Ericsson Review

No 3
1939

ERICSSON REVIEW

Responsible Publisher: HEMMING JOHANSSON
Editor: SVEN A. HANSSON
Editor's Office: Döbelnsgatan 18, Stockholm
Subscriptions: one year $ 1:50; one copy $ 0:50

CONTENTS

Printed in Sweden, Esselte ab., Stockholm 1939

Electrical Measuring Instruments

R. LUNDQUIST, TELEFONAKTIEBOLAGET L. M. ERICSSON, STOCKHOLM

The manufacture of electrical measuring instruments, as now carried on by Telefonaktiebolaget L.M. Ericsson, comprises in the first place instruments with the more simple measuring systems for current and voltage measurement of DC and AC. Moving coil instruments and moving iron instruments are made as ammeters and voltmeters, for various ranges of employment, e. g., motor cubicle instruments, large panel instruments for wireless and signalling purposes, marine instruments and so on.

To provide for all ranges of employment two sizes have been made of the two measuring systems, the moving coil systems and the moving iron systems. The moving coil systems are intended only for DC measurements, though by the addition of rectifiers they may also be used for measuring AC. The moving iron systems are for both DC and AC measurements.

Moving Coil Systems

The *large system*, Fig. 1, has permanent magnet of tungsten steel and pole pieces of special malleable iron. The pole pieces enclose an aluminium frame holding the core and the moving coil. The pointer, springs and shaft ends fit in the moving coil. The moving coil has point bearing, with shaft ends of hardened steel working on synthetic sapphires.

The system is furnished with adjustable restoring device for correcting the pointer's zero position. Deflection of the pointer is about 80°. The requisite damping is obtained by means of the counter-EMF arising in the short-circuited aluminium frame as it moves in the magnetic field. The current is transmitted to the moving coil by two spiral springs of copper-bronze or phosphor-bronze.

The system may be made for current intensities from 30 μA to 10 mA with direct connection to the moving coil and from 10 mA to 5 000 A by the connection in parallel of shunts, Fig. 2. As a voltmeter the system may be connected to voltages from 20 mV up to 1 500 V over limiting coils.

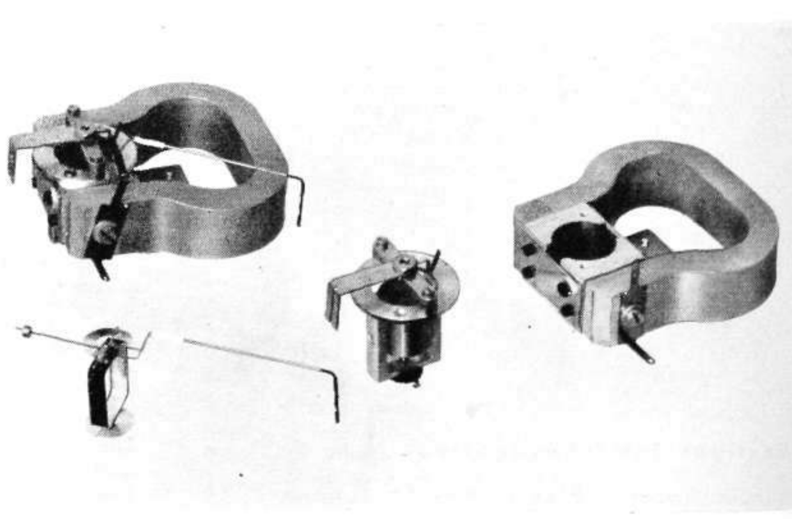
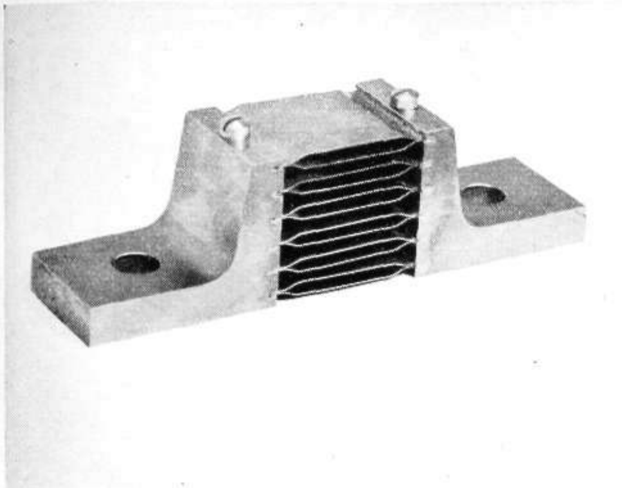


Fig. 1 X 5556
Measuring system for the large moving coil instrument
top left, complete; below, moving coil, frame and magnet



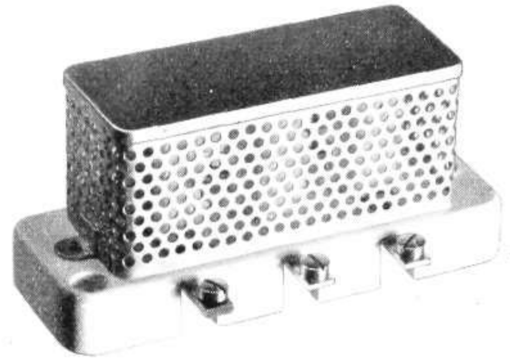


Fig. 2
Shunt and limiting coil

X 7199

The error is normally ± 1.5 % but may by special adjustment be improved to ± 0.2 % of full deflection. The moving coil ammeters for connection to separate shunts are calibrated for about 60 mV voltage drop. The voltmeters may be supplied with various internal resistances; the normal figure is 150 ohm/V, equivalent to 6.67 mA current consumption. They may, however, be supplied for smaller current consumption, *e. g.*, 1 mA, corresponding to an internal resistance of 1 000 ohm/V.

The *small moving coil system*, Fig. 3, is provided with permanent magnet of cobalt steel, one of two qualities being used according to the range for which the systems are to be employed. The actual difference between the large and the small moving coil systems is, as far as design is concerned, that the magnet in the small system has not loose pole pieces — for convenience in manufacture — the two ends of the magnet being shaped into pole shoes, between which the frame with core and moving coil is inserted. The journalling is the same as with the large system, that is with point bearings. The pointer deflection is about 80° and the system is provided with zero restoring device.

The small moving coil system may be made for current intensities from about 200 μA up to 10 mA with direct connection to the moving coil and from 10 mA up to 5 000 A by the connection in parallel of shunts. As a voltmeter the system may be employed for voltages from 60 mV up to about 600 V over limiting coil.

The error is normally ± 1.5 % of full deflection, but may be improved up to ± 0.50 % by special adjustment of the measuring system. The current con-

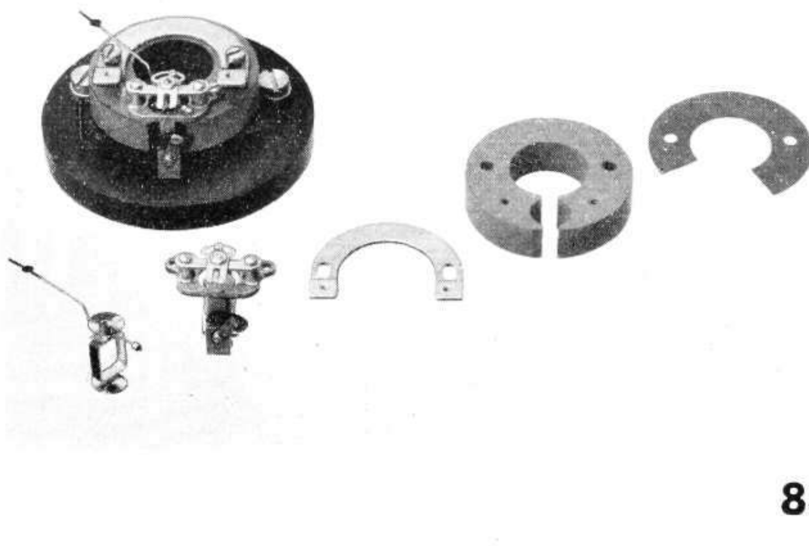


Fig. 3

X 5588

Measuring system for the small moving coil instruments

top left, complete; below, moving coil, frame, scale segment, magnet and insulation plate

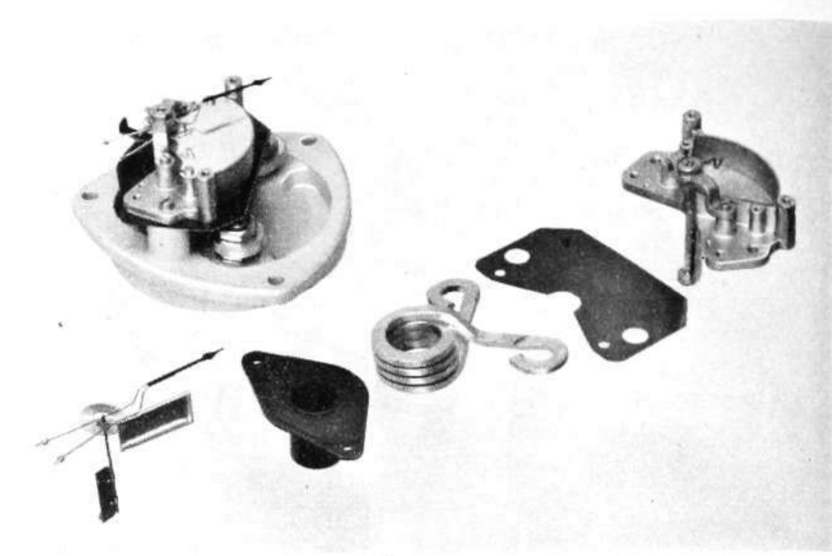


Fig. 4 X 5589
Measuring system for large moving iron instruments

top left, complete; below in row, moving system with pointer, damping vane, moving iron and spiral spring, field spring, field coil, winding, insulation plate and frame

sumption is 5 mA representing an internal resistance of 200 ohms for voltmeters and the voltage drop in ammeters with connection to shunt is 60 mV.

Moving Iron Systems

The moving iron systems are, like the moving coil systems, made in two sizes. The *large moving iron system*, Fig. 4, is intended for the measuring of AC and DC and consists of a frame of die-pressed aluminium alloy, the movement made up of a shaft, moving iron, spiral spring and pointer; and finally a field coil which encloses the moving iron and the fixed iron. The movement has a sapphire bearing. The pointer deflection, about 85°, is obtained by repulsion between the iron mounted on the shaft and the fixed irons which are fitted partly on the frame and partly in the field coil. By using different numbers of fixed irons different scale characteristics may be obtained, *e. g.*, whether the scale is to be as uniform as possible or is to be extended between certain points to provide facility within that special interval for more accurate reading. The system is provided with zero restoring device.

The oscillation of the pointer is checked by air damping obtained by a vane connected to the shaft oscillating in a closed damping chamber. The field coils, the frames of which are of pressed material, may be wound for the direct connection of currents with intensity from about 500 mA to 300 A, and in special cases up to 500 A, and for direct connection in series with limiting coils for voltages from 5 V up to 600 V, in special cases 1 500 V. For current intensities exceeding 300 A and voltages above 600 V the system should be connected over measuring transformers for 5 A or 110 V secondary respectively.

The error normally is ± 1.5 % of full deflection. The loss in the ammeters for 5 A is about 0.8 VA and for voltmeters about 4.5 VA with 110 V.

This moving iron system is characterised by good scale character, large adjustment facility, small dependence on frequency and high mechanical factor of efficiency. The scale divisions are almost uniform starting fom 10 % of nominal current or nominal voltage, as may be seen from Fig. 5. Specific adjustment facility, *i. e.*, the ratio between electro-magnetic torque and pointer deflection, constitutes a check on the instrument's sureness of adjustment; the higher the specific adjustment moment the more readily the pointer comes to rest at the correct point on the scale. As may be seen from the curve, Fig. 6, the large Ericsson moving iron system has very high and level specific adjustment moment at various voltages. From the curve, Fig. 7, giving error as function of the frequency, one can judge the low dependence on frequency of the measuring system, between 25 and 60 c/s.

