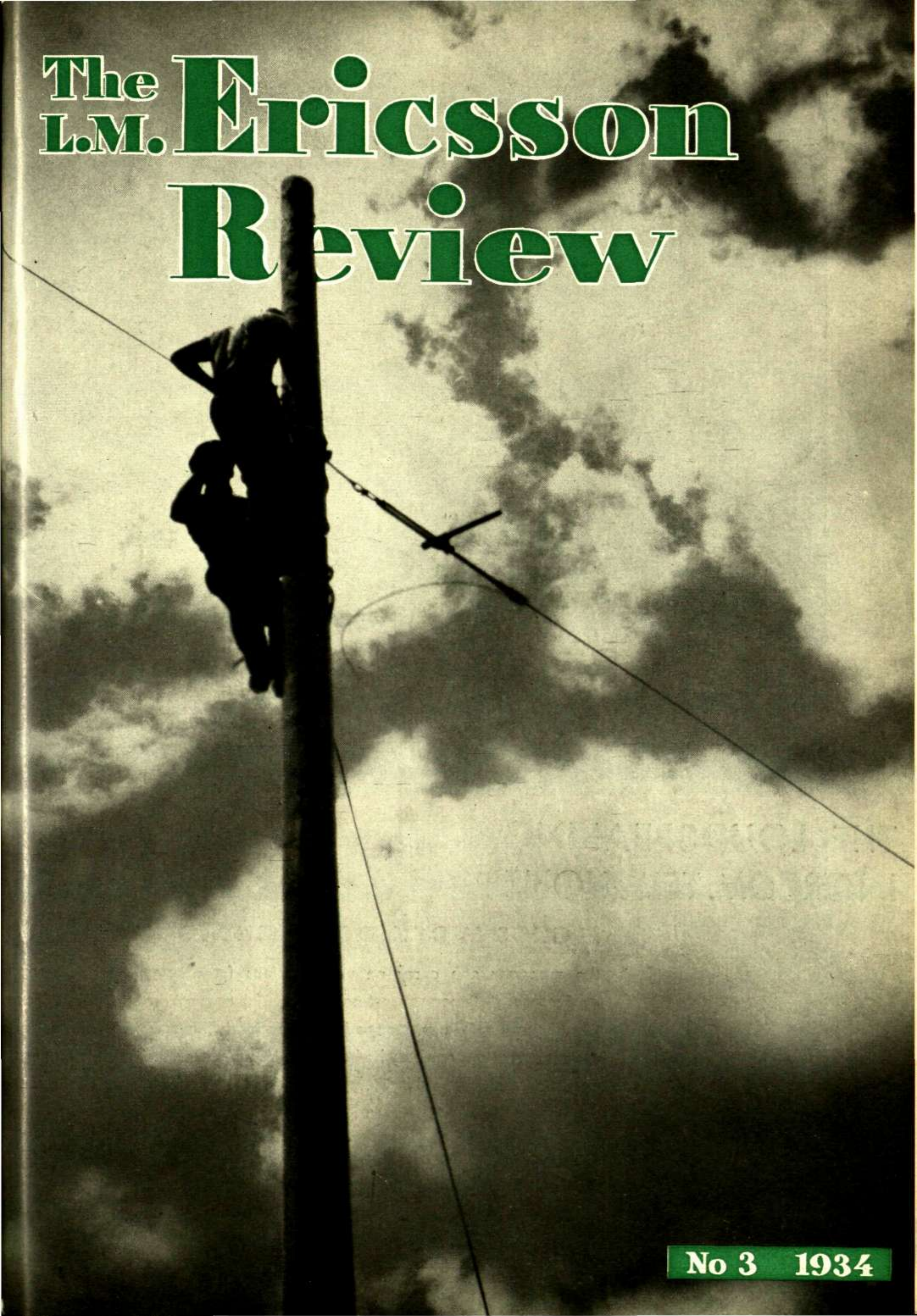
The L.M. Ericsson Review



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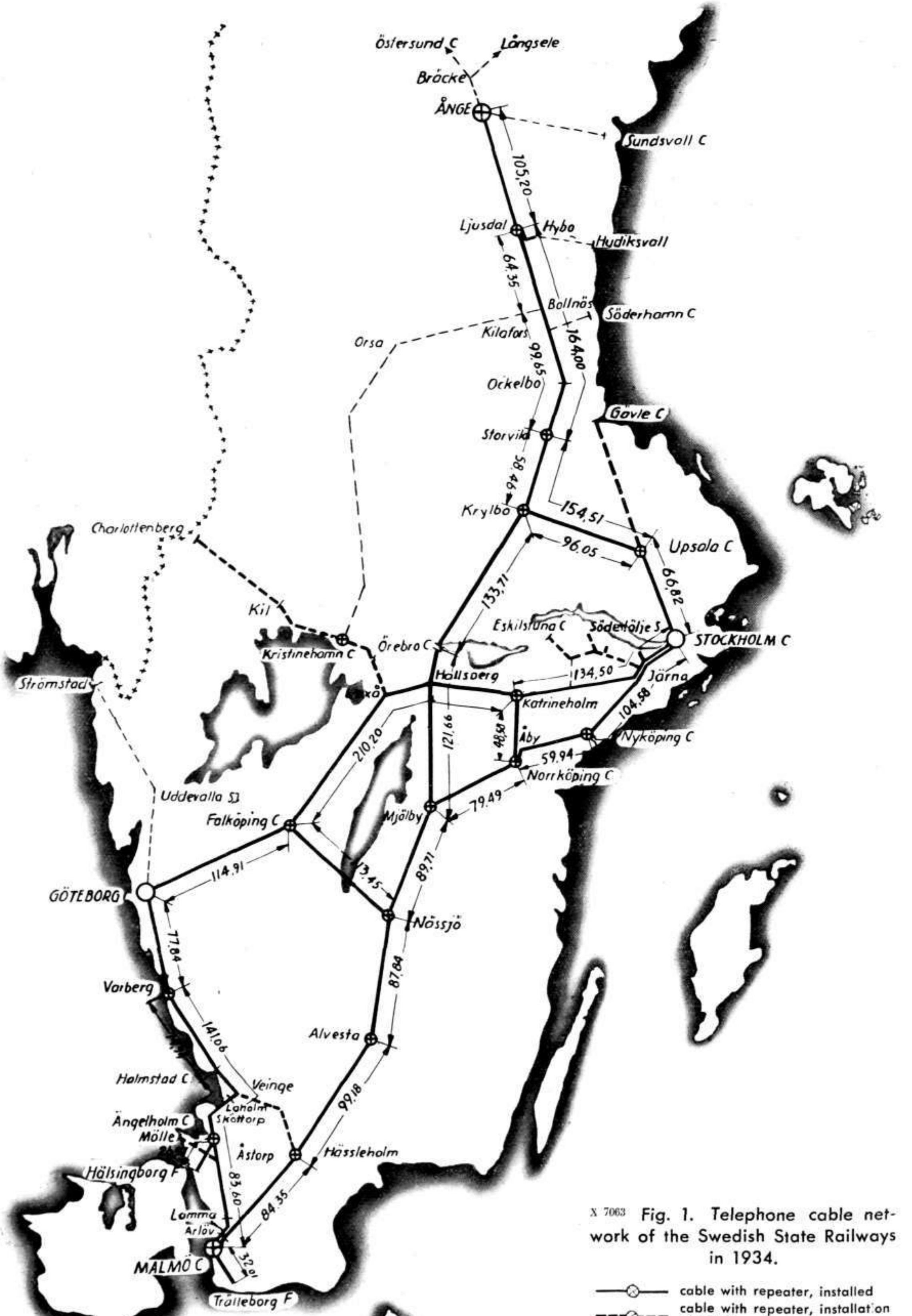


X 7063 Fig. 1. Telephone cable network of the Swedish State Railways in 1934.

THE TELEPHONE CABLE NETWORK ON THE NORTH AND WEST LINES OF THE SWEDISH STATE RAILWAYS

By I. BILLING,
administrative director,
Swedish State Railways,
Stockholm.

With the continued electrification of the Swedish State Railways the major part of the telephone cable installations of the North and West lines has now been completed.[1]
The main cables for these installations have been supplied by Sieverts Kabelverk, while local and distribution cables have been manufactured by the Ericsson Cable Works at Älvsjö. Loading-coil cases and all installation material has been supplied by Ericsson, Stockholm, who have also carried out the installation work.
The installations are described in this article, reprinted by courtesy of »Nordisk Järnbanetidskrift», June 1934.

X 1349 Fig. 2. Booster transformer, mounted on trolley pole.

On the electrification of new lines it has been considered necessary to provide telephone cables for the lines of the railway; this was also done on the Gothenburg and Malmö Lines previously electrified. Investigation showed it to be advisable to lay a common cable from Stockholm to Ånge for the railway and certain lines belonging to the Royal Board of Telegraphs, instead of moving the latter lines to a distance, *i. e.*, at least 200 m from the railway, as was done in other cases. For the Örebro—Krylbo and the West Lines on the other hand it did not seem advisable to use common cables, on the former line because of the position of the railway in relation to towns and other big places, and on the West Lines because the need of a very great number of lines for the commercial telephone service did not permit the construction of a suitable common cable to be placed along and immediately beside the railway. In these cases therefore the overhead lines of the Royal Board of Telegraphs were moved away from the railway.[2]

Power Supply for Electric Traction.

As on the Gothenburg and Malmö lines, the power supply on the lines now dealt with will be by means of three-phase current from the power stations of existing general power distribution undertakings. The three-phase power is fed to the converter stations of the State Railways at 6 300 V, 50 c/s, and from there it is fed direct to the trolley-wire system as single-phase current of 16 kV, 16 $^2/_3$ c/s. For the power transmission

[1] The »North Lines» are the sections Stockholm—Krylbo—Ånge and Örebro—Krylbo, while the »West Lines» are the sections Gothenburg—Ängelholm—Lomma—Malmö and Hälsingborg—Ängelholm.

[2] The previous'y completed telephone-cable installations on the Malmö and Gothenburg Lines of the Swedish State Railways were described in Siemens Zeitschrift 1926, Electrical Communication 1926, ENT 1926, Elektrische Bahnen Ergänzungsheft 1928, Ericsson Review 1932, Siemens Zeitschrift 1932 etc.

to motors and lighting along the line in stations and line-mens' houses there is a 10 kV, 50 c/s, line at the top of the catenary poles. For the North Lines converter stations have been built at Upsala, Krylbo, Ockelbo, Ljusdal and Ånge, and in addition an existing converter station at Hallsberg supplies part of the power for the Örebro—Krylbo line. The power for the West Lines is to be supplied by two new converter stations at Laholm and Varberg, while the existing converter stations at Malmö and Alingsås will supplement the current supply.

The trolley wire system is composed of a trolley wire with a cross-section of 80 mm², suspended on a catenary wire of 50 mm². The distance between the poles is about 60 m; these poles also support a return wire with a cross-section of 130 mm². The lighting line at the top of the poles is of 30 mm² wire. All these lines are of copper. To avoid disturbance on telephone and telegraph lines booster transformers are inserted in the trolley and return circuits. The booster transformers are placed on the poles at a distance of about 5 km from each other, see Fig. 2. Half way between two adjoining booster transformers the return wire is connected to the rails. On the other hand there are no copper connections between adjoining rail ends.

Disturbance from the Electric Traction on Telephone and Telegraph Circuits.

As is known these disturbances are caused by the AC induced, partly by static influence from the trolley voltage and partly electro-magnetically by the current in the trolley wire. The static induction is completely avoided by the use of underground cables for the telephone circuits.

The electro-magnetic induction, which is usually measured in volts/100 ampère-kilometers (the current in the trolley wire × its length along the telephone circuits), is reduced to permissible values in various ways. By having the overhead at a suitable distance from the railway and using booster transformers in the trolley circuit, the electro-magnetical induction may be kept within desired limits. On the Polar Line Svartön—Kiruna—Riksgränsen an induced tension of 8—10 V/Akm, representing about 800—1 000 V, was measured on the original overhead telephone lines which were 15 m distant from the railway; this tension was dangerous and made telephone and telegraph traffic impossible. By moving the overhead lines to about 50 m from the railway and introducing booster transformers in the trolley circuit and the track (track transformers) and the provision of rail connections of copper, the tension was reduced to 0.2 V/Akm with the feeding points (transformer stations) 30—40 km apart. On this line this corresponds to an induced tension of about 20 V, and telephones and telegraphs could function satisfactorily, after insulated double lines had been provided for the telegraphs as well.

