Automatic Section Blocking on the New Subway in Stockholm

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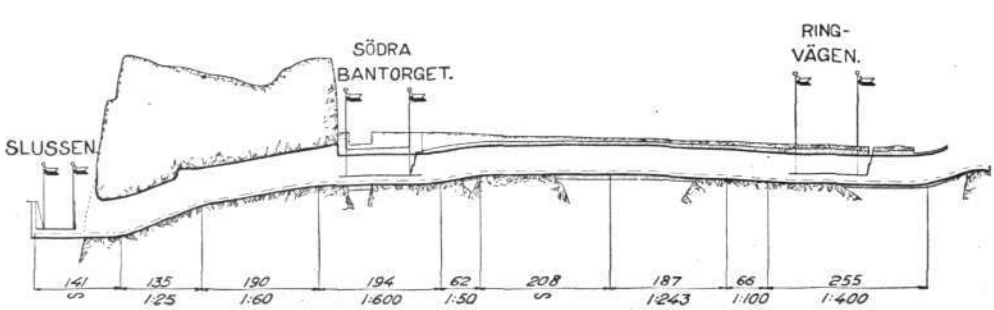
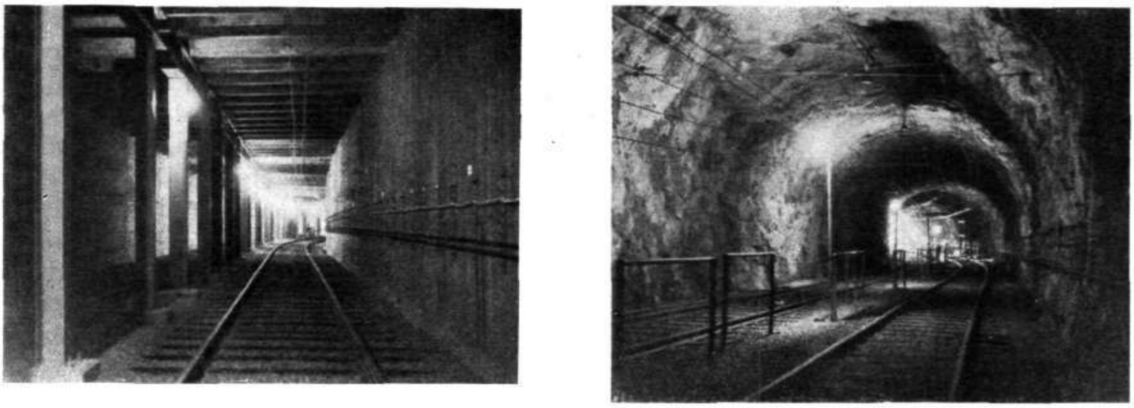
For a long time the difficult traffic conditions at Slussen, where the northern and southern parts of Stockholm meet, have called for a solution, and several different proposals of how to arrange the streets have been made. As early as 1875 a plan was drawn up for the building of a tunnel under part of southern Stockholm, Södermalm. Since then the situation has changed and on March 30, 1931, the Town Council of Stockholm decided to put in hand immediately the building of an underground tramway line under southern Stockholm. The Town Council entrusted the building of the tunnel, namely mining and concrete moulding, to the Street Commission and the building of the tramway with the necessary electric equipment, lighting, automatic section blocking system and complete station equipment to the Stockholm Tramway Company. The planning of the details of the technical installations, which to a certain extent were beyond the scope of the Stockholm Tramway Company, was handed over to specialist firms. Thus L. M. Ericssons Signalaktiebolag was asked to design the signalling system in cooperation with the Stockholm Tramway Company.

X 1235 **Aerial view of southern Stockholm.**
In the foreground, the opening of the tunnel at Skanstull is seen under construction.

The subway was built for two suburban lines, and the automatic section blocking system was at the beginning intended to include complete station blocking and complete section blocking even for single-track working. For this reason crossing points were planned at the terminal station of the subway and immediately north of the first subway station.



X 7038 Fig. 1. Profile of the Slussen—Skanstull tunnel.



X 1217 **Fig. 2. Part of the concrete tunnel (left), and the rock tunnel.** X 1216

This project proved, however, to be too expensive in consideration of actual demands, and the plant was finally designed for the blocking of all stations for double-track. The crossing points were replaced by a single point immediately inside the southern end of the tunnel.