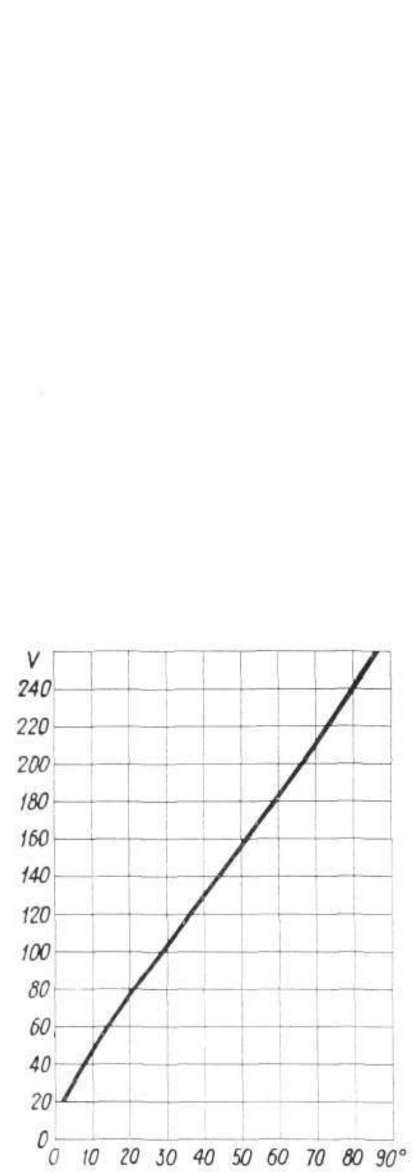


Fig. 5 X 3955
Pointer deflection as a function of the voltage

According to *Keinath*, the ratio between the torque necessary for 90° deflection and the weight of the movable system constitutes a measure of the instrument's mechanical efficiency. This »mechanical efficiency factor» has been calculated for Ericsson's large moving iron system at 1.11 %. This high figure means that the measuring system will stand vibrations and oscillation to a large extent. For purposes of comparison it may be mentioned that a factor of efficiency equal to 1.0 is regarded as good.

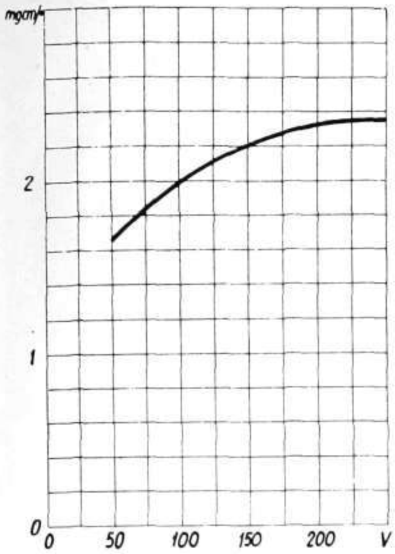


Fig. 6 X 3957
Specific adjusting moment for various voltages

The *small moving iron system*, Fig. 8, is as regards construction a miniature of the large system, and like it has proved to possess very good mechanical and electrical properties. The field coils may be wound for connection of currents with intensity from 100 mA up to 50 A and for voltages from 5 V up to 600 V in series with limiting coils. For current intensities over 50 A and voltages above 600 V the system should be connected over measuring transformer for 5 A or 110 V secondary respectively.

The measuring accuracy is normally ± 1.5 % of full deflection. The system has low loss: in ammeters for 5 A it is about 0.45 VA and in voltmeters for 110 V about 3—3.5 VA. The small moving iron systems display to a large degree the same distinctive qualities as the large.

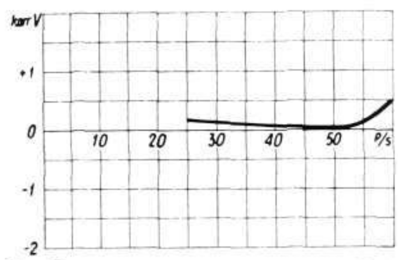


Fig. 7 X 3958
Error as a function of frequency

Construction

The moving coil and moving iron systems above described are fitted in large panel instruments, small panel instruments, panel instruments of curved type, marine instruments and motor cubicle instruments.

Panel Instruments

The *large panel instruments*, Fig. 9, have circular cases of pressed sheet-iron. They are made both for external fitting on the panel and for flush fitting. In the latter case they have a special flush fitting ring. Sizes of instruments, reckoned on the base-plate diameters, are 225, 185, 150 and 110 mm. In colour the cases are supplied in dull black. The cases are dust and splash proof enclosed.

All instruments have zero restoring screw at the front for adjustment of the home position of the pointer. The measuring accuracy of the moving coil instruments is ± 1.5 % — ± 0.5 % and for moving iron instruments ± 1.5 %. Test voltage is 2 500 V.

Ericsson's *curved front instruments*, Fig. 10, are intended for flush mounting only. The cases are cast of light metal alloy and are dust and splash proof

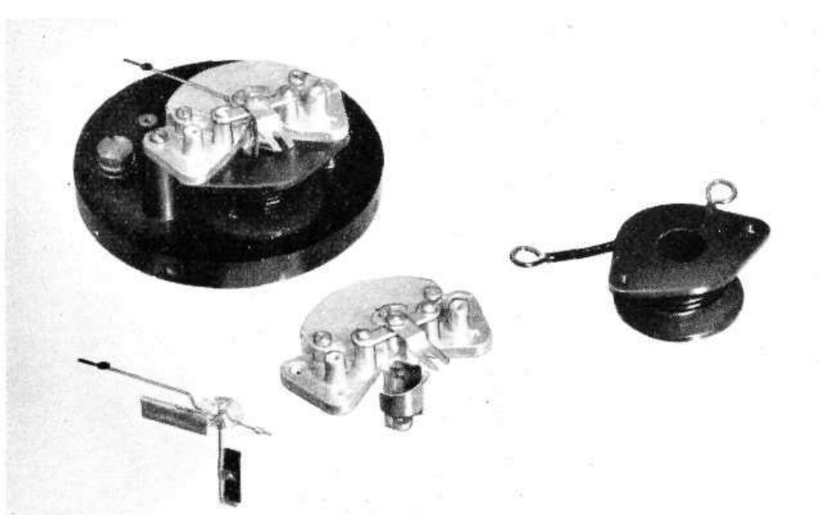


Fig. 8 X 5559
Measuring system for small moving iron instruments
top, complete; below in row, moving system, frame and field coil

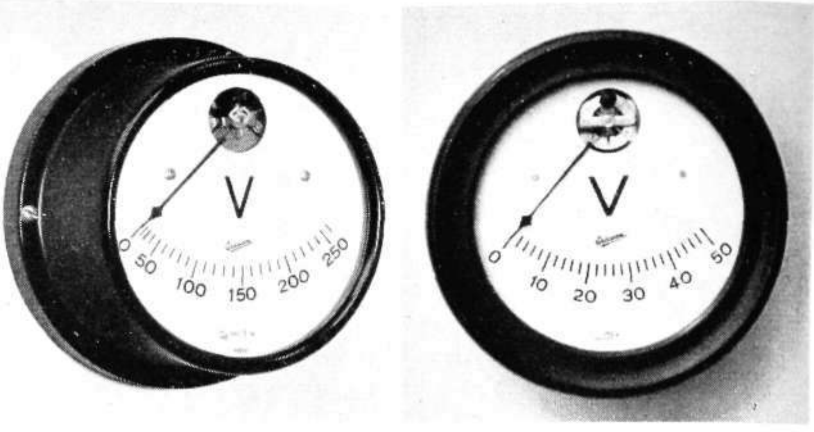


Fig. 9 X 5591
Panel instrument of large type
left, for external fitting; right, for flush fitting in panel

enclosed. The colour is dull black. The dimensions are 154 mm × 70 mm over flanges. The curved front instruments may be mounted with the scale horizontal or upright.

The large panel instruments and the curved front instruments are fitted with measuring systems of the large type, with one exception, the panel instrument with 110 mm base-plate diameter for DC measurements only, this having the small moving coil system.

Fig. 10 X 3959
Curved front instrument

The measuring accuracy for both moving coil instruments and moving iron instruments is ± 1.5 %. Test voltage is 2 500 V.

Small Instruments

The small instruments, Fig. 11, are intended solely for flush mounting on panels, the sizes being 65 mm and 90 mm according to the diameter of flange. The cases are normally of black pressed compound. The small instruments are made only with measuring systems of small types.

These instruments also are provided with zero-restoring screw on the front. In addition they are provided with iron screen against disturbing action of outside fields.

The measuring accuracy for the moving coil instrument is from ± 1.5 % up to ± 0.5 % and for the moving iron instruments 1.5 %. Test voltage is 2 500 V.

Marine Instruments

The marine instruments, Fig. 12, have two kinds of case. One is designed for flush mounting with rear connections, the other for external mounting with front connection over a cable box. The instruments are watertight and made to meet the Swedish Admiralty stipulations; they stand an excess pressure of 1 at. As in preceding instruments the normal colour is dull black. The cases have a flange diameter of 195 mm.

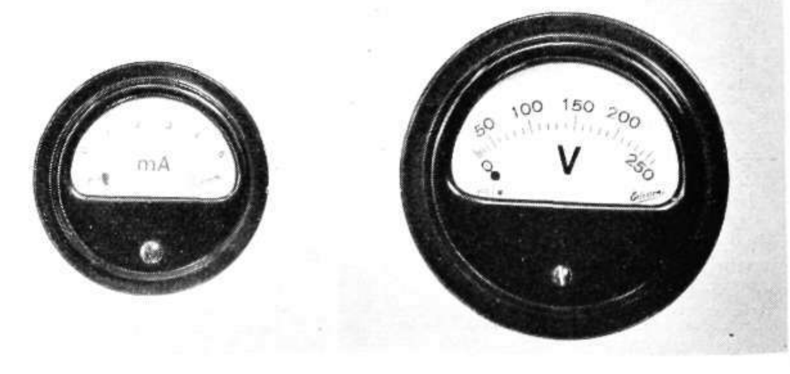


Fig. 11 X 5592
Small instruments

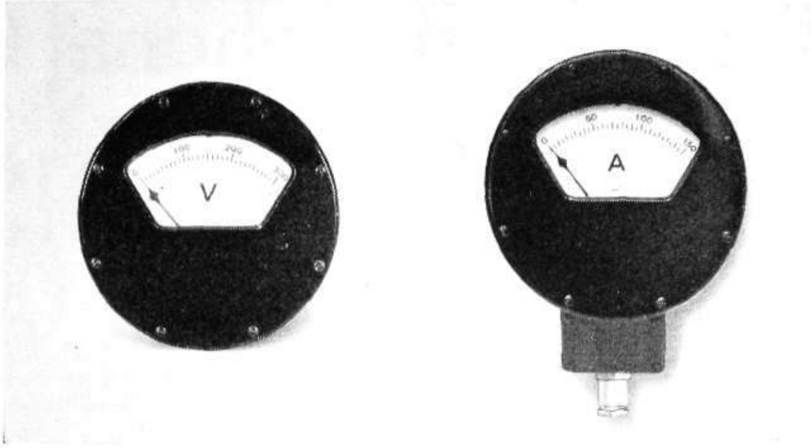


Fig. 12 X 5593
Marine instruments
left, for flush fitting, with rear terminals; right, for external fitting, with terminal connection in front over cable box

The marine instruments have the same systems and the same connection facilities as the large panel instruments.

