

New Interlocking Plant at Sundbyberg

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Interlocking plants have long been in use on railways. Formerly mechanical interlocking plants predominated and these are still by far the most frequent, though in the last 10 to 15 years electrical interlocking has come more and more into use. With the electrical interlocking, a very much larger area may be controlled from one central point than with the mechanical plants; moreover, it is generally possible to handle current traffic requirements in a more flexible manner with electrical interlocking. It may therefore be said that the electrical interlocking plant usually finds its place at stations with a large and varying traffic distributed over the greater part of the 24 hours. Each individual case, however, provides its own problems which without exception require to be considered and solved in their own special manner. What follows seeks to present a rather general account of the special conditions at Sundbyberg and how the plant has been made to meet them, as well as what it was hoped to gain thereby.

The track arrangements at Sundbyberg are exceedingly restricted in relation to the comparatively large traffic that has to be dealt with. Parking space for rolling stock is rather limited and the location of the tracks is such that shunting must invariably be done on the train tracks. The station normally deals with a trains numbering some 90 per day, comprising about 60 suburban trains, 20 express and passenger trains and 8 goods trains. There are moreover at the station locomotive sheds and because of their location here, while the departure and terminal station for the long-distance express and passenger trains is Stockholm C (for goods trains Tomtebodå Nedre), a number of single engines must be passed between Sundbyberg and these stations. At holiday times the movements at the station are augmented considerably, both because of doubling of trains and because the reversing of the passenger trains, usually done at Stockholm C, must then be carried out at Sundbyberg. Shunting with shunting engines is proceeding throughout the day and moreover shunting is done with goods trains.

The station is situated on the 11.4 km long double track between Stockholm and Spånga. The interlocking area comprises in addition to Sundbyberg proper, three further traffic spots, namely Huvudsta, Huvudsta C and Sundbyberg N, an area covering 3.5 km in length. The boundary with the Stockholm C interlocking area is at Huvudsta.

Sundbyberg proper consists of two main sections, the passenger station with three train tracks and the goods station to the east of it. At Huvudsta, in addition to the double track to Tomtebodå Övre there is junction over a single track for goods traffic with Tomtebodå Nedre. At Sundbyberg N tracks branch off to factories in the neighbourhood, including the Ulvsunda industrial district. The double track is traversed in the interlocking area by four public roads, two of them constituting busy streets in the central parts of Sundbyberg. The level crossings are provided with crossing gates which in conjunction with the installation of the interlocking plant have been equipped with electrical operation, controlled from the central interlocking machine.

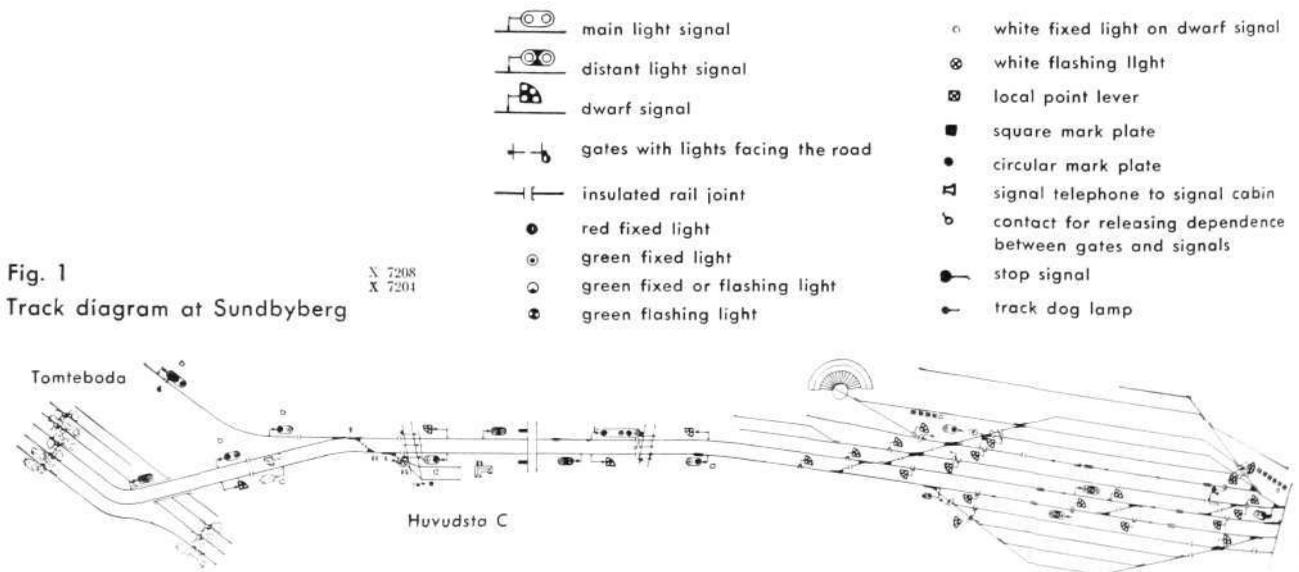
At Sundbyberg proper there were previously two lever mechanical interlocking machines about 30 years old. Line blocking with block-fields were