The tunnel has been provided with an automatic section blocking system with electric light signals in order to ensure safety by regulation of traffic. Tramway and street traffic are regulated by means of signals all the way from a point between the tunnel track and the street track at the southern end to the terminal loop at the northern end.

The signals are operated by the trams as they pass the track circuits (block sections), insulated from each other, into which the track system has been divided. Insulation between two adjoining track circuits is obtanied by means of fibre plates which insulate the joint irons from the rails and the rails from each other. Both rails being used as return for the tram current, impedance joints have been inserted at the ends of the track circuits. These joints allow DC from the tram to pass through the rails and back to the power source over a separate return, but at the same time they do not allow the signalling AC from the feeding transformers to pass from one track circuit to another.

The functioning of the signalling plant can be seen from Fig. 3. At the ends of the track circuits there are signals *(A3, A4* etc.), which show a green light if the next track circuit is unoccupied by trams. If the circuit is occupied by a tram the signal shows a red light. The signals and their position in the tunnel can be seen from Fig. 4, which shows a signal between two stations (home signal of a station) and Fig. 5, which shows a signal at the station (starting signal of the station). Fig. 6 gives an interior view of one of the signal cubicles used in the system.

As may be seeen from Fig. 3, the track circuits *S1, S2* etc. form part of an electric network, composed of the feeeding transformer *TS2* and the two rails of the track between this transformer and the track relay *RS2*. This relay is operated by the signalling current and operates the signal *A3* by means of contacts. As soon as a tram has passed from track circuit *S2* to circuit *S3* the next tram can enter section *S2*, if the first tram is protected from behind by a stop signal, *A4*. If the stop signal does not function, for instance owing to the red lamp being faulty, the current

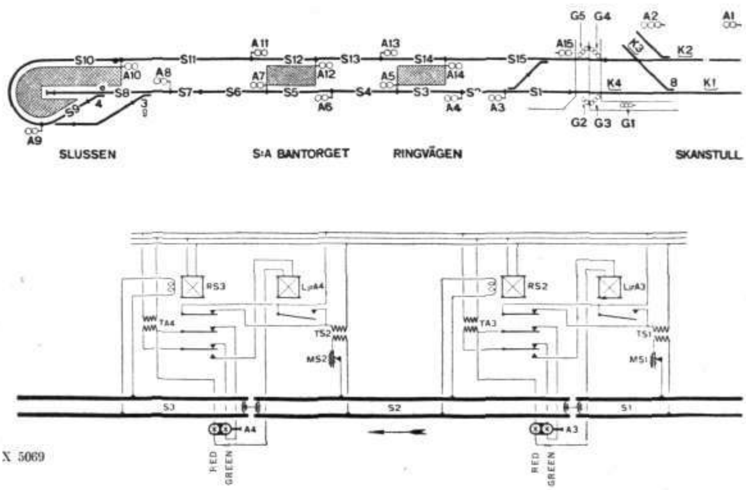


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Fig. 3. Diagram of the signalling plant.

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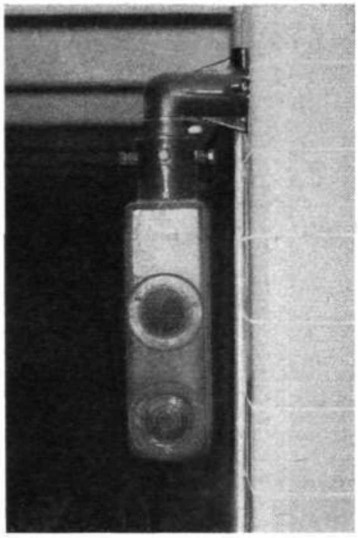