The measuring accuracy for the moving coil instruments is ± 1.5 % and for the moving iron instruments ± 1.5 %. Test voltage is 3 000 V.

Fig. 13 X 3960
Motor cubicle instrument

Motor Cubicle Instruments

The motor cubicle instrument, Fig. 13, has a strong case of cast-iron and is made in six types; four with single system and two with double system. Usually the cases are enamelled in dull machine grey.

The scales for the ammeters have a contracted upper surge area. This surge area is provided to allow of momentary loads up to 300 %. The scale divisions begin at 10 % of the highest figure of the nominal range.

All the types of motor cubicle instruments are equipped with the large moving iron system for connection to DC and AC.

The measuring accuracy is ± 1.5 % and the test voltage 3 100 V.

Leading Telephone Cities of the World 1929—1937

A. LIGNELL, LATE DIRECTOR OF TELEPHONES, STOCKHOLM

It is of course natural that the leading telephone cities of the world should be found in America, since the United States of America occupy a predominant position in respect of telephones. The American Telephone and Telegraph Company and affiliated undertakings had on January 1st, 1939 — despite the temporary setback occasioned by the economic crisis of 1931—1933 — 49 % of the telephones of the world, though the number of inhabitants only amounted to 6 % of the total population of the globe.

The European countries had at the same date 37 % of the world's telephones with a population figure which represented 26 % of the earth's population. In the diagram, Fig. 1, the cities of the world with the highest telephone densities are shown in order and for some of them the variations in telephone density for the years 1929—1937 are also given. America lies at the top. Stockholm's position is foremost among European cities, being third in order in world statistics. Then come eight American cities and twelfth in order is Berne. Basle and Zurich have approximately the same telephone density as Oslo and Copenhagen. London displays 17.2 telephones per 100 inhabitants and has shown a sharp rise in recent years; unfortunately comparative figures for the years prior to 1936 are not available.

The average figure of 16.7 for all the Swedish towns together with the exception of Stockholm — 116 towns of widely varying sizes — is remarkably high. At the same time 54 American cities of more than 200 000 inhabitants had 21.97 telephones per 100 inhabitants.

The changes in the numbers of telephones per 100 inhabitants in the period 1929—1937 are given for five American cities and some European ones. The expansion in the case of the American cities has been affected to a great extent by the 1931—1933 economic crisis, while the curves for the European cities largely display progressive rise. Stockholm for the period 1929—1937 has a rise of 6 % and, if 1938 is included, 8.5 %. Basle shows up to and including 1937 the greatest rise in telephone density with 10.9 %, Berne and Zurich having 10.6 and 8.1 % respectively.

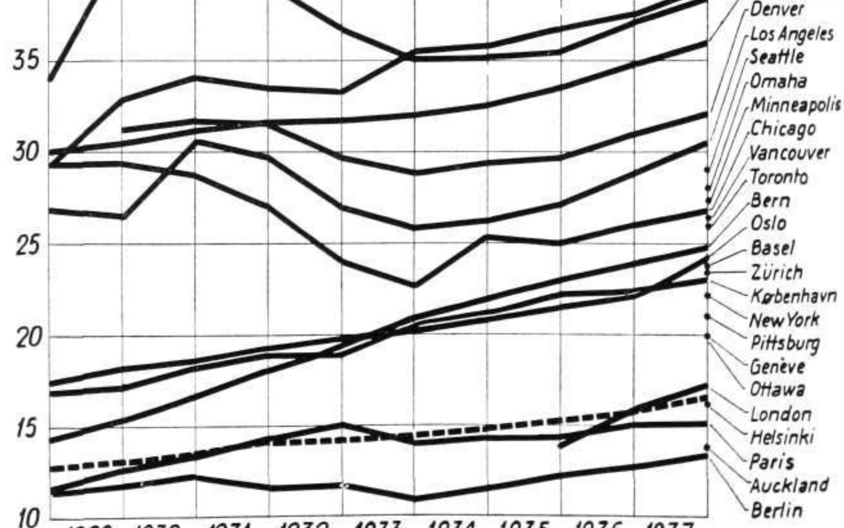


Fig. 1 X 5571

Diagram of the world cities with greatest telephone density 1929—1937

---- all the 116 Swedish towns besides Stockholm

New Interlocking Plant at Sundbyberg

H. DETSNER, TELEGRAPH & SIGNAL ENGINEER, STOCKHOLM–VÄSTERÅS–BERGSLAGENS RAILWAYS, VÄSTERÅS

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 Tomteboda 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, ususally 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 Tomteboda Övre there is junction over a single track for goods traffic with Tomteboda 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.

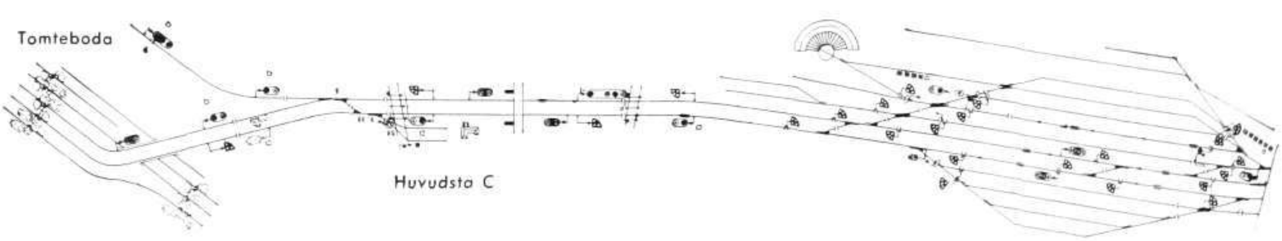
Traffic

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

main light signal
distant light signal
dwarf signal
gates with lights facing the road
insulated rail joint
red fixed light
green fixed light
green fixed or flashing light
green flashing light
white fixed light on dwarf signal
white flashing light
local point lever
square mark plate
circular mark plate
signal telephone to signal cabin
contact for releasing dependence between gates and signals
stop signal
track dog lamp

X 7208
X 7204

Fig. 1
Track diagram at Sundbyberg

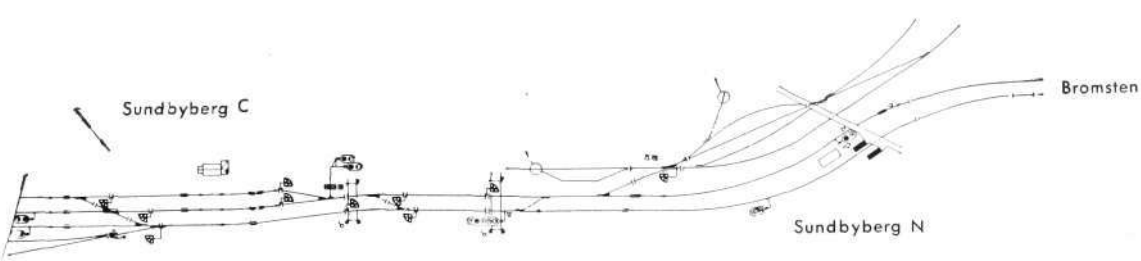


was most convenient. Further, since the interlocking plant controlled the whole track area to Sundbyberg N, there was no necessity to occupy track III with these shunting trains, which may consequently now use the right-hand track for the return to Sundbyberg. The previously existing junction track in 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 Tomteboda 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 Tomteboda and trucks whose destination was north had first to be hauled to Tomteboda 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 Tomteboda 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 Tomteboda 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 Tomteboda 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



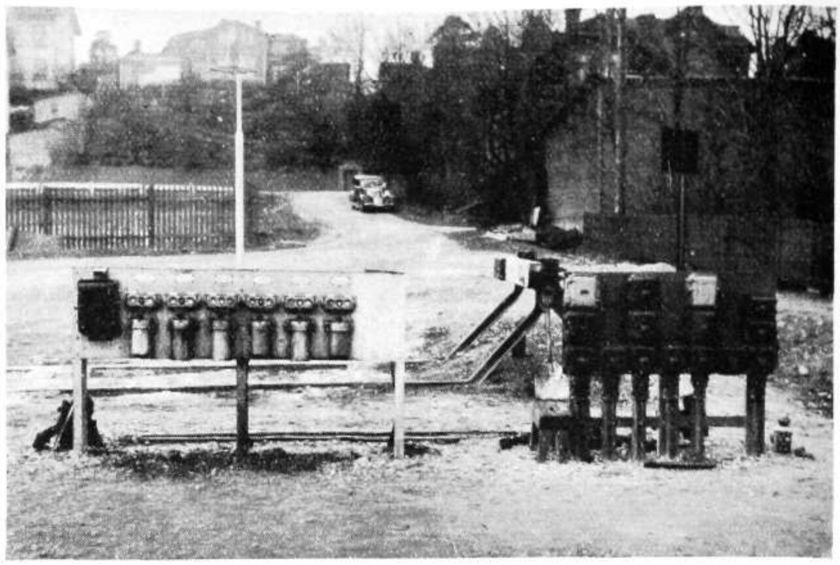


Fig. 2 X 5596
Contact devices for local operating of points

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 Tomteboda 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.

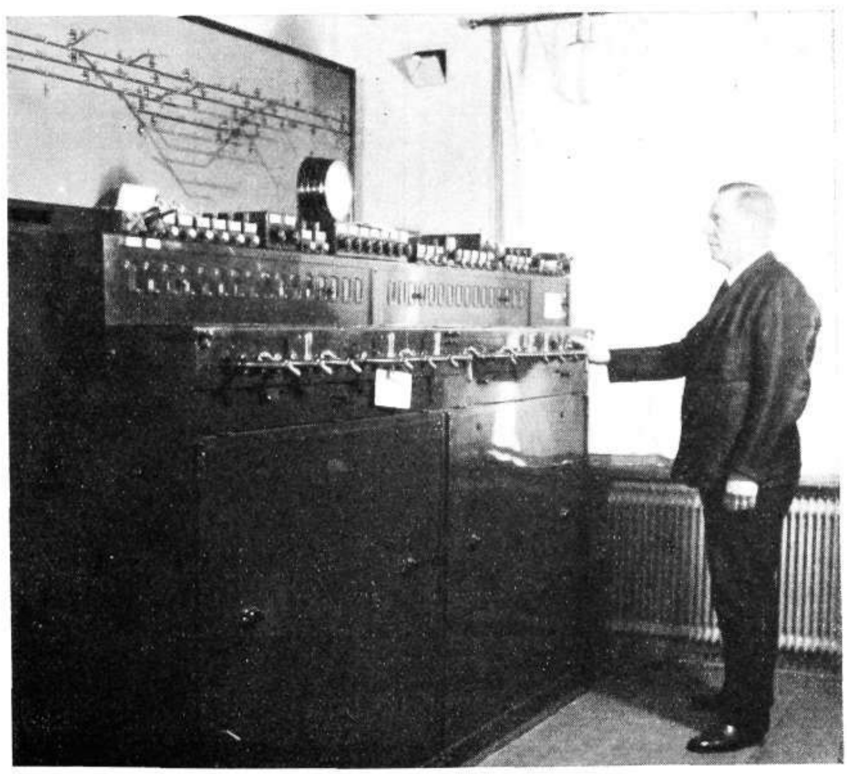


Fig. 3 X 5558
Interlocking machine with illuminated track diagram

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 X 3962
Starting signals west

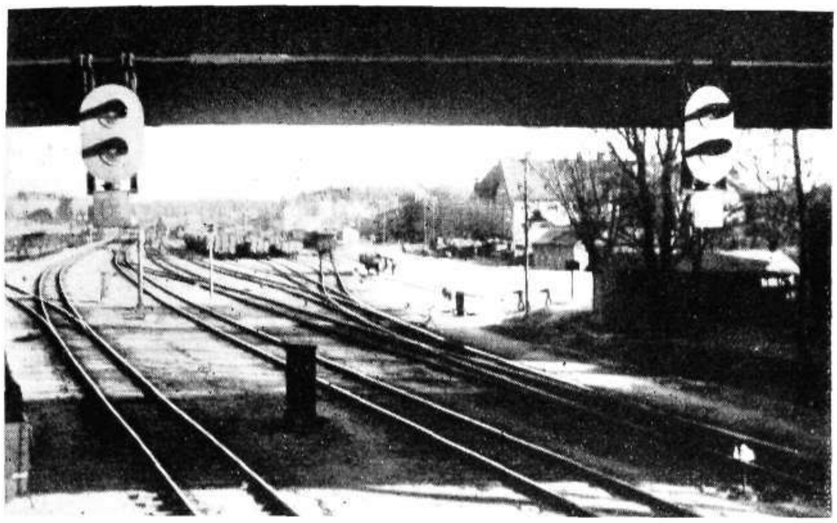


Fig. 5
Starting signals east

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.