arranged to adjoining control places and in addition there was station interlocking to the train dispatcher's office. Besides these two plants there were similar ones at Huvudsta and Sundbyberg N. The level crossing gates at Huvudsta C were controlled locally on the spot, the other gates from the nearest interlocking machine.

On account of the heavy employment during 30 years the mechanical plants had become completely worn out. Moreover the plants had from the beginning been of a rather primitive construction. An investigation made showed that fairly comprehensive and costly repair, replacement and extension work would be required to bring the mechanical plants up to a satisfactory state. On the other hand this work if carried out would mean keeping to the rigid mechanical system with its demand for more staff for a considerable time to come. In view of this it was questioned whether once for all a new electrical interlocking system should not be built, and after the necessary investigation this was decided upon. In view of the almost unlimited range of the electrical interlocking plant a number of attended places could be combined in one, thus saving expense and moreover advantages in regard to handling of traffic might be counted on.

Traffic

The first stage in the construction of the interlocking plant comprised Sundbyberg proper and Sundbyberg N. The plant was then extended to take in Huvudsta and Huvudsta C. As stated, factory tracks branch out to Ulvsunda and other places in the neighbourhood, on which there is shunting every day. The shunting is handled by shunting engines from Sundbyberg. Before the installing of the electrical interlocking plant, when Sundbyberg and Sundbyberg N were separate operating stations the movements between these two places were carried out as trains which invariably, when they were not included in the time-table, had to be ordered by the train dispatching office. In the event of unexpected requirements the system was inelastic and cumbersome. Moreover, the mechanical interlocking devices at both places were constructed for left-hand track traffic and the shunting trains in the direction of Sundbyberg N—Sundbyberg had to go over to left-hand track and cut across track II at both places, since as a rule they had to take one of the tracks VII—XII of the goods station at Sundbyberg. On account of this and of the short station distance these shunting trains took up the whole double track on their return to Sundbyberg. By extending the electrical interlocking plant at Sundbyberg to take in Sundbyberg N as well, these movements could be carried out as shunting movements which the station could undertake as required and then when the position of trains and other work at the station



was most convenient. Further, since the interlocking plant controlled the whole track area to Sundbyberg N, there was no necessity to occupy track III with these shunting trains, which may consequently now use the right-hand track for the return to Sundbyberg. The previously existing junction track in the double track at Sundbyberg N was taken away as no longer necessary. By this arrangement a difficulty was solved, which had been present for many years and which had even been the cause of plans for a third track between Sundbyberg and Sundbyberg N.

As concerns shunting at Huvudsta and the movement of goods trains to Tomtebodan nedre a similar arrangement was made as at Sundbyberg N. As Huvudsta was a separate station all shunting was carried out there of the goods trains during the time they were at the station. On account of the situation of the tracks, shunting could only take place with the trains in the direction of Tomtebodan Nedre and trucks whose destination was north had first to be hauled to Tomtebodan Nedre and then back to Sundbyberg for dispatch from there. Moreover the down track was occupied during the whole of the shunting, which was frequently inconvenient, especially when there was dislocation of the train services. Since Huvudsta has also been controlled from Sundbyberg the shunting now takes place with locomotives dispatched to Huvudsta as required from Sundbyberg when it is most convenient, taking into account the position of trains and other circumstances. The shunting trains usually take the down track in both directions. Goods trains no longer stop at Huvudsta.

The extension of the electrical interlocking plant to Huvudsta made possible still another simplification as regards the progress of goods trains to Tomtebodan Nedre. These start as a rule from track VII at Sundbyberg and previously had to go over left-hand track to Huvudsta thus having to cross over the up-line at both places. On account of this and the short station distance both tracks of the double track were occupied by these trains. Goods trains to Tomtebodan Nedre are now dispatched on the right-hand track and the down track is now free of these trains. The shunting junction at Huvudsta in the double track could now be dispensed with like the corresponding track at Sundbyberg N, but is retained for the time being as a reserve connection.