X 3123 Fig. 4 and 5. Home signal (left) and starting signal. X 3124

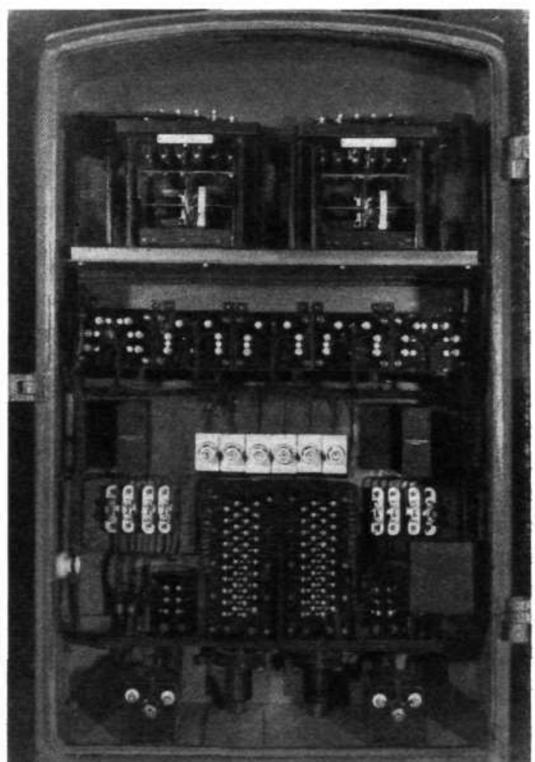
to the feeding transformer $TS2$ is interrupted by a contact on the relay $Ljr\ A4$, which is connected in series with the red lamp of the signal $A4$. This relay closes the current only when the red lamp glows. If $A4$ gives no stop signal the track relay $RS2$ receives no current. This relay keeps signal $A3$ in stop position and no tram can enter section $S2$, as long as section $S3$ is occupied by a tram. Consequently there is no risk of a tram in the section being run into from behind by another tram which has passed the unlit stop signal $A4$. When the tram in section $S3$ has proceeded to the next section, thus making section $S3$ free, the track relay $RS3$ closes the current to track circuit $S2$, of which the relay $RS2$ is attracted and switches over signal $A3$ to green light.

Signal $A1$ regulates the entering traffic from the southern side. This signal normally indicates clear, but is automatically switched over to stop when a tram has passed the contact $K1$ and remains in this position till the tram has entered track circuit $S1$. Signal $A1$ can be set in stop position also from the control cabin at Slussen, if it should be necessary to stop traffic approaching the tunnel. On such occasions signal $A1$ will prevent a tram approaching the southern end of the sub-way from stopping in the street next to the tunnel entrance, where it would block the street traffic crossing the tracks at this point.

Street traffic is there regulated by the signals $G1$—$G5$. These signals show green light when there is no hindrance to street traffic. When an approaching tram arrives at a certain distance from the crossing, the signals show a yellow light for a few seconds, thus warning the street traffic of a coming change of signals. This green-yellow signal is followed by a red light. When the tram passes the crossing, yellow light is shown together with the red, and when the street traffic is again free to cross the tracks, the signals $G1$—$G5$ show a green light. The signal $G2$, which is provided for pedestrians, shows a green or a red light only, without yellow warning light.

At the provisional terminal station at the northern end of the tunnel there are special signalling and safety arrangements for regulating the traffic on the main track, track circuits $S9$ and $S\ 10$.

As can be seen from Fig. 1, the section between the first subway station and the northern end of the tunnel has a gradient of 1 : 60 for about 190 m and a gradient of 1 : 25 for about 135 m. On account of local conditions the terminal loop at Slussen could only be given a radius of 16 m. In order to eliminate all risks the points 4 have

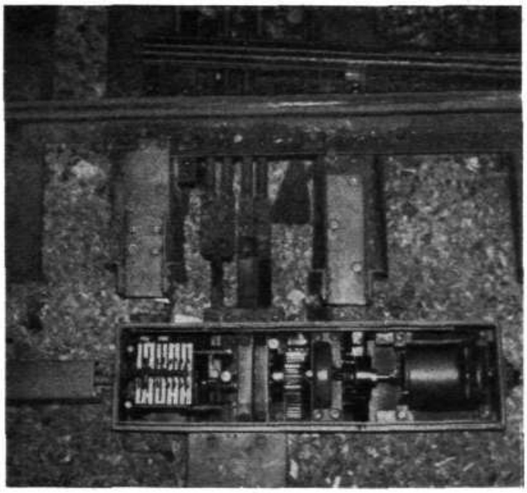


X 1248 Fig. 6. Interior view of a signal cubicle.

been inserted in the main track *S9*. These points lead to a special safety catch-track with strong stop blocks, Fig. 7.

The points *4* are normally set for the safety track. By means of an electric driving device, Fig. 8, the points are automatically thrown over to the main track a certain time after a tram has entered track circuit *S6*. This time is fixed in relation to the tram speed permitted in this section. If the tram is running at a higher speed the point will not have been thrown over when the tram arrives, and if the tram cannot stop at the points, for one reason or another, it will be diverted to the safety track. If on the other hand the tram is running at normal speed the points are thrown over for the main track, and signal *A8* indicates clear if track circuit *S9* (the main track) is unoccupied. As long as the tram remains on track circuit *S8* the points cannot be moved, but after it has passed *S8* the points automatically return to normal position, see Fig. 7.