If the overhead lines are replaced by underground telephone cables immediately beside the railway and a separate return wire is used for the booster transformers instead of using the rails as return, the induced tension will be about 0.15 V/Akm, which was easily attained on the Stockholm—Gothenburg line. In this case no rail connections are necessary. However, the induced tension was reduced still more by placing the return wire, so that the total induction from the trolley and return wires on the cable circuits and the rails approached a minimum. By this arrangement the tension was reduced to 0.05 V/Akm, and by accurate adjustment of the return wire's position it could be reduced to as little as 0.02 V/Akm. Such an accurate adjustment was as a rule never necessary, but it was considered sufficient to reduce the tension to 10—18 V induced at a load of 20 000 Akm under normal conditions and 47 V as a maximum on short-circuits.

The results obtained in this manner made it possible, among other things, to increase the distance between the feeding points (transformer stations) considerably. On the Polar Line this distance was on the average only 35 km. On the Gothenburg Line the distance varies between 80 and 128 km, on the main Malmö Line 60—135 km, with 95—169 km on the branch lines, on the main North Line 95—123 km, with 156 km on the branch lines, and on the West Line 98—123 km. On account of this the separate high-tension line, as built along the Polar Line, has been rendered unnecessry on the other lines, these lines being fed from the three-phase systems of the State and certain private enterprises which carry out general power distribution to industry.

The distance between two adjoining booster transformers, which on the Gothenburg line is

1.4 km near the converter stations and 2.8 km elsewhere, has, following the experience gained, been increased to about 5 km on the more recently built Malmö, North and West Lines.

Types and Design of the Cables.

In view of the fact that a common cable for the State Railways and the Royal Board of Telegraps is used on the Stockholm—Ånge line, which is not the case on the other lines, different types of cables have been employed. The following types have been employed:

on the *North Lines*

Type I, Stockholm—Upsala,
$12 \times 4 \times 1.1 + 17 \times 4 \times 0.9$, which corresponds to 58 pairs with 19 phantom circuits;

Type II A, Upsala—Kilafors and Ljusdal—Ånge,
$7 \times 4 \times 1.3 + 2 \times 2 \times 1.3 + 11 \times 4 \times 0.9$, which corresponds to 38 pairs with 10 phantom circuits;

Type II B, Kilafors—Bollnäs—Ljusdal,
$7 \times 4 \times 1.3 + 4 \times 2 \times 1.3 + 12 \times 4 \times 0.9$, which corresponds to 42 pairs with 11 and 12 phantom circuits respectively;

Type III, Örebro—Krylbo,
$3 \times 4 \times 1.3 + 2 \times 2 \times 1.3 + 9 \times 4 \times 0.9$, which corresponds to 26 pairs with 2 phantom circuits;

Type IV, Ljusdal—Hybo,
local cable $14 \times 2 \times 0.9$, 14 pairs;

(on the Stockholm—Ånge line two phantom circuits in the quads of greater diameter are utilized for a four-wire circuit for long-distance traffic)

on the *West Line*

Type V. 1, Hälsingborg—Ängelholm,
$1 \times 4 \times 1.3 + 8 \times 2 \times 1.3 + 13 \times 4 \times 0.9$, which corresponds to 36 pairs with 3 phantom circuits;

Type V. 2, Gothenburg—Ängelholm—Lomma,
$3 \times 4 \times 1.3 + 4 \times 2 \times 1.3 + 8 \times 4 \times 0.9$, which corresponds to 26 pairs with 3 phantom circuits;

Table 1. Electric Properties of the Cables (Measured on Completed Lengths in the Cable Works).

	fixed require-ments	measured mean values				
		North Lines			West Lines	
		Type I	Type II A	Type III	Type I	Type II
Line resistance at + 15° C, ohm/km, max.						
conductors 1.3 mm	13.2	—	12.40	12.38	12.41	12.42
1.1 mm	18.5	17.42	—	—	—	—
0.9 mm	27.5	26.4	26.4	26.4	26.5	26.3
Difference of resistance for the conductors of a pair in relation to the mean value of their resistance, %,						
maximum value	3	0.4	0.4	0.4	0.4	0.4
mean value	1	0.1	0.1	0.1	0.1	0.1
Insulation resistance at 100 V DC, megohm/km, min.	10 000	30 000	30 000	30 000	30 000	30 000
Capacity at 800 c/s, μF/km						
pairs 1.3 mm max.	0.040	—	0.0331	0.0328	0.0333	0.0329
mean	0.036	—	0.0325	0.0322	0.0325	0.0324
1.1 mm max.	0.040	0.0323	—	—	—	—
mean	0.036	0.0318	—	—	—	—
0.9 mm max.	0.036	0.0292	0.0283	0.0289	0.0287	0.0295
mean	0.033	0.0287	0.0277	0.0283	0.0281	0.0290
Capacity unbalance for cable lengths of about 275 m, $\mu\mu$F, max.						
pairs: between adjoining pairs, mean value	75	—	—	—	11	—
between arbitrary pairs, mean value	150	—	—	—	33	—
quads: side to side in one quad	175	25	16	14	26	19
side to phantom in one quad	450	114	87	85	80	90
side to side, side to phantom and phantom to phantom in adjoining quads	300	48	40	25	56	26
side circuit to earth	600	170	155	160	175	178
Leakance coefficient at 800 c/s, max.	0.005	0.0034	0.0036	0.0032	0.0038	0.0034

(on the Lomma—Arlöv line a $4 \times 2 \times 0.9$ local cable has been provided in addition to the 22-pair cable which had been installed previously between Malmö and Lomma on the Malmö Lines).

As these cables are laid immediately beside electric raliways, 1.9 m from the middle of the nearest track, the previous requirements in respect of dielectric strength, 1 000 V between the conductors and 2 000 V to the cable sheath, have been applied in this case. The test voltage for quads, in which it is intended to connect earth-connected telegraph circuits when necessary, has been determined at 2 000 V to other circuits.

The detailed technical prescriptions for the manufacture of the cables and the figures taken in the cable works, are chiefly indicated in Table 1.

In addition it might be mentioned that the insulation consists of wood-pulp paper and that the lead sheath is 2 mm thick on the main cables but only 1.5 mm on the local cables. The tightness of the lead sheath has been tested at the cable works under a pressure of 2 atmospheres for 2 hours. The armouring consists of two tape-irons each 1 mm thick. Submarine cables at pivot-bridges are protected by an additional armouring of 5 mm round iron wire.

The cables have been supplied in lengths of about 275 m, for the North Lines ranging from 260.5 to 275 mm, and for the West Lines from 276 and to 279 m, according to the loading coil sections fixed, each of which contains eight cable lengths.

X 1350 **Fig. 3. Loading-coil case containing 38 coils.**
The main cable is connected to the coil cable in the splicing box at the top.

Loading.

The length of the loading coil sections, which had been fixed at 2 200 m, varies for different repeater sections. The lengths of the loading coil sections on the various lines have been fixed after check measurement of the length of the line, special attention being paid to the requirement of a half loading coil section at the end of a repeater section.

As regards the inductance of the loading coils, it should be mentioned that for direct lines which usually operate with repeaters the loading has been made with 160 mH in side circuits and 63 mH in phantom circuits, while pairs of all dimensions have been loaded with 177 mH. On the Stockholm—Ånge line one four-wire circuit has been arranged on two phantom circuits. The two quads used for this purpose have been loaded with 160/40 mH. The existing quads with 0.9 mm wires have been loaded with 177/63 mH and so have the quads of 1.1 and 1.3 mm wires which are used by the Board of Telegraphs on the Stockholm—Upsala—Ånge line.

The loading-coil cases are illustrated in Fig. 3, which shows a case containing 38 coils for a cable, Type II A, on the North Lines. The case has an overall height of 946 mm and a base of 526×384 mm; the weight is about 350 kg. As may be seen from the illustration the loading-coil case is of such a design that the main cable is connected direct in the splicing box on top of the case; in this box the connecting cable from the loading coils terminates, and, consequently there is no stub cable.

In the technical prescriptions for the cable installations the electric properties of the loading coils have been specified. The most important requirements are given in Table 2, which also shows some of the figures obtained on test in the cable works of Telefonaktiebolaget L. M. Ericsson. At the prescribed 2 minute tests for endurance of the loading coils against puncture of insulation by AC of 50 c/s at 1 000 and 2 000 V between the windings of the coils and between the windings and the case there was no failure.

Table 2. Properties of Loading Coils (for the Cable Sections Stockholm—Upsala—Storvik and Örebro—Krylbo).

	fixed requirements	measured mean values
Insulation resistance measured with 100 V DC, megohm, min.	10 000	114 000
Self-inductance at 1 800 c/s, 1 mA, mH		
for side circuit coils	177	177.5
	160	159.7
for phantom-circuit coils	63	63.3
	40	39.9
Stability of self-inductance on magnetizing in one winding with DC, 0—2 A; change of inductance after 5 minutes, %, max.	1.0	0.79
Resistance to DC, ohm, max.		
coil group 177/63 mH, side circuit	10.5	9.02
phantom circuit	5.2	4.51
coil group 160/63 mH, side circuit	10.2	8.26
phantom circuit	5.1	4.14
coil group 160/40 mH, side circuit	10.0	6.77
phantom circuit	5.0	3.39
coil 177 mH	7.5	5.46
Resistance to AC of 800 c/s, 1 mA, ohm max.		
coil group 177/53 mH, side circuit	12.5	10.72
phantom circuit	6.0	5.06
coil group 160/63 mH, side circuit	12.2	9.71
phantom circuit	6.0	4.63
coil group 160/40 mH, side circuit	12.0	8.28
phantom circuit	6.0	3.74
coil 177 mH	9.0	7.17
Resistance to AC of 1 800 c/s, 1 mA, ohm, max.		
coil group 177/63 mH, side circuit	17.2	14.02
phantom circuit	8.7	6.07
coil group 160/63 mH, side circuit	16.9	12.66
phantom circuit	8.5	5.73
coil group 160/40 mH, side circuit	16.7	11.30
phantom circuit	8.3	4.50
coil 177 mH	13.6	10.21
Difference of resistance between the two conductors of the coil, ohm, max.		
in side circuits	0.10	0.011
in phantom circuits	0.15	0.016
Difference of inductance between the two conductors of the coils, %, max.		
in side circuits	0.10	0.028
in phantom circuits	0.15	0.051
Cross-talk attenuation between two speech circuits in one loading coil case at 800 c/s, 10 mA, neper, min.	10	12
Capacity unbalance to earth, measured at 800 c/s, $\mu\mu F$, max.		
in side circuits	100	7
in phantom circuits	100	24

Cable Laying.

As with the previous cable installations on the Gothenburg and Malmö Lines, the cable laying work on the North and West Lines has been carried out by the State Railways. In the main the same methods have been used as for the previous installations.

The cables have been laid at a distance of 1.9 m from the middle of the nearest track and 70 cm below the level of the rails. As a rule the cable has been laid so that on single-track lines the trolley poles and the cable are on the same side of the track, in order that the tension induced in the cable circuits may be the minimum. Only exceptionally is the cable laid on the side of the track opposite to the trolley poles, *e.g.*, in rock sections and at certain curves which have been straightened out in connection with the electrification, and in places where local conditions have made such an arrangement necessary. Along double-track lines the cable as a rule is on the side where the overhead lines of the railway have previously been, so that the commercial telephone lines on the other side of the track should not interfere with the erection of the trolley poles.

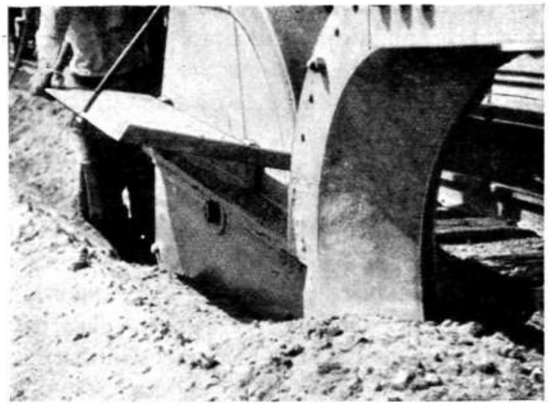
In addition to a large American excavator acquired for the work on the Gothenburg Line, the cleaning and cable-laying plough built in 1932 and employed on the Malmö line, has also been used; this plough is shown in detail in Fig. 4, and working on the simultaneous laying of main and local cables in Fig. 5.