It has already been stated that a number of single engines proceed daily between the locomotive shed at Sundbyberg and Stockholm C or Tomtebodan Nedre. These locomotives which proceed as trains always, before the arrival of the electrical interlocking plant, must be taken in on the passenger train tracks I or II and depart from track I or III. Between the locomotive shed and the passenger station the locomotives were piloted by the shunting staff. It was very necessary to avoid having these locomotives on the passenger tracks and at the western part of the goods station where shunting was continually proceeding. In view of this the electric interlocking plant was designed and made so that these locomotives may now go direct to and from the locomotive shed without troubling the shunting staff and without either occupying the passenger tracks I, II or III or passing over the very busy western part of the goods station. For an outgoing locomotive the procedure is as follows: as the time of leaving approaches the locomotive should be standing ready on the track at the locomotive shed. The interlocking plant is set for that and puts the dwarf signal on the shed track to »clear» which in this case also means »go». The locomotive moves forward and stops on track VII just

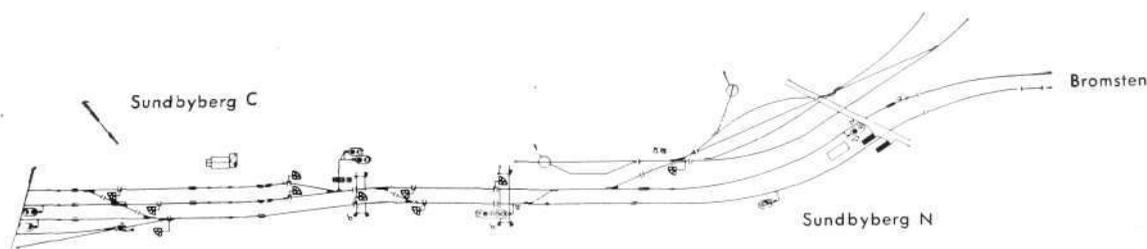
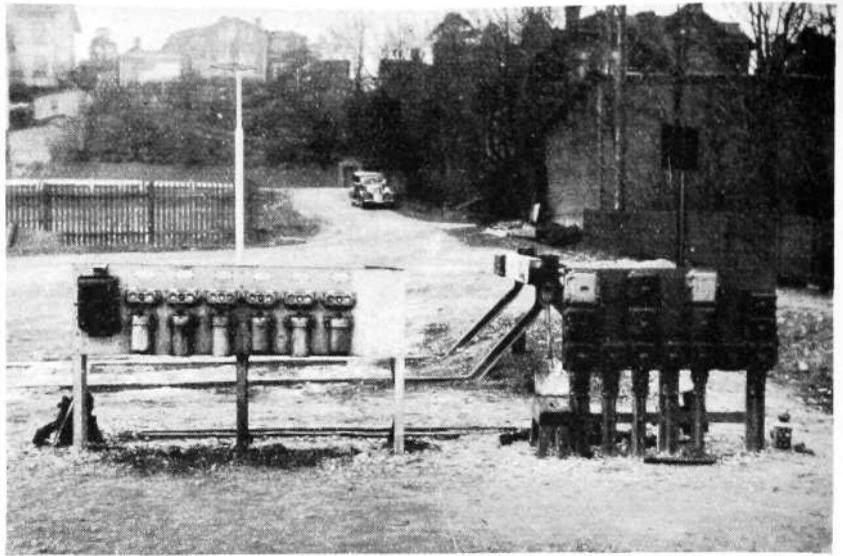


Fig. 2
Contact devices for local operating
of points

X 5596



before the nearest dwarf signal. The departure from track VII is cleared from the interlocking plant, clear signal is shown on the main signal (for locomotives proceeding to Tomtebodå Nedre, which use the right-hand track, the clear signal is given only on the dwarf signal) and the departure signal is given by the train dispatcher who presses a button at the interlocking plant. The button causes an illuminated *A* to appear in an electrically illuminated device in front of the locomotive, which thereupon goes. Incoming locomotives are directed in similar manner direct to the locomotive shed. All movements and the signals given may be observed by the train dispatcher on an illuminated track diagram set up in his office.