Interlocking Plant at Upsala C

HERMAN HOLMQUIST, SIGNAL ENGINEER, STATE RAILWAYS, STOCKHOLM

As far back as 1913 there was installed at Upsala an electric interlocking plant, up-to-date at the time, which has worked satisfactorily throughout the years. Naturally, however, it called for a numerous staff while in addition there were men for operating crossing gates at a large number of level crossings. Then when the line was electrified this caused the mechanical semaphores, of which there were a large number in the plant, and the scotch block signals on masts to be difficult to observe on account of the overhead line bridges and the overhead lines. For several reasons also it was considered advisable to exchange the old plant for a modern interlocking plant with light signals and track circuits, which moreover was a necessity to enable Upsala station to be connected to the automatic interlocking Stockholm—northwards.
The new interlocking plant with illuminated track diagram, relays, point machines, locking devices and dwarf signals was ordered from Signalbolaget, while the greater part of the cables was supplied by Sieverts Kabelverk. The work of installing was begun in the autumn of 1936 and was largely completed by the autumn of 1937. For various reasons, however, the plant was only put into operation in February 1938.

In the older installation the signal cabins numbered three and all the points requiring to be set for fixing a train road were centrally controlled from the signal cabins. The electrical station blocking and the track locking were dealt with by the train dispatcher. Single track section blocking with blocking apparatus was arranged to Upsala Norra and there was double-track section blocking southwards. In the new safety installation the three interlocking machines are united in one central interlocking machine housed in the same building that formerly occupied by interlocking machine II at the south end of the station area. The plant works as order interlocking machine, since signal to an incoming train is given without reference to the train dispatcher. With departing trains the train dispatcher gives bell signal to the cabin when the train is ready to leave, this to avoid the train roads being locked too soon in the event of lateness.

Fig. 1 X 5575
Dwarf signals in the station track area

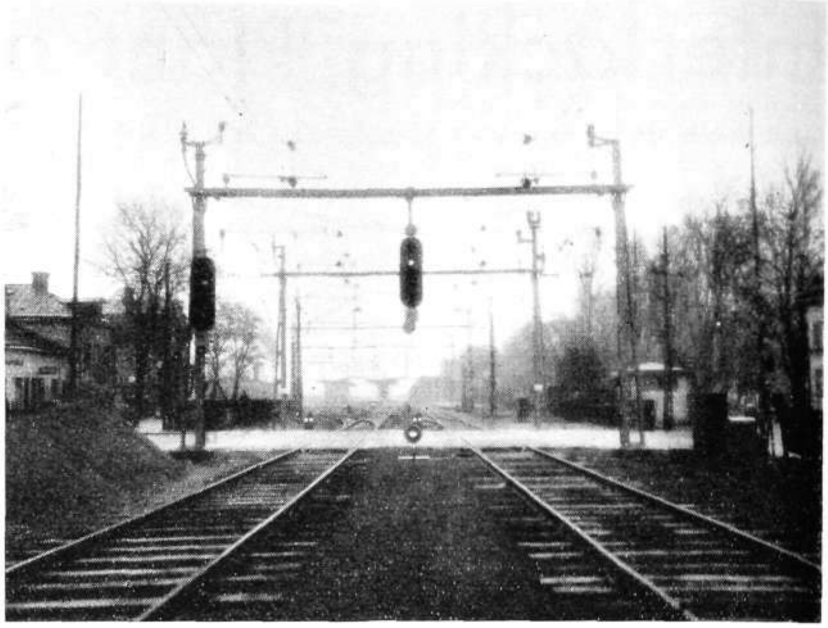


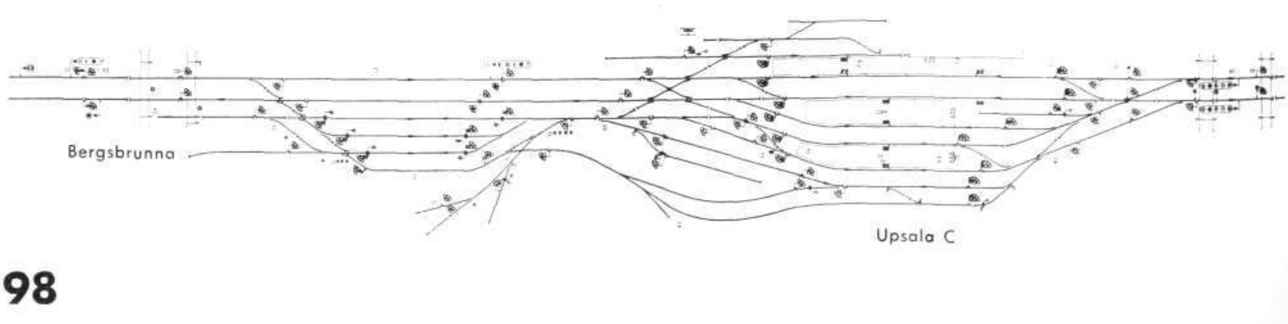
Fig. 2 X 5574
Entrance from north to Upsala C
with home signals, dwarf signals, caution signal and electrically operated gates for the level crossing

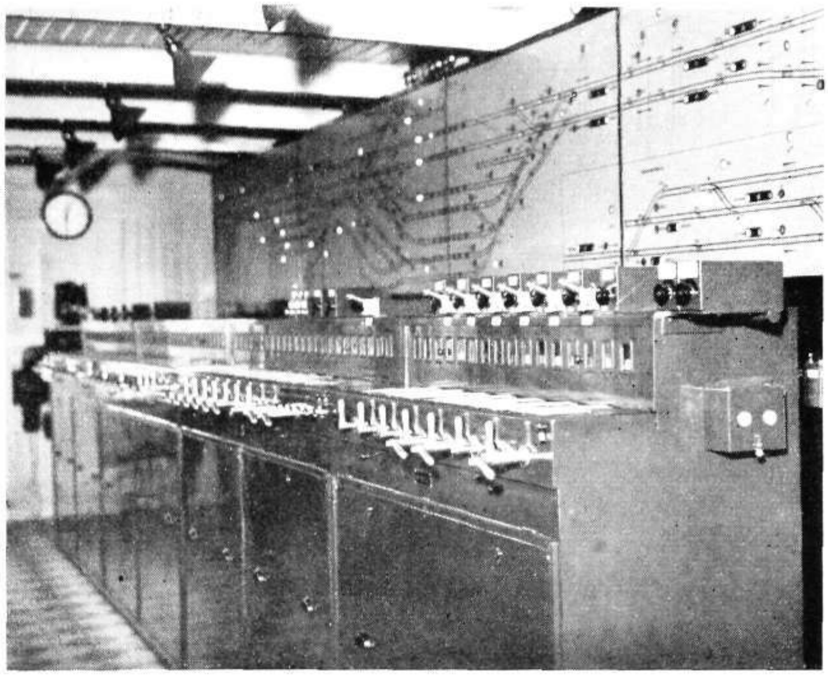
All shunting movements in the station area are directed from the signal cabin by means of dwarf signals, Fig. 1, while shunting on the ranger track is done by local switching devices for all the central switchable points. When the signal cabin gives permission for local switching, the dwarf signals concerned are set at »out of use». On the entrance or departure of a train on the ranger track the permission for local switching is withdrawn and the signal for the train is given by the interlocking plant.

All the train tracks are insulated, *i.e.*, formed into track circuits on which traffic is directed by dwarf signals. By means of the track circuits the giving of clear signal is prevented for tracks which are occupied by vehicles. The track circuits are also employed to prevent centrally switched points being switched from the interlocking machine when vehicles are in the track circuit. The dwarf signals which constitute home signals cannot be observed with sufficient clearness by rapidly approaching trains, but must be repeated by light signals set up on power line poles or in bridges, Fig. 2. For departure roads, indication that the train road is cleared is given by green light below the ordinary white in the innermost dwarf signal.

A modern electrical interlocking plant of the type used at Upsala is distinguished from older types of plant by the fact that in the latter only two train roads may be set by each signal lever. The interdependence with the

Fig. 3 X 7198
Track diagram at Upsala C



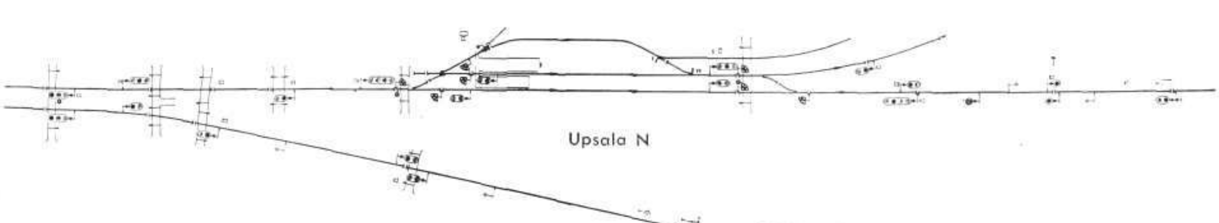


X 5576

Fig. 4
Interlocking plant
with illuminated track diagram

point levers is then obtained by means of mechanical guides which on throwing the signal lever are pushed to one side and by means of locking elements lock the point levers in plus or minus position. This mechanical interdependence is absent in a modern interlocking plant, being replaced by electrical locking. This means that it is possible with a single signal lever to give signal to all the train tracks on the station area where the track system allows of the train entering. When the signal lever is thrown, *e. g.*, to the right, there is obtained clear signal for the track for which the points are set, but only on condition that the train road is free of vehicles. The throwing of the lever to left gives clear signal for departure from the track from which the points at the moment are set. The signal cabin attendant therefore must take care that the points are set just to or from the track concerned. This is ensured by the train roads being mostly made up of several dwarf signal train roads, which must be set first. When finally the main lever is thrown, a special pilot lamp marks the tracks for which signal has been given.

The advantage with the modern interlocking plant is thus that a large number of train roads may be obtained without the interlocking plant being unreasonably cumbersome. Thus it is possible to have train roads out and in on all tracks in the station area to and from all lines, even for right-hand track traffic with double track lines, Fig. 3. This allows of a freedom of movement hitherto unimagined as regards employment of the station area for the entrance and departure of trains. A great advantage also is the direction of shunting work from the signal cabin by means of dwarf signals. In this way the points are locked at each shunting movement which appreciably increases the speed in shunting. If only one track circuit is free from vehicles the dwarf signal shows »caution», but if two track circuits are free the caution signal automatically changes to »clear», whereby the speed may be increased while safety is retained. The shunting movements at a passenger station are practically the same day



after day, so that the signal cabin staff has no difficulty in directing them. In the event of lateness or other interruptions, communication with the signal cabin is obtained by means of telephones in the track area.