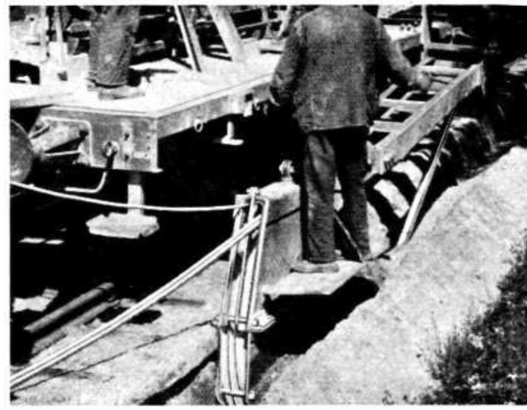
On account of the great number of station lines and the curves necessary at splicing boxes, loading-coil cases, distribution boxes, etc., the cable installed is considerably longer than the track. Extra length has also been caused by the necessity of laying certain additional lengths of cable so as to obtain an even half loading-coil section on either side of the repeater station. On the North Lines the installed cable is 624 244 m, while the railway is 615 980 m, which represents an increase of 1.37 %. On the West Lines the corresponding figures are 318 462 m and 314 614 m, representing an increase of 1.22 %.

The railway installation staff has been housed in trains of specially equipped old goods vans, which have been put in good condition and arranged as lodgings with four sleeping-berths to a van, each provided with wash-stands, wardrobes, heating and electric lighting. Kitchen vans were attached to the trains, Fig. 6, so that there was no difficulty in housing and feeding the staff.

A cable train with cable drums on jacks ready to start out for cable laying is illustrated in Fig. 7.

The laying of the cables had to be carried out at times which did not interfere with railway traffic. On account of this the periods during which the cable could be laid were very short, but nevertheless the speed of work was kept up to a





X 1351 Fig. 4 and 5. Plough during cleaning (left) and simultaneous cable laying (right). X 1352

high level. As an illustration it might be mentioned that during the installation work of 1933, carried on from May 3rd to December 14th, which corresponds to 179 working days, a total of 493.6 km cable was laid on the lines Örebro—Krylbo, Stockholm—Storvik, Arlöv—Ängelholm—Skottorp and Ängelholm—Hälsingborg; this represents an average of 2.8 km a day, or 16.6 km cable laid in a week, taking no account of local and signalling cables installed at the same time.

In 1934 work was commenced on March 5th at Skottorp and the remaining installation work on the West and North Lines, amounting to about 453 km, will probably be completed about December 1st 1934.

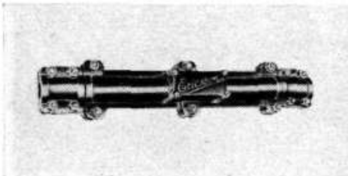
It should be observed that the lengths given above refer to the main cables of the State Railways, but that at the same time considerable lengths of other cables were laid including about 120 km local and distribution cables, considerable lengths of signalling cables, and in addition about 15 km cable between Stockholm and Häggvik for the Royal Board of Waterfalls. All these cables have as a rule been laid in the same conduit as the main cable.

Installation Work.

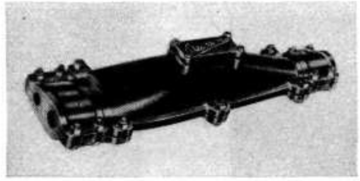
The installation work was carried out by Telefonaktiebolaget L. M. Ericsson, Stockholm, this being the first time work of this kind has been done by the Company for the State Railways. A few months before May 1933 when the work was to be started the firm arranged a school for splicers at Sieverts Kabelverk, Sundbyberg, where the installation staff received practical instruction; the tution consisted of all the details for perfect cable splices and tappings etc., the connection of condensers for the balancing of the circuits, connection of loading-coil cases, etc. The equalization of the capacity to earth and the line capacity has been carried out by means of additional condensers, which have been inserted partly

X 1353 Fig. 6. Lodging train.

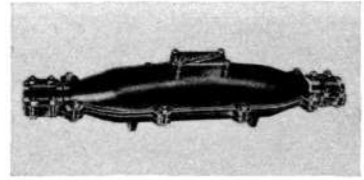
X 1354 Fig 7. Cable train.



X 3230 Fig. 8. Splicing box.



X 3231 Fig. 9. Distribution box.



X 3232 Fig 10. Condenser box.

in certain splicing boxes designed as condenser boxes, and partly in certain loading-coil cases.

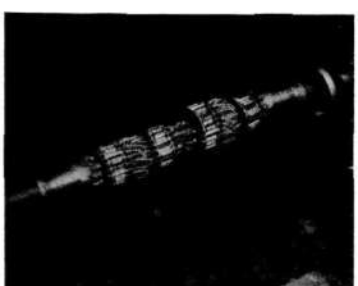
The types of splicing boxes, loading-coil cases and condenser boxes are illustrated in Fig. 8, 9 and 10. Several sizes of the type of loading-coil cases shown in Fig. 3 have been used depending on the number of loading coils. A few details of the fitting and design of the condenser boxes are illustrated in Fig. 11. Fig. 12 shows how the loading-coil cases are connected to the cable fitted with condensers, and, in addition, the tinned tombac box in the splicing box of the loading-coil case is shown after is has been soldered together.

Several means were used for drying the cable ends for the splicing and connecting to all kinds of boxes. In outdoor work, which was always carried out under the shelter of tents, soldering lamps with protective plates of various types were used. In addition electric hot-air fans of 800—1 000 W, of the same type as hairdressers' fans and supplying hot dry air at about 110° C, were employed.

At stations and other places where electric power was available this was made use of. At places where electric power was not available a transportable motor generator was used, consisting of an air-cooled petrol engine of 3 HP, 2 200 rpm, direct coupled to a DC generator, 1.5 kW at 110 V. Lighting current for the work was also supplied by this generator. The motor generator with a hot-air fan is illustrated in Fig. 13.

The terminal boxes used at the stations and for distribution and local cables are of a new design. After exhaustive investigation certain standard types were adopted. All types have uniform terminal blocks with 10 pairs of contact pins moulded into bakelite and a frame of tinned copper, see Fig. 14. These bakelite blocks are moulded in such a way as to fit air-tight to the contact pins and the frame.

The necessary number of such blocks corresponding to the size of the cable were then soldered to a common metal case of tinned tombac, so that the contact pins are accessible inside the metal case for the soldering of the cable conductors. The lead sheath of the cable is soldered direct to the metal case. There is no filling of the metal case with compound, but the paper insulation of the cable conductors and the space in the metal case are carefully dried, after which the cover of the metal case is carefully soldered to the back. The box completely fitted in this manner is then tested as to its tightness with a suitable pressure, about 0.5 atmospheres. On the front of the blocks the contact pins are fitted with screws for the connection of station circuits or interconnection with other boxes. The metal case of the box is screwed to a bracket of cast iron. The bracket plate has a slot with a packing against which the sheet-iron cover of the box fits tightly as it is held tight by means of excentric fasteners. Terminal boxes for 10-pair cables (see Fig. 14, right) are as a rule used is linemens' houses and for similar tappings. In places where the cable continues to a nearly telephone station on the line, or for local cables in station yards, terminal boxes are used, having two cable inlets



X 3233

X 3234

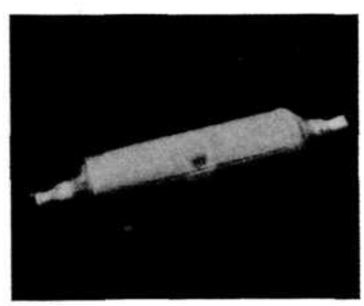


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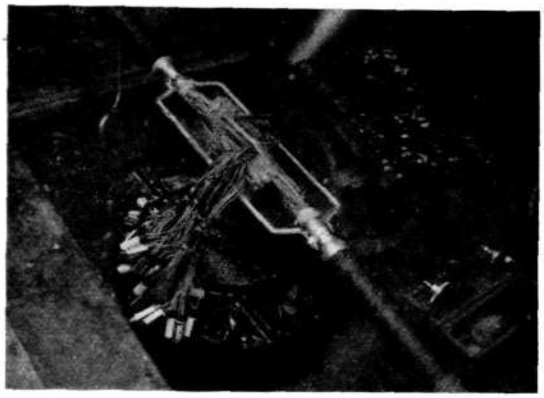
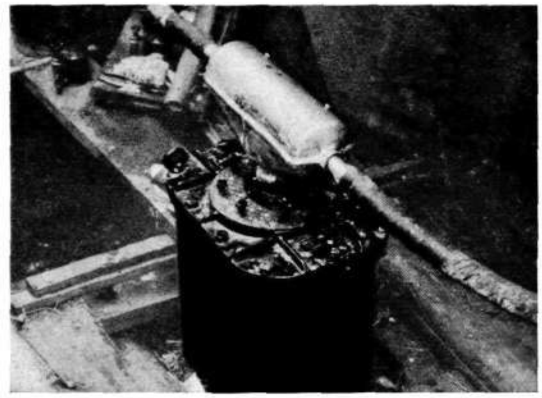
Fig. 11. Condenser box under mounting.





X 1355 Fig. 12. Loading-coil case under mounting. X 1356

on the same bracket and with two similar metal cases under a common cover.

In all stations the main cable has been cut off and taken into a station box with two cable inlets. The station boxes on these lines are made for cables of 2×30, 2×40, 2×50 and 2×60 pairs. The first-mentioned type is shown in Fig. 14.

Terminal boxes are made in the following types:

1×10, 1×20, 1×30, 1×40, 1×50 and 1×60 pairs,

2×10, 2×20, 2×30, 2×40, 2×50 and 2×60 pairs.

For connections between station boxes and local boxes tube connections with air-tight rubber packings are used. In a similar way the station circuits are taken out from the boxes by means of lead cables, which are screwed to the boxes with similar packings. All such connections have been made through holes in the bracket plate of the boxes.

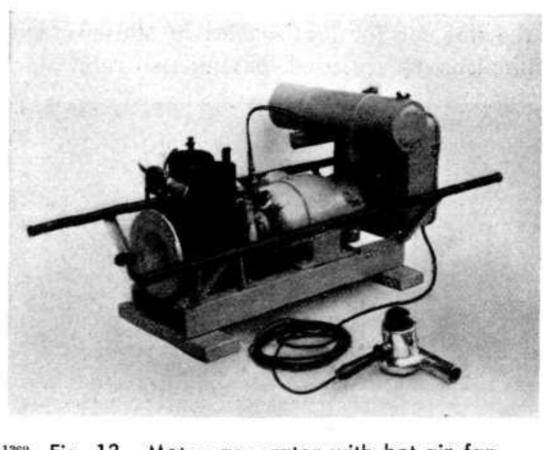
All station and terminal boxes have been built in a uniform manner, with equal projection from the wall and with covers of the same height. They can therefore be mounted alongside each other and screwed together so that interconnections and tappings can be made in a reliable and neat manner. As an example the cable boxes at the Upsala repeater station are shown in Fig. 15.

The numbers of station circuits and tappings on the main cables are rather great on account of the nature of the cable system. According to the contract about 90 station branches and 400 tappings have to be made on the North Lines, and about 68 station branches and 200 tappings on the West Lines, which corresponds to one station branch per 7 km on the former and one tapping per 4.7 km on the latter line, and an average of one tapping per 1.6 km installed cable on the two lines. The numbers of branches actually made will be 83 station branches and about 320 tappings on the North Lines, and about 175 branches on the West Lines.

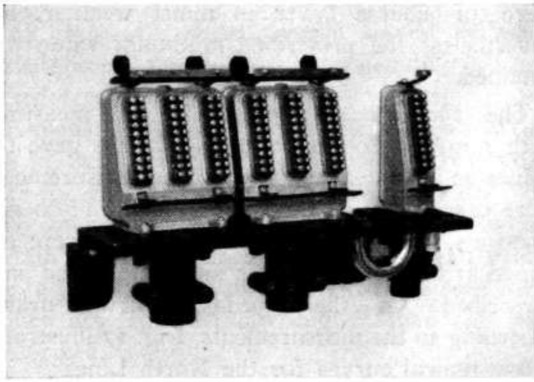
Branch types of several kinds have been used to meet varying local conditions.