It has thus been ensured that the points cannot be thrown over while a tram is passing over them. The points can also be operated from the control cabin of the station or locally, if necessary, by means of a special contact device, Fig. 9, which is easy for the driver to reach by means of an ordinary point iron. Such local operation is required when a tram has not covered the distance from the last station in proper time, and, for this reason, the signal *A8* indicates stop, the points *4* not being set for the main track. The tram is then stopped on track circuit *S7*, which is necessary for it to be possible to move the points locally by means of point iron.



X 1219 **Fig. 8. Electric driving device.**

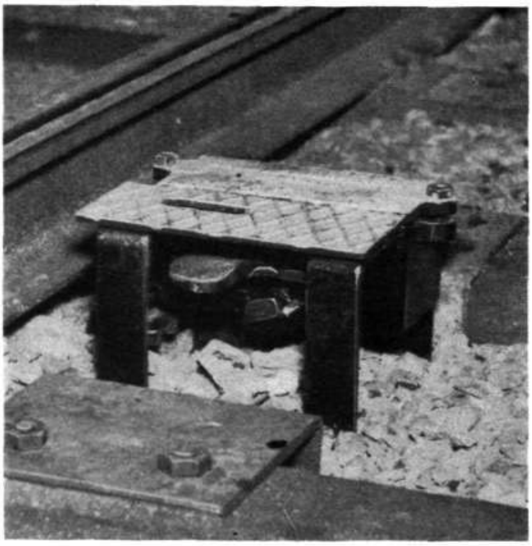
In addition to the above-mentioned block signals there is one signal, *A2*, which indicates the position of the points *8* between the subway track and the street track. The signal shows one green light when the points are set for the subway track and two green lights when they are set for the street track. If the points are in an intermediate position the signal shows a red light.

X 5060 **Fig. 7. Safety points and catch-track.**
In the foreground, the contact device for throwing over the points.

Auxiliary arrangements.

Special arrangements are provided, which are connected to and operated by the section blocking system. These arrangements give information in advance of the arrivals of trams and their destinations. This information is given by means of illuminated boards as shown in Fig. 10.

For instance, when a tram approaching from the southern end enters track circuit *S1*, the illuminated board at the first station is



X 1220 **Fig. 9. Contact device for throwing over the safety points.**

lit up and thus indicates that a north-bound tram is approaching. When the tram departs and enters track circuit *S4* the illuminated board is switched off, but a similar board is lit up at the next station.

For south-bound trams there are two illuminated boards in the two tunnel stations, one for each of the two lines that pass through the subway. In the control cabin there is a press-button for the illuminated boards of each line. If a tram is to start on one of the suburban lines, the corresponding press-button is pressed in good time before the departure. At the same time the starting signal *A10* is set in clear position. When the tram has departed and entered track circuit *S11*, signal *A10* is set in stop position. The current impulse from the press-button in the control cabin is repeated automatically to the illuminated board of the first subway station. This board is then lit up, indicating that a tram on the suburban line in question has left the terminal station. When the tram leaves the first subway station, the illuminated board of this station is switched off, and the corresponding board at the next station lights up.

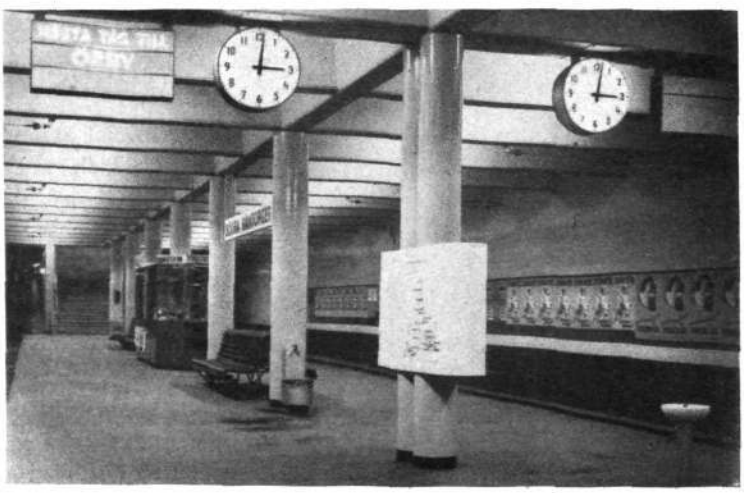
In the control cabin at Slussen there is an illuminated track diagram, Fig. 11, which gives a complete view of all track circuits. Each track circuit is represented by a lamp, which glows only when that track circuit is clear.

