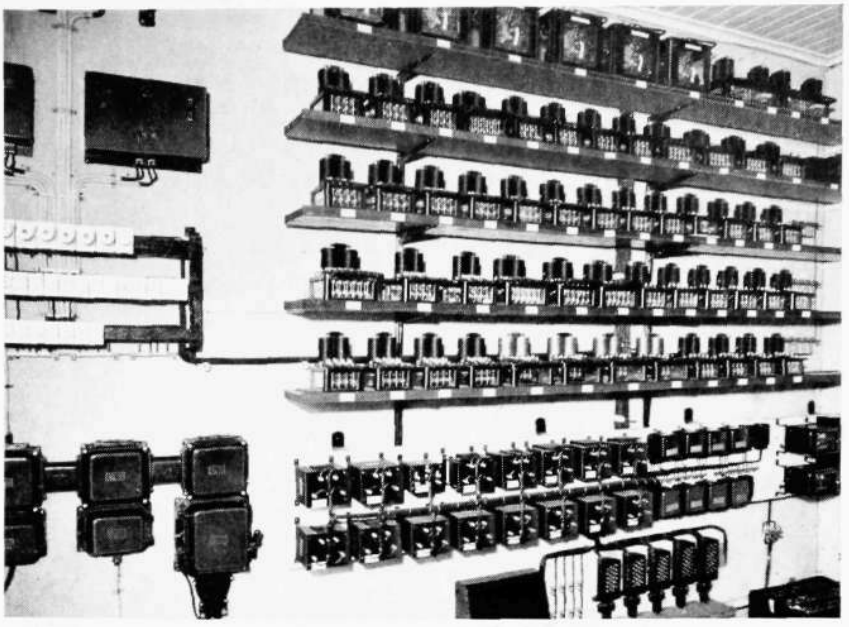


Fig. 8 X 5979
Inside view of relay room

At the different stations special relay rooms have been arranged in the station buildings. The relays required for the interlocking plants are arranged on shelves and transformers for illuminated signals and track circuits are put up either in the relay rooms or in small cabinets out at the different signals or insulated track joints. The CTL-apparatus are also mounted in the relay rooms. Fig. 8 shows an example of how the fittings are arranged at Saltsjö-Duvnäs station and Fig. 9 shows a relay cabinet.

Power Supply

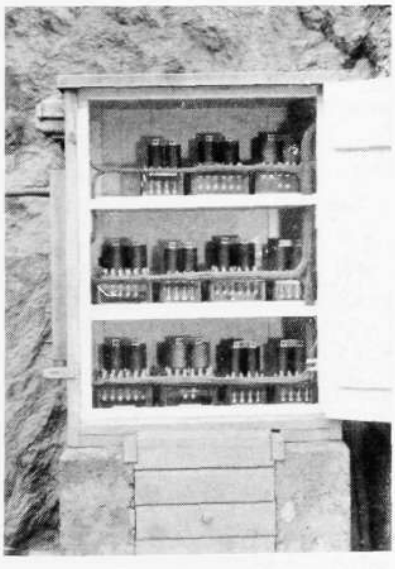


Fig. 9 X 4263
Relay cabinet

For the line section Saltsjö-Duvnäs—Henriksdal the power supply for the interlocking plants is provided from a 3300 V three-phase network along the line. Power at Neglinge is obtained from a local 3×220 V network.

Outdoor transformers have been set up at the various stations and these transform the tension down to 3×220 V with secondary zero taken out. From this secondary network there is then tapped the power requirement at the stations for illuminated signals, point machines and barrier raising machines, relay equipments etc. For the CTL-devices there are used 24 V Nife batteries and for the relays of the interlocking plant 12 V Nife batteries. The batteries are kept constantly charged from metal rectifiers.

In projecting the work of reconstruction and the subsequent working out of details there was very close collaboration between the chief inspector of the line Mr. J. Andersson and Mr. T. Hård of the State Railways, acting a technical adviser and supervisor, on the one hand and Signalbolaget on the other.

The CTL-system as used for the distance control proper was worked out by Signalbolaget in conjunction with Mr. Hård. The system differs in essential parts from earlier similar American relay systems, among other things in the use of selectors as components as well as relays. The actual work of erection was carried out under the railway company's own management, with Mr. Hård as supervisor.