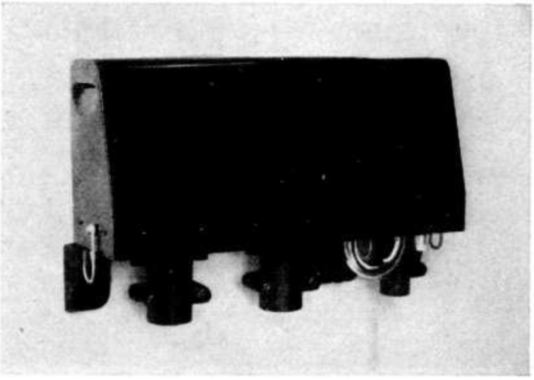
Most of the branches have been led into linemen's houses where connection has always been made to two railway telephone lines, one of which has been made as a direct tapping with a two-wire line, while the other has been cut off in the distribution box and the two ends led in by two two-wire lines, so as to facilitate the localization of faults on the cables. In addition connection has been made at all these tappings by a two-wire line to the power-telephone line for direct communication with the converter station.

Consequently the distribution cables of this type always contain at least four two-wire lines to the line-mens' houses. This is the case on the Stockholm—Upsala line, but on the other lines the tappings have been made with 10-pair cables, in which



X 1362 Fig. 13. Motor generator with hot-air fan.





X 1357 Fig. 14. Station box for 2×30-pair cable, assembled with terminal box for 2×10-pair cable. X 1358

case the additional pairs are connected to the three block-signalling lines (in both directions). On the Stockholm—Upsala line where there are four block lines separate tappings have been arranged for these lines.

Tappings to overseers and repairers are as a rule made in the same manner as above, with the exception that direct tappings without interruption in the distribution boxes are made to the two railway-telephone lines, while the remaining line in the distribution cable has been used for the connection to a selective-calling telephone line, so that the line inspector can get into connection with all overseers in his section.

In addition there are special tappings at the converter stations with 10-pair cables which are connected to two recording lines (in and out) for recording the power consumption in the converter stations, the two railway-telephone lines, power telephone and two selective-calling lines and one direct power-station telephone, which when desired connects the converter stations with each other and with the power station supplying the power.

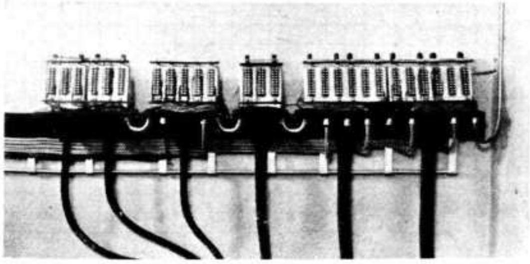
Finally on the Stockholm—Ånge line there are some special tappings, for connection to certain lines belonging to the Royal Board of Telegraphs at the same time serving as tappings to the linemens' houses. For these special tappings local cables with as a rule 7 or 10 quads have been used, so as to make possible the access to phantom circuits.

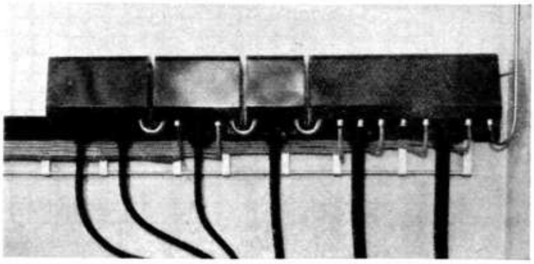
Connection between underground cables and bare-wire overhead lines, such as on not electrified branch railways belonging to the State as well as to private companies, have been made by means of pole boxes, Fig. 16, of a new design in two types, for 5 and 10 pairs. These boxes are fitted with rare-gas lightning arresters and fuses.

Properties of the Cables.

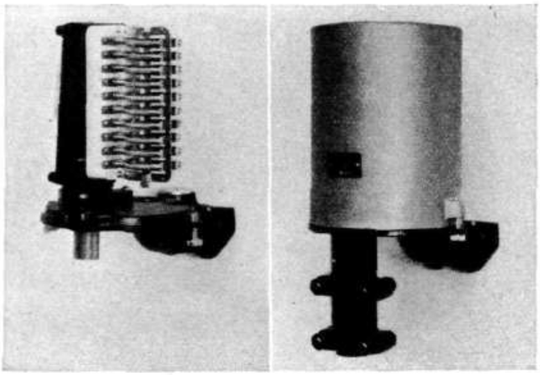
According to what was prescribed in the technical programme for these cable installations, tests have been carried out on each repeater section to ensure that the installed cables fulfil the prescribed requirements. The results of these measurements for some of the sections have been entered in Table 3, from which it may be seen that the transmission properties of the installed cables are better than the requirements prescribed. In addition the following results may be mentioned.

For the *dielectric strength* to earth the cables were tested with 1 200 V before the connection of the loading coils.





X 1359 Fig. 15. Station boxes in Upsala repeater station. X 1360



X 1361 **Fig. 16. Pole box for 10-pair cable,**
with lightning arresters and fuses.

The *mean capacity* in a repeater section had been fixed at the following maximum values: for pairs and side circuits of 1.3 or 1.1 mm wires 0.033 μF/km, and for the corresponding phantom circuits 0.056 μF/km, for pair and side circuits of 0.9 mm wires 0.030 μF/km, and for the corresponding phantom circuits 0.051 μF/km. From the transmission properties indicated in the table it may be seen that these requirements have been very well fulfilled.

The *capacity unbalance* to earth between the two conductors of a pair after the cables have been completely spliced should as an average not exceed 150 $\mu\mu$F for lines to be loaded, and 500 $\mu\mu$F for other lines. Installation tests showed condiderably lower, and consequently better figures.

The *insulation resistance,* which had been fixed at a minimum of 10 000 megohm/km, was, as may be seen from Table 3, considerably higher on the most important lines. On some lines with a great number of tappings, such as railway-telephone and block lines, the measured insulation resistances were of course lower in moist weather, but nevertheless the prescribed minimum value was obtained.

The *characteristic impedance* was measured with 1 mA at 800 c/s, and calculations gave the values as indicated in Table 3. The measurements were carried out at frequencies between 300 and 2 600 c/s, and, as may be seen, values were obtained at 800 c/s which are higher than the ones prescribed. Of the impedance curves drawn according to the measurements, Fig. 17 illustrates a few typical curves for the North Lines.

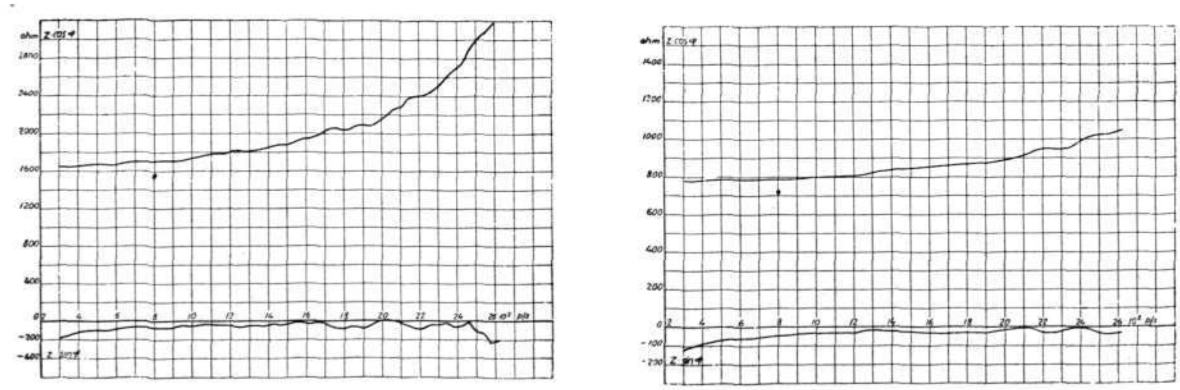
The *propagation constant* at 800 c/s had been fixed at the maximum values for various types of circuits indicated in Table 3. From the attenuation curves measured in the frequency range 300—2 600 c/s it may be seen that the propagation constant at 800 c/s is as a rule considerably lower than the maximum value prescribed, on an average 22.4 % lower (min. 18, max. 27.5 %).

A few typical attenuation curves are illustrated in Fig. 18.

The *cut-off frequency* for the various types of circuits had been fixed at the average minimum values indicated in Table 3. The cut-off frequencies measured are, as may be seen, considerably higher than the minimum values prescribed.

The requirements of *cross-talk* were, as in the case of the Malmö Lines, that the cross-talk attenuation between two arbitrary speech circuits on a completed repeater section should be at least 8.0 neper.

Regarding the cross-talk in quads, somewhat more severe requirements had, however, been imposed, inasmuch as the cross-talk-attenuation between the side circuits of a quad should not be less than 8.5 neper on the average for all quads in a repeater section.

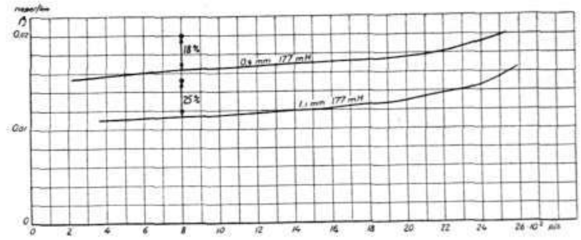


X 1363 X 1364

Fig. 17. Characteristic impedance of cable, Type I, Stockholm—Upsala, 66.8 km.
Left, pair, 1.1 mm, 177 mH; right, phantom circuit, 1.1 mm, 63 mH. The points indicate calculated values.

All cross-talk measurements should be made with speech current or corresponding AC of mixed frequencies.

Exhaustive measurements have been carried out in accordance with this, both in respect of near-end and far-end cross-talk. Mean values have been calculated from the measured values for certain repeater sections, and these mean values are to be found in Table 3. As may be seen these values are considerably higher than the ones prescribed.

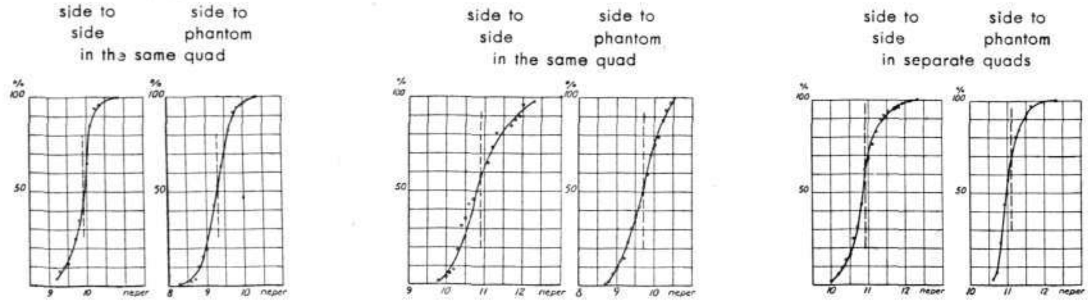


X 1365 **Fig. 18. Attenuation curves for cable, Type I Stockholm—Upsala, 66.8 km.**

The points indicates the values prescribed by the State Railways.