At a station with dense traffic and restricted track conditions the great adaptability of the electric interlocking plant to varying conditions is especially valuable. Thus alternative train roads on the same signal picture may be arranged if required and by means of dwarf signals it is possible for a train, though at reduced speed, to be directed in a multitude of ways, depending on the degree of complication of the track system. At Sundbyberg the facility of arranging alternative train roads on the same main signal picture has been utilised in one case only, *viz*: for trains from Bromsten to track VII: the entrance road may as required be directed over passenger tracks I, II or III.

Interlocking Machine

An important question when planning the installation was the choice of location for the interlocking machine. Two alternatives were to be considered, one in a separate interlocking plant building at the station, the other to locate it in the train dispatcher's office. The latter alternative was chosen for a number of reasons, one being that the train dispatcher should not be entirely divorced from the safety service but should himself be able to supervise the interlocking machine. It was reckoned also that at quiet times of the day the train dispatcher might be able to deal with the whole of train operation without the assistance of a man for the interlocking machine. This last expectation, however, has never been realised. It was found that the station required a man permanently in attendance on the central interlocking plant.

Another question which was settled in conjunction with the fixing of the location of the interlocking machine was the manner of dealing with shunting. With a separate interlocking plant the shunting would be done by dwarf signals with all moving of points attended to from the interlocking plant. With the arrangement decided upon the shunting may also be done in that manner, but as a rule only the clearing of the train roads is done from the interlocking machine, the changing of points being carried out by the shunting staff by

means of special point levers on the track, Fig. 2. When a track is made free for shunting the dwarf signals concerned are set at «out of use». In order that the shunting staff may know that local changing of points may be carried out, this is indicated by a pilot lamp lighting at the point lever. There are two other lamps at the lever which show in what position the points are set.

The points and scotch blocks in the train roads are provided with electric motor drive in the ordinary way. Joint working points or points and scotch blocks are as a rule connected in pairs to the same lever. Points and track dogs for parking tracks connected to train tracks are locked electrically but cannot be operated from a distance; the shunting staff therefore must throw these over to make them lock. The farthest point operated from the interlocking plant is 2 km distant from it.

The interlocking machine itself, supplied by Signalbolaget, is of the type now in general use on the State Railways. It has no mechanical locking between the levers but all locking and dependent movements are produced electrically. Each lever therefore constitutes a mechanical unit in itself having no other connection with other levers than electric circuits. The feature of the system is that the levers are furnished with blocking magnets which block or release the lever, the circuits for these magnets being drawn over contacts at other levers or relays for producing the requisite interdependence. The system provides great adaptability, particularly at large stations with complicated track systems and varied traffic. Thus, as stated, the train roads may be arranged for alternative roads.

With an electrical interlocking plant covering an extensive track area it is not possible directly to watch over the area. In order that the interlocking plant attendant may be able at all times to follow what is taking place at the station this has been reproduced on an illuminated track diagram, arranged above the interlocking machine, see Fig. 3. Lamps on the track diagram indicate the signal pictures made by the main signals and the dwarf signals, also whether tracks are occupied by rolling stock or not. Free tracks are marked by lighted lamp and occupied tracks by unlighted lamps. The four signal pictures of the dwarf signals are marked by lamps of different colours. The main signals are indicated by red and green lamps which are directly connected in series with the signal lamps themselves.