Behind the interlocking machines there is an illuminated track diagram on which the track system is shown and each track circuit is marked by a lamp. All the signals also are repeated on the track diagram, so that it is possible to observe their positions at any moment, Fig. 4. The signal cabin staff can observe all movements over the station tracks on the plan and have therefore actually no need to follow the movements through the windows. The track diagram includes the Upsala ranger and station tracks, also the track system at Upsala Norra and intermediate line, as well as the line to Old Upsala. Points and signals at Upsala Norra are also operated from the central interlocking machine. Automatic block sectioning is arranged southwards to Bergsbrunna and northwards by single track via Upsala Norra up to Brunna station. On the single track the direction to be taken by trains is directed by the interlocking plant at Upsala C. This interlocking plant can also carry out train meetings at Upsala Norra where there is no train dispatcher.

A special feature of this interlocking plant is the large number of crossing gates across streets and roads in and outside Upsala, which are operated electrically from the signal cabin. The number of level crossings is no fewer than 13. All the gates are protected by light signals, which display »clear» only when the gates have been lowered. Immediately the last vehicle of a train has passed a level crossing the gates are raised automatically. On the track diagram at the interlocking plant there are pilot lamps for each level crossing, these indicating whether the gates are up or down and that the red lamps facing the road are burning when the gates are down. It has ben found that no trouble is experienced in operating all these gates centrally, and no accident has occurred up to now, despite the fact that there is no attendant at the street and road crossings.

It is obvious that a plant as described must involve a large capital outlay, in this case a total of about 550 000 kronor. This amount, however, will yield interest through the reduction in staff that could be done after the plant was completed, by the concentration of three interlocking plants into one, by the taking away of the train dispatcher from Upsala Norra, by dispensing with the attendants previously required for operating the various level crossing gates. The saving in cost of staff amounts to 36 000 kronor per year, while in addition there are the advantages described with the handling of the trains and the utilisation of the station tracks for the ever growing traffic.

Mains Connected Automatic Switchboard for 10 Lines

H. FREDBORG & V. E. SJÖDIN, TELEFONAKTIEBOLAGET L.M. ERICSSON, STOCKHOLM

Telefonaktiebolaget L.M. Ericsson has quite recently put on the market a new automatic telephone switchboard OL 15 for 10 extensions, and which may be connected to the AC mains. This switchboard is a development from the automatic switchboards OL 10 and OL 12, designed some years ago, and like them it is equipped with a single conversation facility. In contrast to the previous switchboards, however, switchboard OL 15 provides facilities for both secret and non-secret conversations and, in addition, for general calls, i. e., calls to all extensions simultaneously. Another advantage is that ordinary telephones with AC ringing may be used.

Ever since the two automatic switchboards OL 10 and OL 12 were put on the market, they have been in exceedingly great demand. It was therefore evident that the switchboards met a decided need. An automatic switchboard of the ordinary type, as we are aware, is provided with facilities for several simultaneous conversations which makes it far too expensive for the very smallest installations. A switchboard with only one conversation facility, on the other hand, may have a very much simpler and consequently cheaper construction than a switchboard with facilities for several simultaneous conversations. Examples of cases where a switchboard with one conversation facility may suitably be employed, are small offices and businesses, shops, private residences etc.

In switchboards OL 10 and OL 12 the source of current employed consists of dry batteries which gradually become exhausted and must be replaced. Recently, therefore, the dry battery has frequently been replaced by a storage battery which is kept charged by a constantly connected rectifier. In this way, of course, replacement of dry batteries is avoided but, on the other hand, the storage battery requires inspection and the charging requires checking at regular intervals. The most efficient solution of the problem is obviously to have the switchboard connected direct to the AC mains.

In switchboards OL 10 and OL 12, it will be recalled, instruments with DC bells are used. The power of the galvanic ringing is limited by the voltage of the battery used, about 12 V. By mains connection there is obtained the advantage that ordinary telephone instruments with AC ringing, *e. g.*, DBK 1101, may be used. The AC ringing may be made considerably more effective since the ringing voltage, obtained by transforming the mains voltage down, may be chosen at will. In Ericsson's new automatic switchboard OL 15 for mains connection the ringing voltage is approximately 85 V. Extra bells may be connected without trouble to an extension instrument that is equipped with AC bell.

The standard type of switchboard is usually made for connection to AC mains with tensions of 110, 127 and 220 V. By means of a simple changing of connections one switchboard may be used for any of these voltages. The frequency of the AC mains may in the normal execution of the switchbord vary between 40 and 60 c/s. If required the switchboards may be supplied for other voltages and frequencies.

The switchboard is intended also for connection to DC mains, but then it must be supplemented by a vibrator converter. Where electric current is not available or where interruption of current supply occasionally occurs and the use of the switchboard cannot be dispensed with during such interruptions, it is necessary to install a switchboard for battery operation instead of one for mains operation. Ericsson therefore will still manufacture switchboard OL 12 as well as OL 15.

In designing this switchboard the aim has been to make it as far as possible independent of variations in the mains voltage. If the normal mains voltage is 220 V the switchboard will work satisfactorily even though the voltage falls to 190 V or rises to 250 V.

To ensure economy in operation the power consumption of the switchboard must be low. With 220 V mains voltage the power consumption when idle is less than 3 W and during conversation about 3.5 W. The maximum power consumption which takes place during dialling and while ringing signal is transmitted is 7 to 8 W.

Normal telephone instruments BDH, DBK and DBN for automatic systems are used with this switchboard. The resistance of the subscriber's line may amount to 400 ohms, which if normal circuit cable, *e.g.*, EEB 0.5 mm, is used, is equivalent to a distance between switchboard and instrument of more than 2 km. The instrument numbers are *1, 2, 3, 4, 5, 6, 7, 8, 9, 0*.

Construction

The switchboard OL 15, Fig. 1, is enclosed in a case of aluminium bronzed sheet-iron with the following dimensions, inclusive of protective cover: height 375 mm, width 250 mm, depth 160 mm. The net weight is about 9.7 kg.

When the protective cover is removed all the parts which are not dangerous to touch are accessible. Adjustment, testing and alteration of connections can thus be carried out while the switchboard is under current. Those parts which are directly connected to the mains and are under dangerous tension are guarded against being touched and cannot be reached until the switchboard has been made currentless. This is done by drawing out the contact plug visible on top of the switchboard. It is only then that the protective plate covering the parts under dangerous tension may be unscrewed and removed. A further protection is obtained if the switchboard earth terminal, to which all the metal parts of the switchboard are connected, is connected to a waterpipe or some other well-earthed object. Certain power companies stipulate that such a connection be made.

Connection to the AC mains is done by means of a cord fitted with a plug contact at the free end. It can be inserted in an ordinary wall outlet, so that no wiring is needed to connect the switchboard to the mains.

The battery eliminator contains a rectifier together with a transformer and a filter comprising two electrolytic capacitors and a choke to smooth the rectified

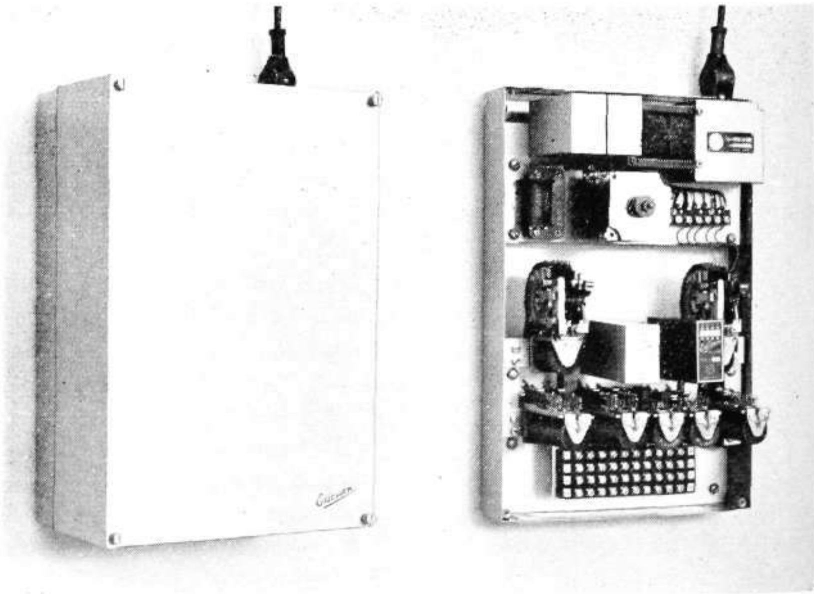


Fig. 1 X 5582

Automatic switchboard OL 15

left with cover, right with cover removed; at top, battery eliminator with rectifier, transformer and filter; in middle, capacitors and relays; at bottom, terminal block current. The central part of the switchboard contains two selectors for the hunting of the calling subscriber and for the connecting in of the called subscriber, and in addition a number of relays and capacitors. The ten two-wire lines to the extension instruments are connected to the terminals at the bottom. The necessary alterations for secret or non-secret conversations, for cutting in facility on conversations going on and for general call are carried out on these terminals by means of bare wire stirrups.

Traffic Properties

Generally it is required that a conversation shall not be disturbed by a call from another extension. The switchboard is therefore as a rule connected for secret conversations. A switchboard of this simple type being provided with only one conversation facility, the switchboard will be blocked for all others, when conversation is going on between two subscribers. In some cases this may be a disadvantage and the switchboard has therefore been made so that it may be altered in a simple manner to enable conversations to be non-secret. This gives the advantage that, when the switchboard is occupied, any of the extensions may request the speakers to hasten the conversation so that a new call may be made. On the other hand, there is the disadvantage when all conversations are non-secret that they may be overheard at any of the extensions.

Consequently the new switchboard has been provided with one additional facility. The switchboard may be altered in such a way that some of the extensions — one, two or three — have the advantage of secret conversations, while those of the other extensions may be overheard. All calls, both incoming and outgoing, on the privileged instruments are secret. If the switchboard is occupied when a third party lifts his handset he does not come in if a conversation is going on between two privileged instruments or between one privileged and one non-privileged instrument. On the other hand he does come in if the conversation is going on between two instruments not entitled to secret connections and the person who has cut in can now require that the conversation be terminated.

One of these privileged extensions, namely the one having *1* as call number may, if desired, be equipped with absolute preference, which means that from this extension cutting in can take place on all connections, both those ordinarily secret and those not secret, and that all connections over this instrument are absolutely secret. Cutting in can therefore not take place from any other extension when the switchboard is occupied by the person who has absolute preference. This special advantage is suitably reserved for the head of the undertaking.

Still another advantage compared with earlier types of switchboards is offered with the new switchboard OL *15*. The extension which may be given absolute preference, *i. e.*, usually that of the head of the undertaking, may have the facility of general call, that is the facility of calling all the extensions at the same time. This is done by dialling the digit *1*. This facility may come into use for the giving of general communications, instructions and the like applying to all extensions. It is also possible to arrange conferences in this manner, provided that normal telephone calls can be dispensed with during the conference.

Operation

When the switchboard is idle, see diagram Fig. *2*, all instruments are connected to the impulse receiving relay *R2*, which is attracted and starts the switching process immediately the handset of one of the extension instruments is removed. The line finder *AS* is moved forward one step and relay *R1* attracts, thereby disconnecting all extensions from relay *R2*. During dialling, of course, only the calling instrument should be connected to the switchboard, since disturbance of the switching process might occur if another instrument called the switchboard during the dialling. The calling subscriber, therefore, is hunted by the line finder *AS* and is then connected alone to relay *R2*.

Relays $R2$ and $R3$ attract and dialling tone is emitted to the calling subscriber as a sign that the desired subscriber's number may be dialled. During dialling relay $R2$ is attracted and released in time with the impulses of the dial. At each impulse the connector LV moves forward one step until it reaches the position corresponding to the desired subscriber's number. The relays $R3$ and $R4$ remain attracted during dialling.