Table 3. **Properties of Installed Cables.**

	fixed values	measured mean values			
		Type I Stockholm C—Upsala	Type II A Upsala—Krylbo	Type II A Krylbo—Storvik	Type III Örebro—Krylbo
Insulation, megohm/km, min.	10 000	41 000	77 000	106 000	36 000
Difference of resistance between the conductors of one pair, ohm					
0.9 mm unloaded	—	0.24	0.20	0.12	1.49
0.9 mm loaded	—	0.16	0.32	0.23	0.41
1.1 mm loaded	—	0.14	—	—	—
1.3 mm loaded	—	—	0.16	0.10	0.27
Characteristic impedance at 800 c/s, ohm					
side circuit, 1.3 mm, 160 mH	1 480	—	1 554	1 531	1 540
1.3 mm, 177 mH	1 560	—	1 666	1 648	1 660
1.1 mm, 160 mH	1 480	1 573	—	—	—
1.1 mm, 177 mH	1 560	1 691	—	—	—
0.9 mm, 177 mH	1 640	1 740	1 779	1 768	1 750
phantom circuit, 2 × 1.3 mm, 63 mH	715	—	780	780	765
2 × 1.3 mm, 40 mH	570	—	619	616	—
2 × 1.1 mm, 63 mH	715	792	—	—	—
2 × 1.1 mm, 40 mH	570	627	—	—	—
2 × 0.9 mm, 63 mH	750	827	848	845	—
Propagation constant at 800 c/s, max.					
side circuit, 1.3 mm, 160 mH	0.0120	—	0.0097	0.0096	0.0100
1.3 mm, 177 mH	0.0116	—	0.0089	0.0089	0.0091
1.1 mm, 160 mH	0.0159	0.0127	—	—	—
1.1 mm, 177 mH	0.0152	0.0117	—	—	—
0.9 mm, 177 mH	0.0200	0.0168	0.0163	0.0163	0.0170
phantom circuit, 2 × 1.3 mm, 63 mH	0.0124	—	0.0095	0.0095	0.0100
2 × 1.3 mm, 40 mH	0.0155	—	0.0113	0.0112	—
2 × 1.1 mm, 63 mH	0.0163	0.0125	—	—	—
2 × 1.1 mm, 40 mH	0.0205	0.0151	—	—	—
2 × 0.9 mm, 63 mH	0.0215	0.0174	0.0168	0.0168	—
Cut-off frequency, c/s, min.					
side circuit, 1.3 mm, 160 mH	2 950	—	3 030	3 030	2 990
1.3 mm, 177 mH	2 800	—	2 940	2 940	2 900
1.1 mm, 160 mH	2 950	3 060	—	—	—
1.1 mm, 177 mH	2 800	2 970	—	—	—
0.9 mm, 177 mH	2 950	3 060	3 140	3 140	3 040
phantom circuit, 2 × 1.3 mm, 63 mH	3 530	—	3 810	3 820	3 720
2 × 1.3 mm, 40 mH	4 400	—	4 770	4 790	—
2 × 1.1 mm, 63 mH	3 530	3 840	—	—	—
2 × 1.1 mm, 40 mH	4 400	4 800	—	—	—
2 × 0.9 mm, 63 mH	3 690	4 010	4 120	4 110	—
Cross-talk attenuation between two arbitrary speech circuits, neper, min.					
near-end cross-talk	8	9.6	9.6	9.7	10.1
far-end cross-talk	8	10.1	10.1	10.1	11.0
Echo attenuation at 300—2 400 c/s, neper, min.	3.0	3.8	3.7	3.8	3.8



X 3238 X 3237 X 3236

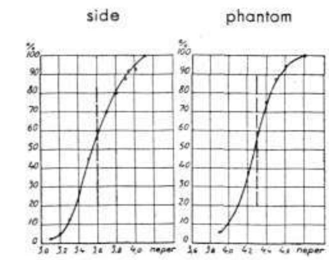
Fig. 19. Cross-talk attenuation curves for quads of loaded 0.9 and 1.1 mm cable, Stockholm—Upsala.

Left, near-end cross-talk; middle, far-end cross-talk; right, cross-talk.

Finally, to show how many measurements have been made of a certain cross-talk attenuation together with the values read and the corresponding mean values, a few curves for typical cases have been selected, Fig. 19.

Regarding *echo attenuation* it had been stated that in a repeater section and for the frequency range 300—2 400 c/s the echo attenuation should be at least 3.0 neper, so that the transmission properties of the completed cable should be as uniform as possible and suitable for telephone repeaters. The requirements in this respect were thus more severe than for the Malmö Lines, where the requirement called only for at least 2.7 neper in the frequency range 300—2 000 c/s.

On measurements made in the frequency range 300—2 400 c/s the mean values indicated in the table have been obtained for certain sections. It should, however, be observed that when measuring a fixed balance has been used for a certain type of circuits.



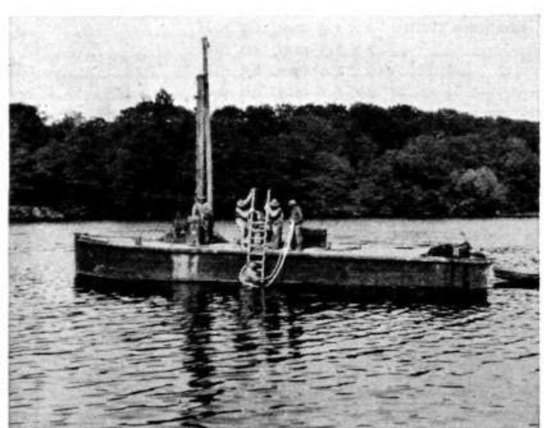
X 3239

Fig. 20. Minimum value of echo attenuation for loaded but untapped, pairs 1.1 mm, in the frequency range 300–2 400 c/s, Stockholm—Upsala.

The values obtained for the echo-attenuation minimum in the frequency range 300—2 400 c/s for the loaded circuits on the section Stockholm—Upsala without tappings are illustrated in Fig. 20.

In conclusion it can be stated that the installation very well fulfils the requirements imposed and particular notice should be taken of the extremely good transmission properties of the new lines.

X 1379 **Fig. 21. Installation of submarine cable.**



X 1380 **Fig. 22. Inspection of submarine cable by diver.**

ELECTRIC RAILWAY-SIGNALLING PLANT IN WARSAW

By S. BORKOWSKI,
engineer of the Railway Administration,
Warsaw.

In the summer of 1933 an electric interlocking plant on the Ericsson system, the first of its kind in Poland, was installed at the Warsaw-WCZ station; this was carried out in connection with the reconstruction of most of the interlocking plants at the Warsaw railway stations and with the putting in service of the intermediate railway line.

Although the interlocking plant has only 21 points and 6 signals it has been equipped with electric apparatus designed to meet severe traffic conditions. The number of trains to be dealt with by this interlocking range in 24 hours is more than 300; in addition as most cases require the points to be thrown, it means that almost all points have to be thrown some 200 times in the 24 hours.

The interlocking machine has been installed in a two-story building placed between the tracks giving a view of all the points.

The upper story of the building houses: the interlocking machine, blocking apparatus and signalling relays. The lower story houses: a sub-station of the electricity works, cable inlets, distribution room and a room for the signal fitter on duty.

Interlocking Machine.

The chief feature of the interlocking machine is that is not locked by mechanical means; all locking being carried out electrically.

The interlocking machine has 8 signal switches, 14 point switches and 2 reserve positions. On account of the use of electric interlocking, each signal switch operates a whole group of home signals for one direction or starting signals for another.

X 1366 Fig. 1. Interior view of the interlocking plant in Warsaw—WCZ.
From left to right: interlocking machine, blocking apparatus, relay box and track diagram.

Most of the point switches operate two points connected in series. The small number of signal switches, due to the use of electric interlocking of the points two by two, has allowed of the interlocking machine being made very small; the length is only 195 cm and the width including the switches is only 70 cm. In addition the interlocking machine has 17 road selectors, one for each road. These are of great importance in interlocking machines where mechanical interlocking is not used and where one signal switch operates a whole group of signals. This is particularly the case in master interlocking machines where the road selectors permit of testing whether all conditions for the indication of the signal corresponding to certain road have been fulfilled.

The *point switches* are made as latches and when in home position they are at an angle of 70° to the perpendicular. When the points are to be thrown the handle is turned 140°. Each switch operates a group of shaft contacts which switch on the current to the motors and also vertical contact drums for controlling and interlocking the points in question. In addition the horizontal shaft of each switch has two segments which cooperate with the locking devices operated by the armatures of the group of electro-magnets placed on top of the segments.

There are four such electro-magnets:

1 indicating magnet which in this case will be energized only when the position of the point switch and that of the points correspond. The armature of this electro-magnet operates the coloured disc in the supervisory window of the switch and the group of supervisory contacts. When the electro-magnet is energized a white disc appears in the window and the supervisory contacts are closed; when the electro-magnet is not energized a red disc appears in the window and the supervisory contacts are open;

1 point locking magnet, which in this case is energized only when the points may be thrown, *i.e.*, when they have not been locked previously by thrown signal switch. The armature of this electro-magnet operates the blue pointer in the supervisory window. A clear white window indicates that the points may be thrown; a vertical blue line indicates that the points are locked;

2 electro-magnets which lock the point switch in home and thrown position. The armatures of these electro-magnets have locks, which cooperate with the segments of the point-switches. The electro-magnets are energized over contacts on the signal switches by means of which the points in question are interlocked (these contacts are closed in the side positions of the signal switch). In addition this current is led over a contact, which is closed when the point switch is pulled forwards to be thrown. On account of this the electro-magnet is idle under normal conditions.

A *signal switch* operates a vertical shaft with contact drums and one segment fitted on the horizontal shaft of the switch. This segment cooperates with the lock which is operated by the armature of an electro-magnet placed on top of the switch. This electromagnet partly locks the signal switch in the side positions and in half-thrown position, *i.e.*, as soon as the point switches have been locked which cooperate with this signal. In addition the armature of this electro-magnet operates a coloured disc in the supervisory window of the signal switch. Should the signal switch be locked blue appears in the window. When the signal switch may be thrown, white is seen in the window. The signal switches can be turned 70° from the vertical to each side and can operate two groups of contrary signals. The points are interlocked by the signals by means of contacts on the vertical drums of the signal switches

X 1368 **Fig. 2. Interlocking machine with supervisory panel.**

which are closed only when the signal switch is in one of the end positions, and by means of supervisory contacts on these point switches which are closed only when the position of the switch and the points correspond. This kind of interlocking replaces altogether the mechanical interlocking of old types, and in addition it carries with it great advantages, for, the equipment being very flexible and simple in design, alterations and extensions are easy to carry out.

Power Plant.

Since it is possible to feed the interlocking plant from two different electricity supply works, 220 V AC was chosen for the operation of the points and 110 V AC for the light signals. The two supply circuits feed the interlocking plant over automatic switches, which change over from one to the other. The switch is usually thrown to the circuit supplying the power at the lower price. When the power from this supply fails the switch changes over automatically to the other. When the voltage returns on the mains of the first

X 1373 **Fig. 3. Distribution panel of the power plant.**

supply the second is automatically disconnected and the first one is connected anew.

All electro-magnets and signal relays in the signal cabin are fed with 30 V DC, supplied by cuproxide rectifiers. Only the relays of insulated tracks are fed over small rectifiers, supplying 8 V DC.

All equipment for supplying electric power to the interlocking plant has been fitted on a common distribution panel; the equipment is composed of automatic switch, transformer which supplies 220 V for the motors and 110 V for the signals, disconnecting switches and fuses for the various instruments rectifiers and measuring instruments.

In addition there is a small distribution panel on top of the interlocking machine; this panel is fitted with voltmeter and ammeter for the point-operating current, and voltmeter and ammeter for the supervisory DC.

Point Machines.

As all points in the interlocking range have point locks, the point machines have been made with one driving lever, operated by gear and worm wheels from a repulsion motor for 220 V AC.

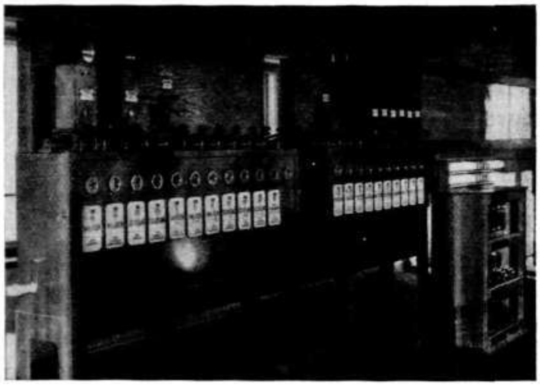
The movement is transferred by means of an adjustable friction clutch which allows elastic throwing of the points and permits them to be trailed. The trailing of points will cause no injury to the point machines, but only the burning of the fuse in the supervisory circuit of the points in question. All contacts in the point machines are knife contacts and operate in a satisfactory manner even during severe frost. All points which are faced by the trains have been provided with arrangements for checking the position of the tongues. In addition all point machines have separate crank arrangements enabling them to be thrown by hand.

Signals.

All signals in the interlocking range are coloured daylight signals. To obtain uniformity the cases of the main and distant signals are of the same type and can be provided with three lamps, which is quite sufficient for forming the usual signal combinations.

All the home signals have three lamps, the central one being red and serving for the signal »stop», the top one being green for the signal »clear through on the main track» and the top green together with the bottom one also green for the signal »clear through on the side track».