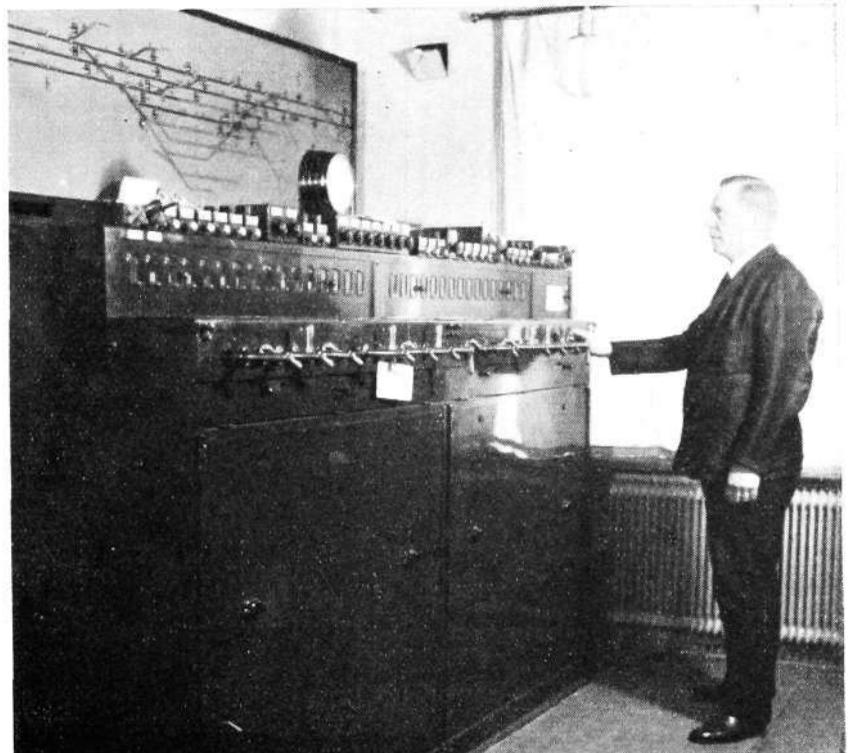


Fig. 3
X 5558
Interlocking machine with illuminated track diagram

For signalling there are used in the plant dwarf signals, main light signals and distant signals of current type. The track area is divided into block sections at the limits of which dwarf signals are set up as entrance signals. Block sections may consist of one or more track circuits. The dwarf signals often apply to entrance for different block sections according to the way the points are set; thus the dwarf signals as a rule do not show which track is clear but only that there is a track clear.

At Sundbyberg the dwarf signals can as a rule display four signal pictures, »stop», »caution», »go» and »out of use». Caution signal on a dwarf signal requires, in addition to its lever at the interlocking plant being thrown, that enemy signals display »stop» and that the points on the block section concerned shall be in running position, but it does not require that the track shall be free. The main significance of the signal picture is for shunting, when it is necessary to approach trucks on the track. Points, safety-points and scotch blocks on the block section are locked by the dwarf signal being set at caution. In general the locking is released immediately the signal is set at stop, and as a result it might happen that a signal be set at »stop» and the point or scotch block changed immediately in front of a vehicle which had not observed or could not stop for the stop signal. In view of this possibility there have been arranged for certain of the centrally placed scotch blocks time contacts which lock the block a little while after the signal has changed to »stop».

In order to make a dwarf signal display »clear» there is required in addition to the fulfilment of the conditions for »caution», that the track is free and any level crossing gates are down and as a rule that the lever for the succeeding signal is thrown. On the line Huvudsta—Sundbyberg where no shunting occurs, the devices are such that the signals show »stop» not »caution» when the track is occupied.

Obviously there is nothing to prevent signalling being carried out with dwarf signals for trains as well, and this is done for traffic on the right-hand track and in other cases. In the ordinary way, however, this would cause loss of time, since trains making continuous progress over a number of dwarf signal sections could only proceed at far too low a speed. Therefore, for the more fixed train roads for entrance and departure main signals are arranged, these showing clear signal by one or more green lights. The most distant signal is 2.5 km from the signal cabin.

Clear signal on a main signal presupposes that all the dwarf signals in the train road are set at »clear»; the train road therefore is locked by the dwarf signals and the dwarf signal levers in turn are locked by the main signal. The locking is also executed for the gates at the level crossings.

In all train tracks, electric track circuits are arranged these being also drawn to side tracks as far in as is necessary to provide freedom from obstacle and for blocking the safety-points. Sidings and ranger tracks are not provided with track circuits.

Track circuits are as is known obtained in such a way that the track area is divided up into sections by insulations in certain rail joints. In each section electric current is fed in at one end, this being taken out at the other end of the section to a track relay the armature of which takes up different positions according to whether the track is occupied by vehicles or not. The movements of the armature are utilised for various marking and safety purposes. At Sundbyberg the track circuits are employed for marking on the track diagram where vehicles are, for blocking of points so that they may not be changed from the interlocking plant when such is not allowable because of movements of vehicles in the vicinity, for locking of train roads after main signals have been set at »clear» and the train has entered the road, and to prevent clear signal being shown when the track is occupied by vehicles.



Fig. 4
Starting signals west

X 3962

Fig. 5
Starting signals east

X 5595



The point blocking is arranged in such a manner that the point lever blocking magnet is without current when the track relay falls, i.e. when there are vehicles on the track, and the point lever then cannot be thrown.

When a main signal is set at «clear» the points in the train road, as stated, are locked. As the front of the train passes the signal this changes to «stop» but the points in the train road are kept blocked by the action of the train on the track circuits and are only released progressively as the train proceeds and such release is permissible.