At the close of the impulse train, relay $R3$ is released while relay $R4$ remains energized a few seconds by delayed action. During this period ringing current is transmitted to the subscriber connected by the connector. The ringing current passes through an extra winding on relay $R2$, so that the calling subscriber also hears that ringing signal is emitted. When finally relay $R4$ is released, the ringing signal ceases and the speaking wires between the line finder and the connector are connected together. Speaking connection is established immediately on the removal of the handset by the called subscriber. If no answer is obtained, the calling subscriber may send out a new ringing signal if — without replacing the handset — he dials *1*, awaits new dialling tone, and then dials the desired number. During this time the switchboard is busy so that no other instrument can make a call.

When the subscribers replace their handsets at the close of a conversation, relay $R2$ is released. Selectors IV and AS are stepped forward to home position and finally relay $R1$ is released. The switchboard is then ready for a new call.

The alteration for secret or non-secret calls is made by means of the connection B. If this connection is made, relay $R1$ will remain attracted during the conversation, thereby disconnecting all instruments not concerned. Consequently, when the handset is removed on any instrument, the conversation cannot be overheard. If the connection B is non-existent, however, relay $R1$ is released immediately following the ringing signal. All the instruments will then be connected to the switchboard and a conversation may be overheard by anybody. Absolute preference for an extension is obtained by making connection A, Fig. 2. By this means the instrument in question will always — except during dialling and ringing signal — remain directly connected to the speaking wires of the switchboard, over which all speaking connections are established. Immediately the handset of this instrument is removed, therefore, a conversation going on may be overheard.

The general call facility is arranged by removing the connection C. If the subscriber dials his own number, relay $R1$ is released immediately after dialling. This causes all subscribers' lines to be interconnected and ringing current is sent out to all extensions.

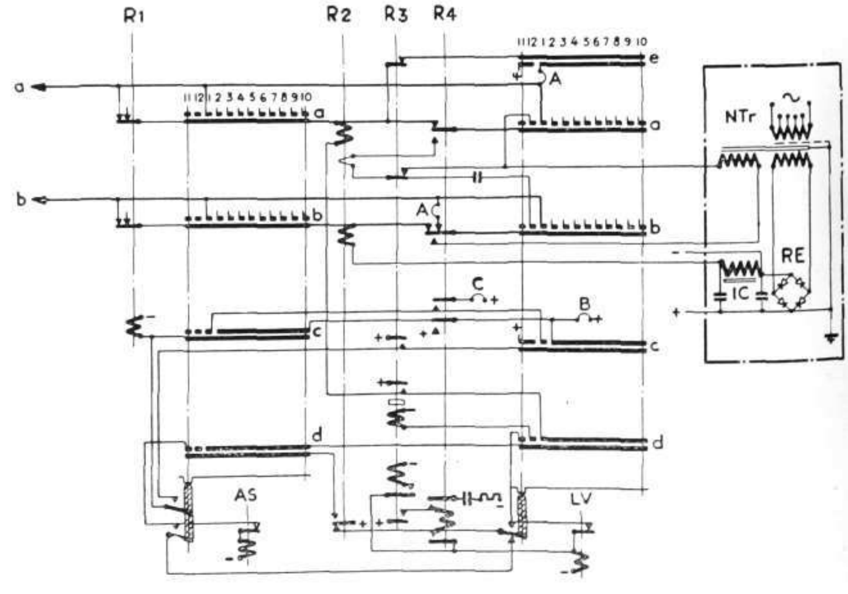


Fig. 2 X 5581

Circuit diagram for OL 15

a, b,	connections to instruments
A, B, C	connecting stirrups for different traffic facilities
AS	line finder
IC	feed current filter
LV	connector
NTr	mains transformer
R1	selective relay for secret conversations
R2	starting and impulse receiving relay
R3	impulse control relay
R4	ringing relay
RE	rectifier bridge

Ericsson Cable-Finder in India

FRANK HYLAND, BENGAL TELEPHONE CORPORATION, CALCUTTA

In Ericsson Review No 1, 1939, was given a description of a cable-finder constructed by Ericsson. With this apparatus determining of the exact position of underground lines and piping may be conveniently done, which is of great value when repairing and blasting. The Ericsson cable-finders have been in use some time in Calcutta, British India, and in the following some measurements which have been made there will be described.

Fig. 1 X 3934
Locating a cable bend

Measurement with the cable-finder constructed by Ericsson is based on the principal that an electro-magnetic field produced by an alternating current can be heard in a telephone receiver. From the intensity of the sound the position is determined of the electro-magnetic field and from it the position of the cable, underground line or piping sought. A cable-finder of this construction has been in use some time at the Bengal Telephone Corporation in Calcutta with the following results.

Fig. 2 X 3935
Locating a cable to avoid injury during street excavation

The buzzer transmitter was once connected to one pair of a 50 pair armoured telephone cable at the end of the cable 6 km from the central office where the pair was connected to the cable sheath and to earth. The output of the buzzer transmitter was lowered to 45 mA. The cable was then traced for a distance of about 800 m. In this distance the pair made several right angle bends round road corners and passed into cables of several sizes. On the approach of a canal bridge the cable carrying the pair was 2.5 m below the street surface. The position of the cables carrying this pair could all the time be accurately determined. The tone was clearly audible above the noises of busy roads and induction from adjacent power cables.

A 26 pair armoured telephone cable 2.5 km long was measured in the same way but only one wire of the pair was used. The cable ran partly parallel to a tramway track, the traction feeder of which ran along the cable within some decimeters of it on one side of the road. In spite of this the two cables could easily be located by the null method. The traction cable could also be located by using its own induction as the transmitter tone.

Fig. 3 X 3936
Determining by the null method the exact position of a cable

By applying the loose finder coil the selection of one of twelve 800 pair armoured telephone cables laid up in a cable rack was easily made by connecting the buzzer transmitter to a certain pair in the cable sought. This pair was earthed in the other end of the cable. The correct cable was readily identified by applying the loose finder coil to each cable in turn. In order not to disturb the telephone traffic going on at the same time on the other cables the output of the transmitter was adjusted to the lowest possible value, about 4 mA. In order to ascertain whether a particular cable could be identified when local conditions would not permit of the coil being applied against a cable, the output of the transmitter was increased to 20 mA. The finder coil was held away from the cable rack and it was possible to identify the cable by sighting the direction in which the finder coil was pointing when the maximum tone was heard.

The measurements described were carried out under normal field conditions in Calcutta. The testing officers were usually the centre of a crowd of noisy interested spectators or were working in heavy street traffic but in spite of this the measurements gave very good results.

New Sound Projector for Sub-Standard Film

R. BEAUJOIN, SOCIÉTÉ DES TÉLÉPHONES ERICSSON, COLOMBES

In France as in most other countries sub-standard film is used to an ever increasing extent for educational purposes. Since the State also has recognised the value of the improved instruction made possible by the sub-standard film with sound and, by making grants to schools, local authorities, agricultural institutes and other organisations has facilitated the acquisition of sub-standard film projectors for educational purposes, there has obviously been created a large market for such projectors in France and, since the 16 mm size has been internationally adopted for sub-standard film, in other countries as well. For this reason Ericsson, Colombes, has put sub-standard film projectors on its programme of manufactures.

In designing a sub-standard film projector, chiefly intended for school use, great demands must be imposed on the apparatus since it will usually be handled by persons who in most cases have no knowledge or experience whatever of film projection. The projector, therefore, must be simple to operate and of no delicacy of construction, it should be easily portable but steady, and moreover present the greatest safety in displaying the films.

In 1936 the authorities approved the sound film projector designed by Ericsson, Colombes, and at the same time the State undertook to make a grant to those institutions that purchased a projector of this type.

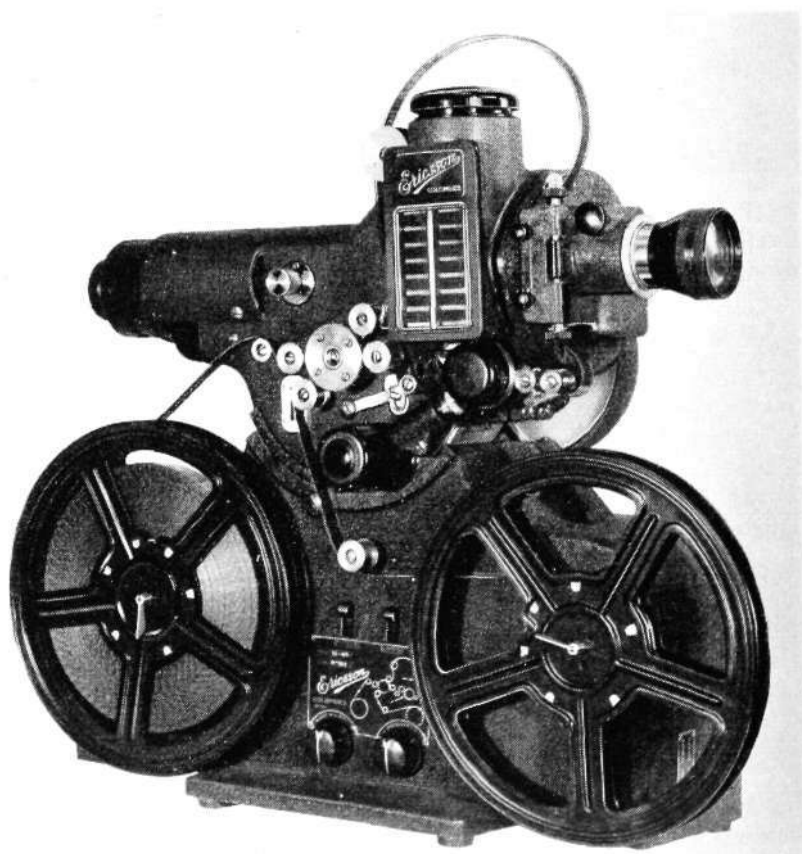


Fig. 1 X 5584

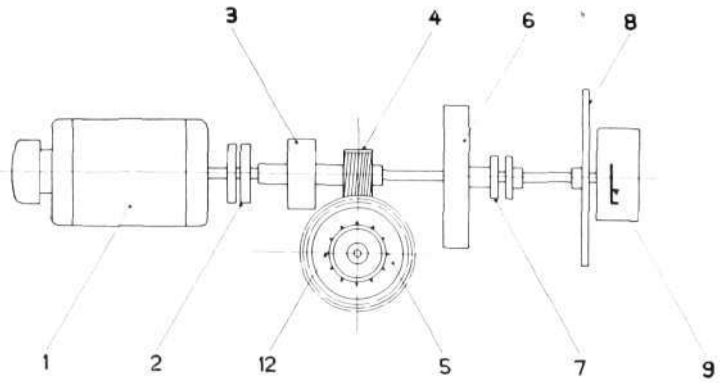
Sound film projector with filament lamp

for 16 mm film, with 300 m film reel

Fig. 2
Diagram of driving mechanism

1 motor	6 fan
2 flexible coupling	7 flexible coupling
3 change-speed box	8 shutter
4,5 gearing for feed wheel	9 claws
	10 feed wheel

X 5587



The Ericsson sound projector for 16 mm film, Fig. 1, is made up of two parts, one of which constitutes the stand and contains the microphone and power amplifiers; the other part holds the mechanical parts for feeding the film forward together with the projection lamp and optical equipment for image and sound. This latter part is movable on the stand, making it easy to adjust the image on the screen.

The apparatus is designed for 110 V AC current, 50 c/s and the current consumption is 800 W.

Motor Part

The general mechanism is reduced to the strict minimum, with all the parts mounted in line upon a single shaft, see Fig. 2. Upon this line of shaft are located: the motor, a flexible coupling, the change-speed box, the worm for operating the worm-wheel, the fan, a second flexible coupling, the shutter and the device for controlling the movement of the claws.