The starting signals are either identical with the home signals or else they have only one green light and one red one. The distant signals have only two lamps: one for yellow and one for green light. The yellow light serves for indicating »caution» and the green light for indicating »clear». In addition all lamps have been provided with reserve lights of the same colour as the main lights. Although lamps of low intensity have been used (the main lamps consume 25 W, the reserve lamps 6 W) the signals are easy to make out particularly during slight fog or cloudy weather thanks to the application of double lens-systems, of which the inner lens is coloured and the outer colourless. In order to obtain a light as concentrated at one point as possible the lamps of the main lights are for only 12 V and have each two parallel wires, one of which has a higher resistance than the other, so as to serve as a reserve should the main wire burn off. In addition each lamp has a separate transformer which reduces the 110 V power supplied from the sig-



X 1367 **Fig. 4. Blocking apparatus.**
In the background, under the track diagram, relay box.

nal cabin to the 12 V required to operate the lamps.

Of special importance is the manner of connection of the lamps for red light.

The current for the lamps for red light is shunted by a contact on a special AC relay, the winding of which is connected in series with the lamp for green light. The red light will, consequently, go out only when this relay is energized, *i. e.,* when green light actually lights. In case of faults or if both wires in the lamp for green have burnt off the signal will not be unlighted after the point switch has been thrown, but it will continue to show red light. All lamps of main and distant signals have been provided with coloured supervisory lamps, which are fitted on a special supervisory board on top of the interlocking machine; these lamps are placed in the same manner as on the signals. Small resistances are connected in parallel with the lamps, which in their turn are connected in series with the lamps of the signals.

This manner of connection ensures that the supervisory lamps will always light with the main lamps and in case a supervisory lamp does break down this will not affect the corresponding main lamp on the signal.

Cables.

Since the points, signals and insulated tracks are concentrated at a few places, a small quantity of cables with several conductors has been used, having the necessary number of reserve wires; the various apparatus has been connected to these cables by means of distribution boxes. Only the points close to the signal cabin have been connected over separate cables. Only the short sections of one-conductor cable for contacts on insulated tracks have rubber insulation around the copper wire; all other cables have conductors with impregnated paper insulation.

The cables are drawn to the signal cabin where the multi-conductor cables terminate in terminal boxes with numbered terminals. The cables from single points are terminated separate boxes.

Line and Station Blocking.

The interlocking machine cooperates with the master interlocking machine of the usual mechanical type, and consequently it must be connected over blocking apparatus.

In addition to the usual track blocking sections the blocking apparatus has entrance and departure blocking sections for line blocking and consent blocking sections in connection with the master interlocking machine. The entrance blocking sections have ordinary electric press-button locks. The departure blocking sections have also electric press-button locks, the function of which is to prevent a starting signal from being set at »clear» again, when a train has already entered the line and the starting signal has automatically returned to »stop» position.

Since the work of the interlocking machine chiefly consists in letting through the trains and there is very little shunting work, the points are not insulated.

For releasing the signal switches which are locked electrically in thrown position there are insulated tracks placed behind the last points of the road in question. For emergency release there are special emergency keys.

The insulated tracks of the starting roads serve also for the automatic restoring of the starting signals to »stop» position.

The above described plant, although installed under hasty conditions, is characterized by model workmanship and operates in an irreproachable manner under severe conditions, with the exception of small trouble due to the imperfect functioning of the point locks, caused by the movement of newly laid tracks.

New Telephone Installations in Tampere

For many years, practically from the outset of telephony, Telefonaktiebolaget L. M. Ericsson has assisted in building and keeping up to date the Finnish telephone system. New telephone installations in Tampere were put into operation on April 1st this year. These installations include the second largest automatic telephone exchange in the country and a trunk exchange with cordless positions, all designed and supplied by Ericsson.

X 5129 **View of Tampere.**

Towards the end of 1932 the telephone company Tampereen Puhelinosuuskunta ordered an automatic exchange for 3 500 lines intended to replace an old LB exchange.

This change-over from LB system to automatic CB system made it necessary to replace the rural exchange belonging to the telephone company by a new one. For the trunk traffic, which is handled by one private and one State enterprise, it became necessary to carry out extensive alterations. The private company, Södra Finlands Interurbana Telefonaktiebolag, ordered a complete new trunk exchange of Ericsson's manufacture. The State enterprise, the Finnish Post and Telegraph Administration, altered its old equipment to meet the requirements of the new local exchange and ordered the necessary material from Ericsson. In addition, subsribers' instruments and manual and automatic telephone exchanges have been supplied by Ericsson. The line system had previously been made adequate to fulfil the more severe requirements due to the change-over from LB to automatic CB system.

Automatic Local Exchange.

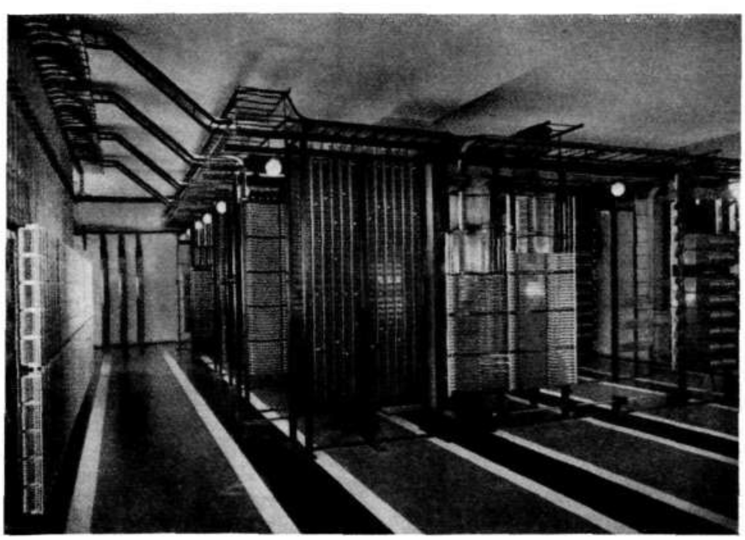
This is built on the Ericsson machine-drive system with 500-line selectors.

The exchange, Fig. 1 and 2, is housed in a new building near the centre of the town.

In addition to the necessary main distribution frames where the street cables are led via the cable cellar over lightning arresters to the automatic exchange, and to the main testing, supervisory and alarm devices, there is room for connecting devices fitted in unit rows for 7 000 subscribers and about 200 trunk lines with individual equipment for incoming trunk calls. At present the exchange is fitted with connecting devices for 3 500 subscribers and 96 incoming trunk lines.

The positions of the various devices are illustrated in Fig. 3. The main distribution frames and various main equipment, such as supervisory positions, testing positions and distribution panel, are placed along one of the walls.

The connecting devices are fitted in unit rows. In each 500-line group there is room for 40 cord circuits with line finders and group selectors



X 5113 **Fig. 1. Apparatus room of the local automatic exchange.**
Left, main distribution frame; right foreground, PBX group.

X 5132 **Fig. 2. Rear view of unit row.**

Left to right: cord circuits, multiple frames for line finders and final selectors, line relays; background, distribution frame.

and 10 registers, but to provide for present traffic it has only been necessary to install 29 cord circuits and 8 registers.

In the selector bays there is room for 50 final selectors per group of 50 lines, of which 35 have been installed up to the present. The larger number of final selectors as compared with the number of cord circuits is due partly to the fact that the trunk traffic is also connected over these final selectors.

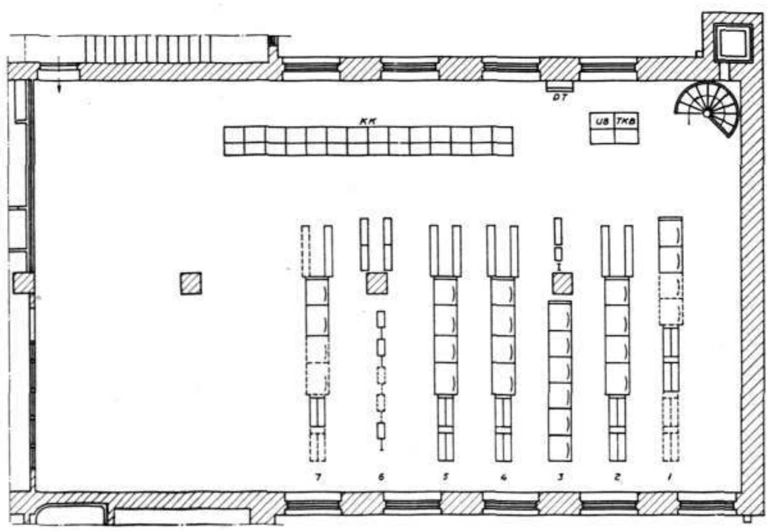
The registers are made with a maximum capacity of 18 000 numbers and 5 special directions.

The special numbers are two-digit numbers, and the present three routes which lead from the group-selector multiple are intended for record-operators traffic to the rural, trunk and State exchanges. The 8 000 first numbers *(2 000—9 999)* of the 18 000 ordinary subscribers' numbers are directed over one group selector only. Calls to the last 10 000 subscribers' numbers *(10 000—19 999)* will be directed from the first multiple frame of the first group selector over second group selectors to the respective 500-line groups.

By a special arrangement the registers have been made for four digits, although five digits have to be received at times. Thus, if the first digit is *1*, a special indication is obtained in the register, which directs the first group selector to the first multiple frame and prevents the disconnection of the first direct-impulse selector in the register before the second digit has been stored.

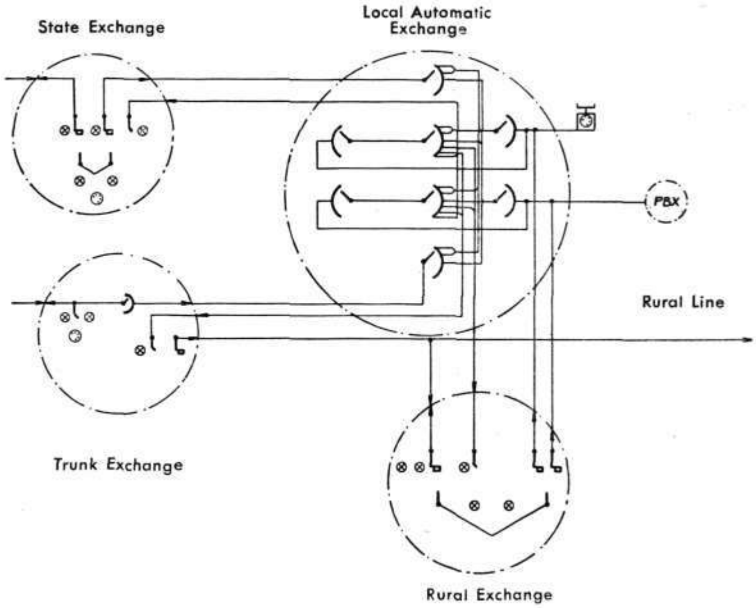
In order to make automatic intercommunication with other exchanges possible, *e. g.*, automatic rural exchanges and PABX exchanges, see the routing diagram, Fig. 4, the cord circuits have been arranged so that through-impulsing is possible, which for an incoming call means that as soon as the proper number of digits has been dialled and the register has been disconnected, additional impulses may be sent through the devices of the exchange.

Though discriminating between local and trunk calls, it is the final selectors with their relays which direct the calls to the called subscribers. If the call has been made by a trunk operator, the relays of the final selector are switched by an extra signal from the register so that the call will reach the local subscriber even if he should be engaged in a local conversation. The operator will then come into connection with the local conversation over condensers. The control relays of the selector then being in the priority trunk position, additional trunk calls cannot reach the subscriber. By operation from the working



X 5131 **Fig. 3. Plan of the local automatic exchange.**

1 trunk-line rack
2 local rack
3 group-selector rack
4, 5 local racks
6 rack for intermediate distribution frame and call meters
7 PBX-rack
KK main distribution frame
UB test position
TKB traffic-supervision position
DT distribution panel



X 5130 **Fig. 4. Routing diagram of the telephone exchanges in Tampere.**

position the local call can be cut off, and if the wanted subscriber replaces his microtelephone the operator can call him anew.

The final selectors of the 500-line groups that contain PBX-subsribers are of a special design. Lines with the same call numbers are placed behind each other in the same multiple frame and special testing lines are placed in front and behind them. If on calls to such a line group all lines be busy, the final selector will reach the back testing line, and if the call is made by a local subscriber the selector stops in this position and busy tone is sent out to this latter. If on the other hand the call comes from an operator with trunk privilege the selector will when all lines are busy reverse at the stopping line placed behind the subscribers' lines, and during its reverse movement the selector tests on the lines in such a manner that when it comes to a line engaged by a local conversation it will stop. Should all lines be engaged by trunk conversations the selector will return to the first testing line and from there busy tone will be sent to the operator.