As has been said, the interlocking plant area is traversed by four public roads. The level crossings are all provided with electrically operated crossing gates, controlled from the central signal cabin. The gates lie as far as 1.8 km distant from the signal cabin so that direct supervision of the level crossings is not possible. On the track diagram therefore indicating lamps are provided for each pair of gates which show whether the booms are raised or lowered and whether the gate warning lamps are lit. The gates moreover are interlocked with the main signals so that on the one hand clear signal cannot be given without the gates being down, and on the other hand the gates cannot be raised once clear signal is shown until the train has passed the crossing. To facilitate the work of interlocking and to avoid holding up traffic on the roads more than necessary, the gates are raised automatically when the last wheel-pair of the train pass the crossing. Formerly, when the gates were controlled each by a special attendant in the nearest mechanical signal box, there were frequent complaints by the public that the gates were kept down too long, but since the arrangement with automatic raising has been put in no further complaints have been heard, despite the fact that the gates, following the introduction of locking connection with the signals, have to be lowered earlier in relation to the train than previously. The cessation of complaints would appear to be due to the wellknown circumstance that the public accept with a certain patience that the gates are lowered in good time before trains, but regard themselves as inconsiderately treated if the gates remain lowered after the train has passed by.

In order that traffic may be handled in the best manner possible with an extensive electrical interlocking plant there is required the maintenance of close collaboration between the signal cabin and the shunting staff. This collaboration requires good means of communication and for this reason a number of telephones have been put up in the track area, by means of which the shunting staff can communicate with the signal cabin. Electric sirens out in the station enable the signal cabin to attract the attention of the outdoor staff. In addition telephones communicating with the signal cabin are provided at the main signals, for use in letting trains proceed when the signal cannot be set at clear. With an electrical interlocking plant of large extent, having numerous signals

and dense traffic supervised from a central spot, the difficulties in the case of fault in the plant in moving the trains forward are obviously greater than when the area is distributed among a number of small interlocking plants with staff available at each plant. The ordinary rules for train road examination and for taking a train past stop signal can usually not then be employed. If clear signal cannot be given, *e. g.*, because of defective track circuit, the train dispatcher certainly can see it on the track diagram, but he cannot know what kind of fault there is on the track and as a rule has no means of inspecting outlying tracks. Generally there is no time to send out men to signals located a distance away for signalling. Special regulations have been drawn up therefore prescribing how engine drivers and train dispatcher shall proceed when a main signal cannot be set at «clear». When a train has stopped at a stop signal, the reason for which the driver does not know, he must after waiting two minutes call the signal cabin from the telephone at the signal. The train dispatcher has the right then, if he does not know of any obstacle to the train, of giving the driver permission to take the train past the stop signal without any kind of signalling taking place there. In such event the driver must take the train forward with special caution, carefully observing signals, points and track and at such low speed that the train can be quickly brought to a standstill if any hindrance is discovered by the driver, such as stop signal, wrongly set points, vehicle on the track or other obstacle. Examination of the train road therefore is to a certain extent entrusted to the driver.

Relays, converters etc. required for the plant are housed in a cellar of the station building. The power is taken from the Sundbyberg Electricity Works. To provide against local interruption of current the plant has been connected to two of the Electricity Works transformer areas. In the event of interruption of current affecting the whole supply works, the plant has no reserve of its own; it is considered that the town will get its emergency plant to work quicker than the unaccustomed station staff could start a reserve unit of their own for the plant.

The total installation cost amounted to 260 000 kronor, in which are included the building of central platforms and waiting room at Sundbyberg N and track changes in conjunction with it. In judging the financial result there should be deducted from the installation costs the amount which, in the event the electrical plant had not been executed, would have had to be expended on the mechanical devices to put them in proper condition, which amounts would not have led to any savings. These amounts are estimated at 60 000 kronor, so that the extra cost for the electrical plant will be some 200 000 kronor. By entirely releasing Huvudsta, Huvudsta C and Sundbyberg N from safety service, it has been possible to reduce the service of staff at these places to a considerably degree or, at Sundbyberg N, dispense with it altogether. Ticket selling at this place is handled by a private undertaking and at Huvudsta C the service is handled by a woman attendant. The savings made possible by the electrical interlocking plant amount to about 35 000 kronor per year. Apart therefore from the advantages as regards handling of traffic that have been gained through the plant, it is therefore fully justified also from the economic point of view.