The *motor* employed is of the asynchronous type and it is started by an auxiliary phase with capacity; it operates with 110 V AC current, 50 c/s and its consumption is 105 W. The speed of the motor on full load is 2 880 r/m and its regularity of running is sufficient to permit of direct coupling to the shaft.

On the body of the motor is mounted a three-plug terminal, which is connected with the wires of the field winding and allows the motor to be taken out of the frame without disturbing the connections.

One *flexible coupling* serves chiefly to absorb the starting shocks and facilitates the removal and the exchanging of the motor.

The *gear box* is of the planet pinion type. It provides for the two speeds which are necessary for the travel of the silent and the sound films, 16 and 24 frames/s respectively. In the case of acoustic films a fork guide connects the driving pinions with the gear box body, the planet wheels being thereby locked and the whole unit driven at the motor speed, or 2 880 r/m. In the case of silent films the fork guide is disengaged by pushing in the stud which is held in position by a bayonet stop. The stud holds the body of the box and at the same time releases the driving pinion which then via the planet pinions drives the shaft at the reduced speed of 2 160 r/m, equivalent to 18 frames/s. The entire box is carefully balanced to prevent all vibration.

The *feeding drum* is driven by a worm with double thread and a worm-wheel of large diameter, giving a ratio of 1 : 40. This device, as also the gear box, rotates in an oil-bath.

The *fan*, located in the rear of the lantern, provides a sufficiently strong current of air to enable 750 W lamps to be used without excessive heating. It draws in cold air through the film guide channel and through suitably spaced orifices. Immediately after passing over the lamp, the air is discharged outside the projector.

One *flexible coupling* serves to facilitate rapid dismounting of the head of the apparatus comprising the optical system for projection and in addition controls the claws for the film travel, besides counteracting any possible effects of jerk in the claws upon the driving shaft and hence upon the feeding drum's even motion.

The *two-wing shutter* rotates two revolutions for each change of picture, thus giving four eclipses for each picture.

The *claws* operate without any springs, so that there is nothing to get out of order.

The claw device moves the film forward at the rate of 24 frames/s with a motor speed of 2 880 r/m.

Continous lubrication of all rapidly moving parts is ensured by oil-soaked felt packings at suitable points, these also serving to absorb the vibrations in the metal due to the jerky movements.

Projector Part

The projector for the pictures comprises: a concave reflector, a grid filament, a lamp condenser and a set of lenses with 35, 40, 60, 65, 70, 80 and 120 mm focuses, which can be readily interchanged according to the distance of the projection and the size of the screen to be covered.

The reflector and the condenser are fitted definitely at the factory, and require no subsequent adjustment.

The lamp, of 500 or 700 W, is held in the lamp-holder by a bayonet-fitting with unequal wings, which prevents all error in insertion. The movable lamp-holder, of moulded bakelite, is connected with the stationary terminals for current feed by plugs ensuring perfect contact, a definite and unmistakable placing and great facility in the removal and insertion of the lamp. Bakelite being a bad conductor of heat, this lamp-holder may be handled while the apparatus is in operation or immediately after stopping without any risk of burning.

The system for sound reproduction is based upon the projection of a mechanical slit which is reduced by optical means. The system is composed of the following parts: an 8 V, 32 W exciting valve, a condenser, a mechanical slit of 0.03 mm width, a lens and a photo-electric cell.

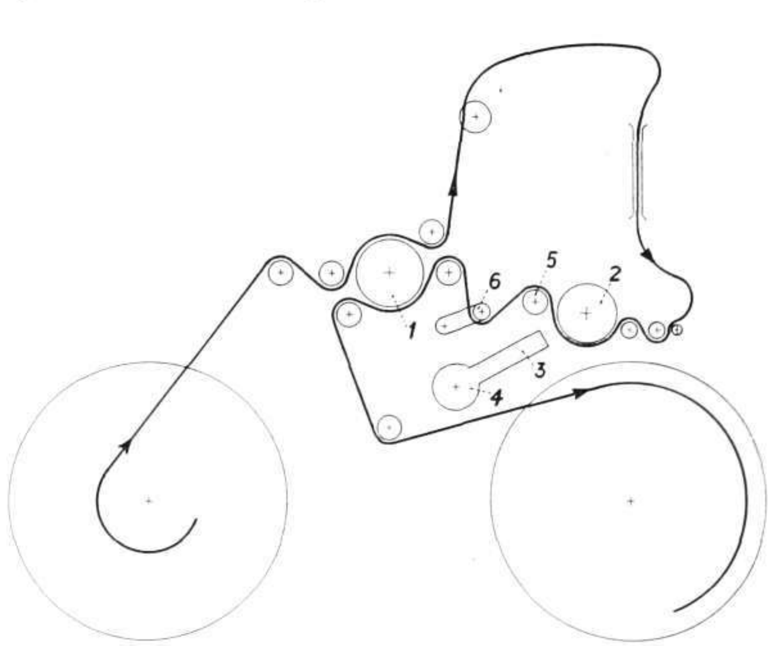


Fig. 3 X 5594

Diagram of the film's progress through the projector

1 feed wheel
2 photo-electric cell
3 lens for sound reproduction
4 lamp for sound reproduction
5 wheel to take up jerks
6 damping spring

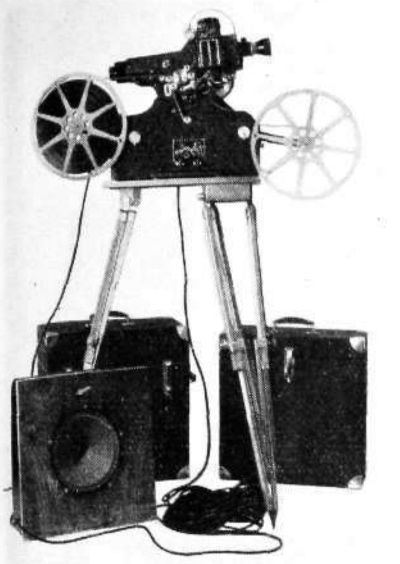


Fig. 4 X 3951
Projector with 600 m film reel
with loud-speaker and transport cases

In the same way as for the sound projection, the optical system provides for the interchanging of the exciting valves without making any adjustment. The caesium cell employed has a great sensitiveness at all feeding voltages varying from 100 to 130 V thus allowing a wide margin in the regulating of the power. The cell-holder is suspended in an entirely flexible manner, and has no mechanical connection whatever with the body.

After leaving the projection guideway the film's motion is jerky from the pull of the claws. For the reproduction of the sound, however, a perfectly even travel is absolutely necessary. To ensure this evenness, the film, after leaving the aperture, makes a loop before entering the guideway for the reproduction. This guideway is circular and consists of a stationary ring located on the same side as the margin record and of a drum rotated by the film. The film then passes over a rubber roller provided with a free flywheel and mounted in ball bearings. The inertia of the flywheel serves to steady the speed of travel of the film. Finally, a compensating roller actuated by a damped spring, stretches the film between the flywheel roller and the feeding drum. This compensating device takes up any differences which may exist in the perforations, the splices or other defects of the film.

Base

On this base are assembled all the controls: the plug box, motor switch, valve switch, knob for regulating the friction of the unwinding reel, switch for lighting the amplifier and switch for regulating the power.

The base also holds the two reel supports. Each reel support is provided with a friction device. The friction device for the winding reel serves to take up the differences of speed between the belt drive which is constant and the reel which varies according to the amount of unwound film. The normal apparatus is adapted to receive reels having 350 m of film. However, it can easily be supplied with longer reel supports which will receive reels for 600 m of film.

The amplifier, of 65 W, is located in the base. It is mounted on a rubber bed in order to prevent vibration which might cause disturbing noise. By means of a potentiometer the sound can be regulated according to the acoustics of the premises and the sound quality of the film. The volume of sound can be regulated according to the size of the premises.

An electro-dynamic loud-speaker, Fig. 4, 28 cm diameter, mounted on a 70×70 cm baffle (for permanent installation) or 50×50 cm baffle (for portable apparatus), owing to its size, permits of the diffusing without saturation of the power transmitted by the two valves of the push-pull stage.

A special plug-terminal is used for the connection of a pick-up or a microphone. The acoustic degree is also regulated by the potentiometer used for the sound volume. An extra loud-speaker may also be connected to the projector to permit a better distribution of sound in big localities.

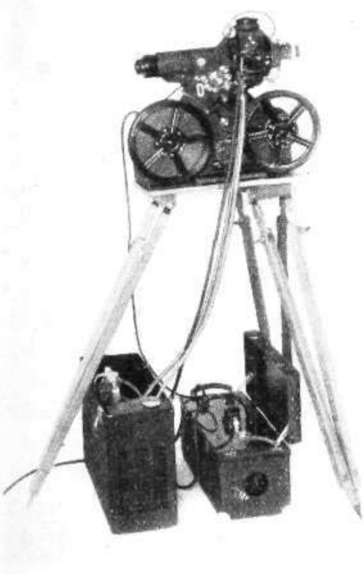


Fig. 5 X 3953
Projector with mercury lamp
with cooling unit and distribution box

Projector with Mercury Lamp

The Ericsson 16 mm projector has been designed for employment in schools and consequently is intended for display in comparatively small premises. However, in view of its rigid construction and good sound reproduction it has also been utilised in larger places. The filament lamp with which the projector is normally equipped certainly gives a well lighted image 4 m wide at 25 m distance, but does not provide sufficient light for larger premises. It has therefore been found necessary in the event of such employment to provide the projector with a stronger source of light.

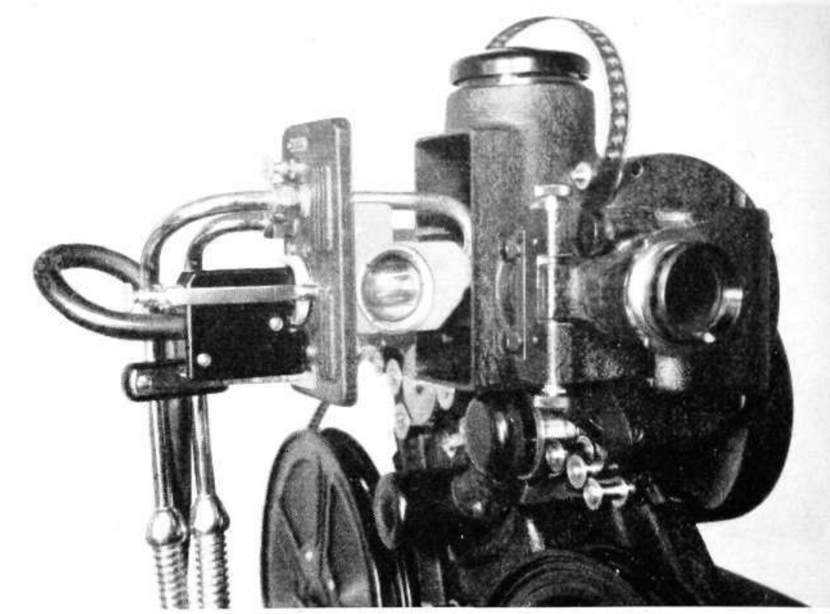


Fig. 6 X 5585
Mercury lamp and holder
with connections to cooling unit and distribution box

The arc lamp, on account of the heat it develops, which very soon injures the film, as also because of the risk of fire, is not so suitable for this purpose and Ericsson therefore uses for the large projectors a water-cooled high-pressure mercury vapour lamp as source of light. With such a lamp it is possible to have a well illuminated image 6 m wide at a distance of 40 m.

An apparatus of this type was exhibited in March 1938 at the Paris Film Exhibition and in November the same year was tested at the Central Testing Institute at Paris, being approved for employment even without projector cabin, which constitutes good evidence of its good safety qualities.