For the supervision of the subscribers, the lines and the automatic connecting devices, there are special positions for testing and traffic supervision. In the testing position the lines and telephone instruments can be tested, and in the traffic-supervision position the subscribers can be informed and if necessary be assisted to reach the right subscriber. On a lamp board near the central supervisory equipment of the exchange all faults and need for manual cutting-in on account of faults due to subscribers or technical equipment are indicated.

Actual tests at 400, 800 and 1 400 c/s have shown a maximum attenuation in the exchange of 0.06 neper between two subscribers, and the cross-talk attenuation measured under the same conditions is a minimum of 10.6 neper.

In respect of the connecting process the exchange operates with good reliability and without special arrangements with line resistance up to 1 500 ohm and for a minimum insulating resistance of 25 000 ohm.

The exchange, which operates with 24 V, has two storage batteries of about 1 000 Ah each, and it is possible to increase the capacity to 1 440 Ah. Two rotary converters each of 2×220 V DC on the the primary side and 200 A charging current have been installed for battery charging.

The signalling current is supplied by the driving motors of the bays, which serve also as rotary convertors for the ringing current. These motors have special rotors for producing the buzzer tone.

Rural Exchange.

The traffic between the local subscribers of Tampere and the adjacent rural exchanges is directed over a separate rural exchange, Fig. 6, which also has been supplied by Ericsson.

Rural calls are set up manually by ordinary cord-circuit working in the seven-panel local multiple, which has at present 3 500 lines.

The calls are charged and have therefore the same priority as ordinary trunk calls.

Two of the six working positions, each of which has 14 cord circuits and 6 electrically driven time checks, have been equipped as concentration positions with calling devices also in the multiple of the rural lines.

Two ordering positions, one supervisory position and various arrangements for service and junction circuits to other exchanges in the town have also been provided for.

Trunk Exchange.

Fig. 7 shows the working hall and Fig. 8 the technical equipment of the trunk exchange supplied by Ericson and belonging to Södra Finlands Interurbana Telefonaktiebolag.

The exchange, a routing diagram of which is presented in Fig. 4, has

X 3211 **Fig. 5. Distribution frame under mounting.**

X 5133 **Fig. 6. Rural exchange.**
Left, supervisory table; right, switchboard containing from left to right: 2 recording positions, 2 concentration positions, 4 working positions.

7 trunk positions, 2 concentration positions and 1 ordering position.

The most interesting point technically about this installation is that the trunk positions have been provided with individual key groups for each trunk line; by means of these key groups the calls are worked without the use of cords. The cordless working groups, which are shown in Fig. 10, have also the advantage that they are fitted in removable units together with the nesessary relays and condensers; the maintenance of the exchange is thereby considerably simplified.

Of the 7 trunk positions proper, right in Fig. 7, 5 have been fitted with 6 working groups for trunk lines, Fig. 10 a, and 2 for transit calls to be directed through cord repeaters. The remaining two positions have 2 working groups each with double exits, Fig. 10 b, and like the above-mentioned positions, working groups as Fig. 10 a, and 2 circuits with cord repeaters. All 7 *trunk positions* have individual key groups for each position, Fig. 10 c. In the working groups there is room for electrically driven time checks. Fig. 9 shows a trunk position, at the right.

The ordering position, left in Fig. 9 has arrangements for 10 incoming ordering calls. By means of the buttons 20 service circuits can be called. At night the calling lamps are disconnected and the orders are worked in the concentration positions.

The six panels of the concentration positions have the following equipment, from the left:

panel 1: switching jacks for occasional moving of the trunk circuits to various trunk positions. On top there is room for time checks;

panel 2: record operators' circuits from the automatic and rural exchanges, junction lines to the State exchange, service lines, lines to special subscribers and public call-boxes;

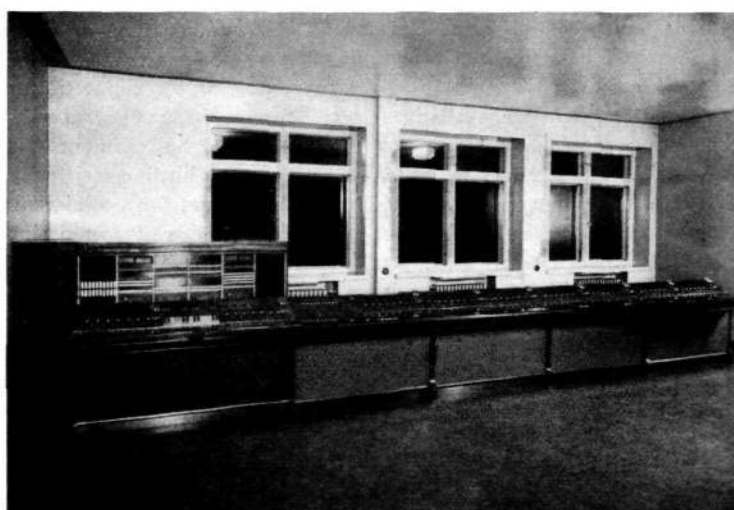
panel 3 and 4: concentration positions of the trunk circuits, with their transit multiple below;

panel 5: the same record operators' circuits as in *panel 2,* and at the bottom the multiple of the rural circuits with balance jacks for certain circuits with repeaters.

The two-position working plate is divided into two fields, each with 7 key groups and working equipment to the right. In the middle there are arrangements for the setting up of transit calls with and without cord repeaters, and on the horizontal part of the working plate there are the answering and ringing cords and the transit cords belonging to the key groups, and on the vertical part there are a key for connecting en alarm bell, calling lamps for ordering calls, group lamps for calling and clearing signals, and buttons for inserting cord repeaters.

Process of Working and Connection for Trunk Calls.

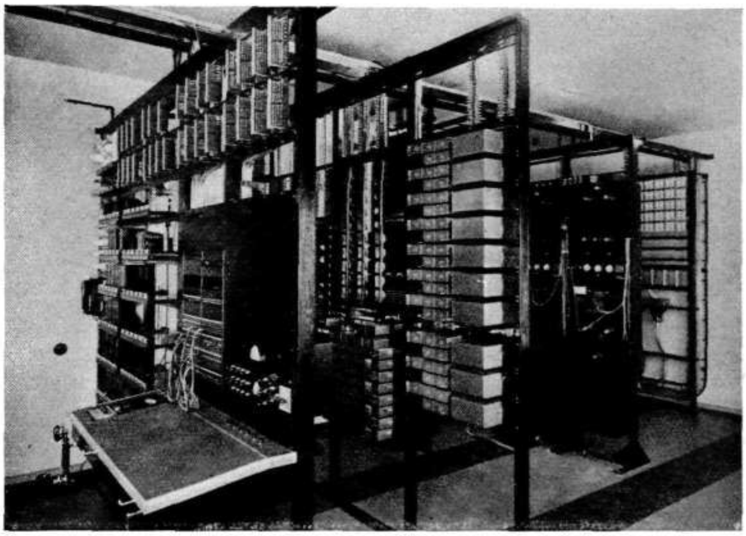
A trunk circuit is led in over lightning arresters and equipment for line measurements and testing to the line transformer, immediately



X 5134 **Fig. 7. Working hall of the trunk exchange.**
Left to right: 2 concentration positions, 1 recording position, 7 working positions.

beside which the balancing transformer is placed. From here the trunk circuit and the balancing circuit continue over line and cut-off relays to a double jack in the switching and concentration positions. In the relay frame tappings are made on trunk lines proper over the intermediate distribution frames to the concentration positions and the trunk working groups in question. When calls come in, the calling lamps in the trunk and concentration positions light up and, on the condition that the line is guarded in the trunk position, the call is received by throwing the working key. According to the destination the call may take one of three different routes:

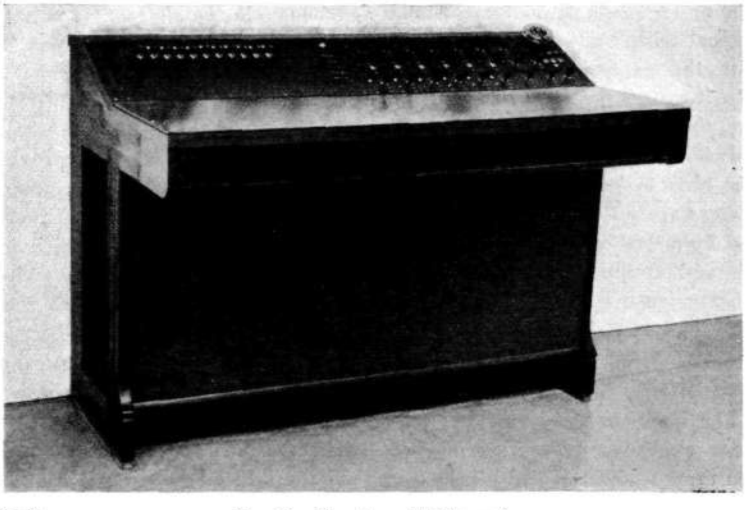
1. by throwing upwards the top of the three keys, a subscriber's selector is started, which finds a clear line to the *automatic local exchange*. To show when dialling may start, a red lamp lights up in the trunk position and, after the automatic setting up of the call has been completed in the local exchange, the call may be forwarded to the local subscriber by means of the cut-off and ringing buttons. If a local conversation must then be cut off, the unwanted subscriber will hear the busy tone. Should the line already be engaged by a trunk call the operator will be informed of this automatically by a buzzer tone. She cannot then cut in on the conversation of the local subscriber. If the called party is not engaged by a trunk call she has the possibility of hearing the call and ringing in both directions from the working group. When the local subscriber replaces his microtelephone the clearing signal lamp of the trunk line will light up;



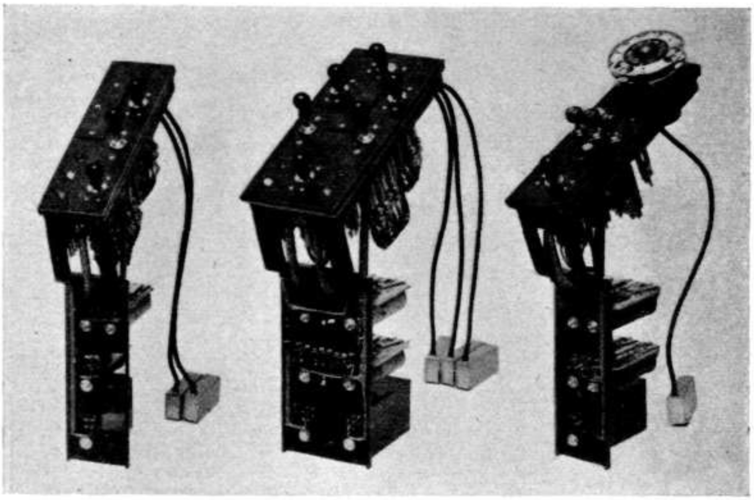
X 5135 **Fig. 8. Apparatus room of the trunk exchange.**
Right to left: line-protection bay, high-frequency and repeater bays, line-relay and selector bays, rack for transformers, line balances, distribution frame, and supervisory and test panel.

2. by throwing downwards the top key in the working group, connection is obtained over a line finder to a 50-lines *automatic switchboard* on the Ericsson multiple-relay system with 10 cord circuits in all; this swichboard is intended exclusively for the trunk exchange. Through this switchboard the trunk call can be directed to special subscribers and telephone call boxes by dialling two-digit numbers. By dialling *5* the operator can select a clear cord in the concentration position for the setting up of transit calls, *e. g.*, rural calls without repetition. The same supervisory facilities have been provided for as mentioned under *1*;

3. by throwing downwards the top key of one of the transit working groups, a selector will be connected which finds a clear repeater cord equipment in the concentration position, and the operator of this position will be called. The trunk operator can then order a repeater to be inserted between the called and the wanted trunk line. The supervision of the call is carried out in the transit group in the same mannes as described above. When the repeater cords are set up in the repeater multiples of the trunk lines, the lines are busied by green lamps in the working groups corresponding to the lines in question. In addition the trunk lines are disconnected from the rest of the exchange equipment. The repeaters are provided with automatic gain regulation in four steps. If perfect balance should not be obtained when not quite faultless overhead lines are connected and consequently the line should have a tendency to sing, the gain may be reduced by 0.3 neper by pressing



X 5137 *Fig. 9. Trunk switchboard.*
Left, recording position; right, working position.