The necessary power for the operation of the signalling system is supplied as 3×220 V, 50 cycles, AC from the Stockholm Electricity Works to the lighting central at the first subway station.

An important auxiliary to the signalling system is the local telephone system, by means of which the staff can communicate during service. The telephone instruments, connected to the line system have been installed at the following places: in the control cabin at Slussen, at point *3*, in the power station of the subway, in the ticket collectors' boxes and in the lighting centrals of the two subway stations, at the emergency exit, at the southern end of the tunnel and at signal *A1*. The automatic telephone exchange is installed in the signal cabin at Slussen.

The section blocking and signalling systems have been planned and built by Signalbolaget in cooperation with the Stockholm Tramway Company.

The work of installation was commenced in June, 1933, and was completed and definitely

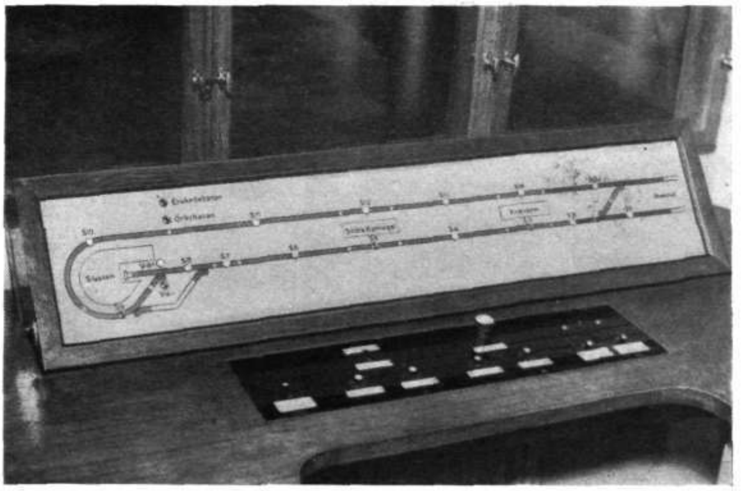


X 5061 **Fig. 10. Södra Bantorget station.**

tested before the opening of the tunnel to traffic on October 1st, 1933.

The installation of the system has required the following staff: 1 fitter, sometimes 2, from Signalbolaget and 2 fitters and on the average 10 workmen from the Stockholm Tramway Company.

As regards operation and maintenance as well as the expense of the signalling system it is difficult to make any statement, conditions differing from those of other systems with which comparison might have been made. We are, however, convinced that all expectations in regard to efficiency and economy of operation will be fulfilled.



X 5062 **Fig. 11. Illuminated track diagram.**

Automatic Telephone Exchanges for LB-Systems

The first automatic telephone exchange in the world to work on the LB-system without DC-signalling on the subscribers' lines has recently been delivered by Ericsson to the Royal Board of Telegraphs in Sweden.

We publish below a short description of this installation, in anticipation of the detailed description of the Ericsson rural automatic system that will be published in a coming issue of the Ericsson Review.

New automatic exchanges are as a rule on the CB-system. This, however, necessitates in cases where there are already manual LB-exchanges, *the providing of new instruments for the subscribers'*, as well as, *to a great extent, an alteration to the subscribers' lines,* as the CB-system makes demands on the insulation of the lines heavier than can generally be met by lines built for the magneto-call system. The cost of these replacements as a matter of fact weighs very heavily on automatization.

The automatization of a telephone network on the LB-system aims at conserving the existing telephone instruments as well as the existing lines. In order to obtain automatic service the instruments require to be fitted with a dial; this is only an addition to the instrument, which otherwise remains unaltered.

X 5080 **View of Kärra near Gothenburg.**

The automatic exchange is built in principle like an ordinary CB automatic exchange, but 50 cycles AC instead of DC is emitted on the subscriber's line by turning his magneto in the ordinary way when he calls the exchange. This AC is emitted by a cord circuit, or a register, and is heard by the calling subscriber as a dialling tone. The subscriber then dials the number desired and, on account of the changes brought about at this mo-