This projector, Fig. 5, the total current consumption of which is 9 A, is very similar to the projector with filament lamp, with some small modification in the optical equipment. The equipment necessary for the mercury light is placed on the floor beneath the projector and consists of a distribution box, a cooling unit and a mercury lamp.

The *distribution box* consists of a special transformer for feeding the lamp and an autotransformer for 90—250 V AC, 50 c/s. There are knobs on the distribution box for regulating the pump and the lamp and also a pilot lamp for distance control of the water circulation.

The *cooling unit* comprises a motor, a fan, a radiator and an automatic switch which cuts off the current to the lamp if the water circulation should be interrupted for any reason: this eliminates the main cause of fault in the lamp. The cooling water circulates in a closed system.

The *mercury lamp* is fitted in a lamp-holder which is inserted in the lamp house from the side, see Fig. 6. It is connected with the cooling unit by means of a flexible armoured hose for water circulation and with the distribution box by a rubber-insulated cable for current feed to the lamp. The mercury lamp has a current consumption of 550 W and a light density of 33 000 Hefner units/cm^2.

The two types of the Ericsson projector: with filament lamp and with mercury lamp, make it possible to utilise the projector in either the smallest or the largest localities. Moreover, packed in its two cases it is convenient of transport and it combines low current consumption with great safety of operation — the 16 mm film is non-inflammable — and is thus exceedingly well adapted for ambulating exhibitions, *e.g.*, for publicity films.

New General Catalogue

A new general catalogue nr 612 to replace catalogue 188 issued earlier will be published shortly. In the main it covers the same material as was included in the earlier catalogues, but it has been enlarged and made more complete. In the case of material which has received the new three-letter designations these have been inserted and a complete index of old and new designations has been added.

The new catalogue is distinguished from the former ones by the arrangement of the text in a single column with a wide margin at the left for illustrations, this greatly facilitating reference. The catalogue is divided into four main sections: telephony, telesignalling, line material and electricity meters.

A modification has been carried out in the telephony section. The three main groups, headed galvanic telephone installations, local battery plants and central battery plants, have been distributed in two main divisions. The first comprises telephone switchboards and instruments for public networks while the other deals with material for private systems. PB exchanges take up an intermediate position, these being designed to link traffic between an intercom telephone plant and the public telephone system.

The first division gives information regarding manual and automatic telephone exchanges, party systems and selective-calling systems, material for long distance telephony and telephone instruments on the LB and CB systems, the latter instruments including those with dials. The other division contains instruments for domestic telephones, self-selective, manual and automatic intercom telephone plants, manger's telephones and ship's telephones.

The telesignalling section is divided into the following sub-divisions: alarm installations, signalling plants, signalling devices, works control and special equipments. A newcomer among alarm installations is the material for air-raid warning. The works control sub-division comprises apparatus for control of staff and control of machinery, as also period control instruments.

The section for net material has been supplemented by some new items. Finally the electricity meters section has been enlarged by the addition of some new types and connecting diagrams for the meters have been added.

Ericsson Technics

Ericsson Technics No 3, 1939

T. Laurent: New Principles for Practical Computation of Filter Attenuations by Means of Frequency Transformations

In Ericsson Technics No 4, 1937, there has been demonstrated the possibility of systematically shaping by means of frequency transformations the image attenuation curve in a filter without dissipation to agree with certain arbitrary requirements. While the effective attenuation in a realizable filter is mainly made up of the non-dissipation attenuation, yet at the same time account must be taken of the additional attenuation due to dissipation in coils and condensers, of the winding and earth capacitances and of the reflections at the input and output terminals. The present paper will demonstrate how this may be conveniently carried out in conjunction with the shaping of the image attenuation curve on the above method. Determination of the attenuation due to dissipation is then done with a special graphic complex frequency transformation, allowance for winding and earth capacitances being made by the introduction of an extra frequency transformation with indirect *bn* function. With normal matching, the reflection attenuation in the pass band may be neglected and by a fortunate circumstance it is possible in simple manner to allow for the reflection attenuation in the stop band when the attenuation is transformed in the negative imaginary frequency range.

The Ericsson Group

Associated Enterprises

EUROPE

Danmark L. M. Ericsson A/S	*København K*, Studiestræde 24
Deutschland Ericsson Verkaufsgesellschaft m. b. H.	*Berlin W 35*, Tirpitzufer 60—62
Prchal, Ericsson & spol.	*Praha I*, Malé náměstí 1
Eesti Tartu Telefonivabrik A/S	*Tartu*, Puiestee 9—11
España Cía Española Ericsson, S. A.	*Madrid*, Marqués de Cubas 12
France Société des Téléphones Ericsson	*Paris XX*, rue Villiers-de-l'Isle Adam 111
Great Britain Ericsson Telephones Ltd	*London WC 2*, Lincoln's Inn Fields 22
The British Automatic Totalisator Ltd	*London WC 2*, Kingsway 56
Electric Totalisators Ltd	*London WC 2*, Kingsway 56
Production Control (Ericsson) Ltd	*London WC 2*, Lincoln's Inn Fields 22
Italia Società Elettro Telefonica Meridionale	*Milano*, corso del Littorio 3
»SIELTE«, Società Impianti Elettrici e Telefonici Sistema Ericsson	*Roma*, via Appia Nuova 572; C. P. 24 (Appio)
»FATME«, Fabbrica Apparecchi Telefonici e Materiale Elettrico Brevetti Ericsson	*Roma*, via Appia Nuova 572; C. P. 25
Società Esercizi Telefonici	*Napoli*, Palazzo Telefoni, piazza Nolana; C. P. 274
Società Urbana Immobiliare	*Napoli*, Palazzo Telefoni, piazza Nolana; C. P. 274
Jugoslavija Jugoslovenski Ericsson A. D.	*Beograd*, Knez Mihajlova 9; P. F. 726
Nederland Ericsson Telefoon-Maatschappij N. V.	*Rijen (N. Br.)*
Norge A/S Elektrisk Bureau	*Oslo*, Middelthunsgate 17; P. B. MJ 2214
Polska Ericsson Polska A. S. Elektryczna	*Warszawa*, aleja Ujazdowska 47
Polska Akcyjna Spółka Telefoniczna	*Warszawa*, Piusa XI, 19
România Ericsson S. A. Română	*București I*, Splaiul Unirii 13
Suomi O/Y L. M. Ericsson A/B	*Helsinki*, Fabianinkatu 6
Sverige Telefonaktiebolaget L. M. Ericsson	*Stockholm*, **Döbelnsgatan 18**
Svenska Radioaktiebolaget	*Stockholm*, **Alströmergatan 12**
Sieverts Kabelverk	*Sundbyberg*
Aktiebolaget Alpha	*Sundbyberg*
Svenska Elektromekaniska Industriaktiebolaget	*Hälsingborg*, **Rönnovsgatan 18**
L. M. Ericssons Försäljningsaktiebolag	*Stockholm*, **Kungsgatan 33**
L. M. Ericssons Signalaktiebolag	*Stockholm*, **Sveavägen 90**
Fastighetsaktiebolaget L. M. Ericsson	*Stockholm*, **Kungsgatan 33**

ASIA

British India Ericsson Telephones Ltd	*Calcutta*, **Victoria House, P. O. Box 2324**
Nederlandsch Indië Ericsson Telefoon-Maatschappij N. V.	*Bandoeng*, **Tamblongweg 11**

AMERICA

Argentina Cía Sudamericana de Teléfonos L. M. Ericsson S. A.	*Buenos Aires*, **Moreno 986**
Corp. Sudamericana de Teléfonos y Telégrafos S. A.	*Buenos Aires*, **Bernardo de Irigoyen 330**
Cía Argentina de Teléfonos S. A.	*Buenos Aires*, **Bernardo de Irigoyen 330**
Cía Entrerriana de Teléfonos S. A.	*Buenos Aires*, **Bernardo de Irigoyen 330**
Brasil Sociedade Ericsson do Brasil, Ltda	*Rio de Janeiro*, **rua General Camara 58**
México Empresa de Teléfonos Ericsson S. A.	*México, D. F.*, 2:a Victoria 53/61; apartado 1396
Cía Comercial Ericsson, S. A.	*México, D. F.*, Articulo 123, No 10
Cía de Teléfonos y Bienes Raíces	*México, D. F.*, 2:a calle Victoria 53/61; apartado 1396
Uruguay Cía Sudamericana de Teléfonos L. M. Ericsson S. A.	*Montevideo*, **rio Branco 1381**

AUSTRALIA & OCEANIA

Australia Ericsson Telephone Mfg Co.	*Sydney*, **Reliance House, Clarence Street 139; G. P. O. B. 2554 E**

Agencies

EUROPE

Belgique "SOTCO", The Swedish Occidental Trading Co.	*Bruxelles*, rue van Orley 14
Bulgarie Chichkoff & Kostoff	*Sofia*, Denkoglou 36
Eire E. C. Handcock	*Dublin C5*, Handcock House, Fleet Street 17
España Sobrinos de R. Prado, S. L.	*Madrid*, Príncipe 12
Grèce C. Missaelidis	*Athènes*, Lefcossias 12
Latvija W. Endel	*Riga*, Doma laukums 7; P. K. 86
Lietuva Th. Witte	*Kaunas*, Sporto gatvė 2
Portugal Sociedade Herrmann Ltda	*Lisboa*, Calçada do Lavra 6

ASIA

China The Ekman Foreign Agencies Ltd	*Shanghai*, Hamilton House, Kiangse Road 170; P. B. 1503
The Swedish Trading Co. Ltd	*Hongkong*, China Building, Queen's Road Central 31 a
Manchukuo A. Mauer	*Dairen (South Manchuria)*, P. O. B. 138
Palestine Jos. Muller	*Haifa*, Kingsway 49; P. O. B. 243
Iran Irano Swedish Company A. B.	*Teheran*, Khiabane Pahlevi Koutcheh Dr Malek Zadeh
Philippines Elmac Inc., Electrical & Machinery Co.	*Manila*, Rizal Avenue 627; P. O. B. 625
Saudi Arabia Mohamed Fazil Abdulla Arab	*Jeddah*
Siam The Borneo Co., Ltd	*Bangkok*, Ban Tawai, New Road
Syrie C. A. Loïsides	*Beyrouth*, place de l'Étoile; B. P. 931

AFRICA

Égypte Swedish Industries	*le Caire*, **rue El Maghraby 25 B. P. 1722**
Moçambique J. Martins Marques Ltda Sucr	*Lourenço Marques*, **rua da Electricidade 9; C. P. 166**
Southern Rhodesia Rogers-Jenkins & Co. (Pty), Ltd	*Bulawayo*, **Fort Street 124; P. O. B. 355**
Union of South Africa Rogers-Jenkins & Co. (Pty), Ltd	*Johannesburg*, **Marshall and Nugget Streets; P. O. B. 654**

AMERICA

Bolivia Cía S K F de Bolivia	*la Paz*, **avenida Montes 642 cas. 678**
Chile Flaten, Royem, Anker y Cía, Ltda	*Santiago*, **Morandé 230; cas. 2168**
Colombia Telefonaktiebolaget L.M. Ericsson	*Medellín*, **calle 49, 51-21; apartado 6**
Ecuador Ivan Bohman y Cía	*Guayaquil*, **Boulevard 211; cas. 1317**
Peru Neisser y Cía	*Lima*, **Mercaderes 432; cas. 597**
United States of America Sven T. Aberg	*New York (NY)*, **420 Lexington Ave**
Intercommunications, Inc.	*New York (NY)*, **Graybar Building**
Venezuela Cía Escandinava Centrum, Gibson & Halvorssen	*Caracas*, **apartado 808**

AUSTRALIA & OCEANIA

New Zealand B. L. Donne	*Wellington*, **Australasia Bank Chambers, Customhouse Quay**