X 5136 **Fig. 10. Key groups for cordless trunk position.**
Left: *key group for single-exit trunk line;*
from top down: key for connection to the local exchange or the automatic switchboard of the trunk exchange, key with working and local ring position, key for trunk ringing and cutting in, signalling lamps for local and trunk lines and for busy-indication of a line occupied by a transit call in another position; space for electric time check;
middle: *key group with double exits;*
top, commutator; rest of equipement similar to above-mentioned group;
right: *key group for working position;*
from top down: dial, service-call lamp, signal lamp, buttons for ringing, concentrating and cutting off, button for gain reduction and insulating key.

a button provided for this purpose in the position equipment.

When after clearing signal the operator disconnects the transit circuit, clearing signal is given to the corresponding repeater cord equipment of the concentration position, and the cords are taken down, after which the cord repeater is available for another transit call.

The connecting process for incoming trunk calls has been described above. Outgoing trunk calls are worked in a similar manner after having been ordered.

The connecting process is also the same in those working positions that have double exits. A two-way key placed above the other keys keeps the trunk line connected to one of two exits and consequently makes possible the setting up of a waiting call in advance when the trunk traffic is heavy; after the clearing signal the trunk line can immediately be connected to the prepared circuit.

In the two positions of the concentration switchboard the working groups have been provided with cords as has already been mentioned. All lines of the trunk exchange are thus available here and all these lines should be accessible at night and partly also during the day from a limited number of working groups. The left cord is intended for trunk lines. When the top key is thrown downwards the right cord is connected to CB lines. When this key is in intermediate position the cord is connected to LB lines, and, when the key is thrown upwards, connection is obtained with the local exchange in the above-mentioned manner without using this cord. The rest of the working process is analogous with that described above, with the exceptions caused by the transit calls being set up direct without the use of the multiple-relay switchbord of the trunk exchange. The calls to be directed through repeaters are set up and supervised direct by means of the working, listening and ringing keys belonging to repeater cord circuits.

Traffic with the State Exchange,

The inter-communication with the State exchange is carried on over two three-wire lines which pass over lamps and calling lamps from the concentration switchboard. Outgoing calls to the state exchange can be set up in three different manners:

1. by means of a single cord in the concentration switchboard,

2. over the multiple-relay switchboard,

3. through a double jack in the concentration switchboard; in this case cord repeaters are inserted in the usual manner and the equipment mentioned under *1* and *2* disconnected. To ensure the perfect functioning of the repeaters over this short line a fixed attenuation network is permanently inserted.

Service Lines.

As has been mentioned above there are a number of service lines between various places in the trunk exchange. These lines are connected to the multiple-relay switchboard. In the concentration switchboard they are called from a special jack strip and in the ordering position by pressing a button. The service lines are connected direct to the headsets of the operators, and calls are led direct to this outfit if it is not otherwise engaged. Should it be so engaged a lamp will flash indicating that a call over a service line is waiting. In the meantime the calling party will receive busy tone.

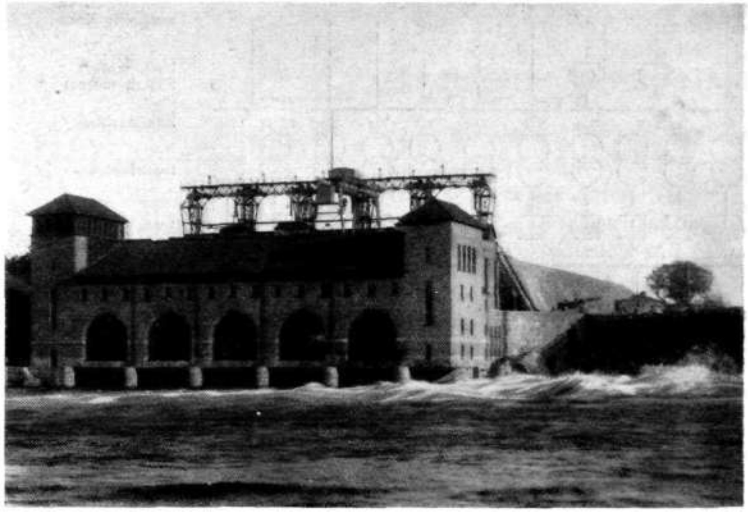
State Exchange.

The routing diagram, Fig. 4, shows how the trunk exchange of the State is connected to the other exchange in Tampere.

In order to make possible the change-over from the previous LB exchange to intercommunication with the automatic local exchange the cord circuits have been provided with arrangements for the connection of a dial. The junction lines to the automatic exchange, which lead from jacks in the trunk switchboards, have been fitted with relays for clearing signals etc. There are 10 LB junction lines to the rural exchange and from the group-selector multiple of the automatic exchange there are lines to a special recording position. In addition there are junction lines to the private trunk exchange. *E. Wester.*

Sum-Total Meters for Power Stations

Telefonaktiebolaget L. M. Ericsson has evolved a sum-total-meter system for the Älvkarleby Power Station of the Swedish Royal Board of Waterfalls. The purpose of the system is to indicate at a central point and in a conspicuous manner the total quantities of power registered by the meters of the power station in the various operating systems and on the 70-kV lines connected to the power station.



X 5123 View of Älvkarleby Power Station.

The electricity meters of the power station are fitted with contact devices which produce impulses at a certain number of kWh or kVArh. These impulses are transferred over relays, either direct or by means of special distributing arrangements, to counters joined up on a board in the control room.

By a suitable distribution of the impulses these counters will indicate partly the group totals for the meters that indicate the power to the same operating system (70 kV, 50 kV, etc.) and partly sum totals for all meters indicating output and input power. There are double counters which operate alternatively every other hour so that the counters which are idle may be read easily during the hour when the others are in service. When the counters have been read they are returned to zero, and, consequently, the reading when kept idle will give direct the power quantity metered during the previous hour.

The plan for the distribution and totalling of the impulses from the meters, which has been worked out by the Royal Board of Waterfalls, may be seen from Fig. 1, and a simplified diagram of the Älvkarleby power station is presented in Fig. 2. As may be seen totalling is done for both active input and output power.

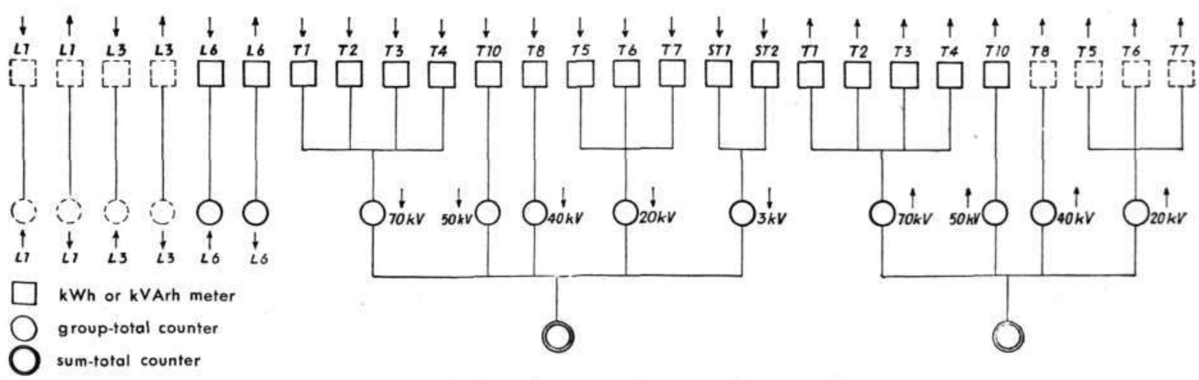
Design.

The contact devices embodied in the meters are of Type VM 100, Fig. 3. The contact wheels are fitted with the number of teeth corresponding to the properties of each meter, so that the impulses sent out will always represent the same quantity of power, in this case 100 kWh or 100 kVArh respectively.

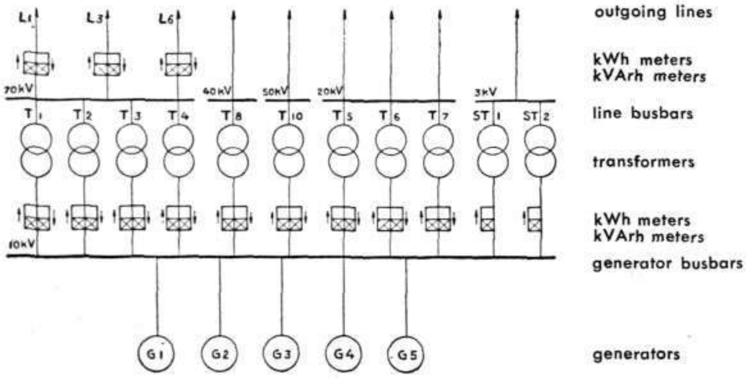
As may be seen from Fig. 1 the system answers two purposes:

1. direct transmission of impulses from the meters of the 70 kV lines *L1*, *L2* and *L6* to a counter that corresponds to each meter, see the diagram, Fig. 4;

2. transmission of impulses from the meters of the transformers to different counters, in connection with which group and grand totals of the impulses are made, see the diagram, Fig. 5.



X 7055 Fig. 1. Distribution diagram of sum-total-meter plant.



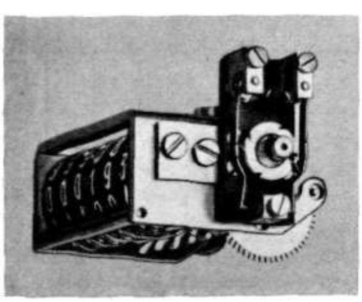
X 1301 Fig. 2. Diagram of the power plant.

The impulses from the meters are in both cases collected by impulse collectors consisting of an impulse relay *LR* and a disconnecting relay *BR* for each impulse contact.

There are in addition 8 impulse-distributing devices for the totalling of the impulses according to the diagram, Fig. 5, which operate alternately 4 and 4 every other hour. Each of these distributing devices is composed of a rotary selector *W* with 12 positions, one test relay *TR* and one stepping relay *SR*.

A switching clock *OU* carries out the switching every hour by means of 5 switching relays *OR*.

All relays and selectors as well as the condensers and resistances used for spark-quenching have been joined to units which have been fitted on bars and connected to two bays by means of plugs and jacks; the bays are shown in Fig. 6. One bay contains the equipment belonging to the meters for active power and the other the corresponding equipment for the kVAr-meters.



X 3196 Fig. 3.
Counter for kWh meter.

The bays, which also contain fuses and terminal strips etc., are protected by sheet-iron covers and are fitted on hinged frames so that the wiring may be easily accessible.

The fuses are provided with alarm contacts which are connected to the ordinary alarm equipment of the power station over two relays, one for each bay.

The counters, *S* and *SS*, used for the counting of the impulses are Ericsson call meters with zero ajustment, Fig. 7.

The counters are either connected to the impulse collectors, when the impulses are only transferred from the meters to the counters, or to the above-mentioned impulse-distributing devices, so that the desired totalling of the impulses may also be obtained.

By simple switchings of the terminal strips of the bays any desired totalling of the impulses may be arranged.

There are two series of counters, each operating for one hour. The switching is carried out also by the switching clock *OU* with its switching relays *OR*.

The counters may be restored to zero position separately by a simple operation. Consequently the readings will be independent of the values read previously, and only the quantities of power for one hour will be recorded.

The figure drums used in the counters have white figures on black background except the last drum, which has white figures on red background. The counters indicate the numbers of MWh and MVArh respectively to one decimal.

The counters have been arranged conveniently in a sloping desk of sheet-iron, Fig. 8. The desk is fitted with a hinged glass window on the front side, and the back of this window has been covered with black paint except for rectangular openings for the reading of the counters. The symbols shown in Fig. 1 are indicated with white colour. All counters are fitted in jacks so that they may easily be replaced, should this be necessary. In the desk there are in addition two indicators, which indicate which of the two series of counters is in service.

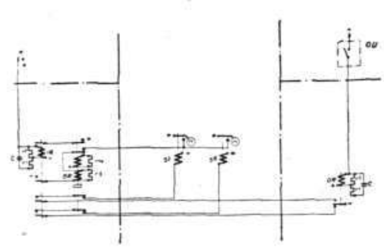
The sum-total counters are fitted with make contacts, which may be used for long-distance transmission of the total number of counted impulses. The Royal Board of Waterfalls has planned to transmit the impulses over an existing high-frequency channel to the central operating office in Stockholm, and to install some kind of recording instrument there.

Operation.

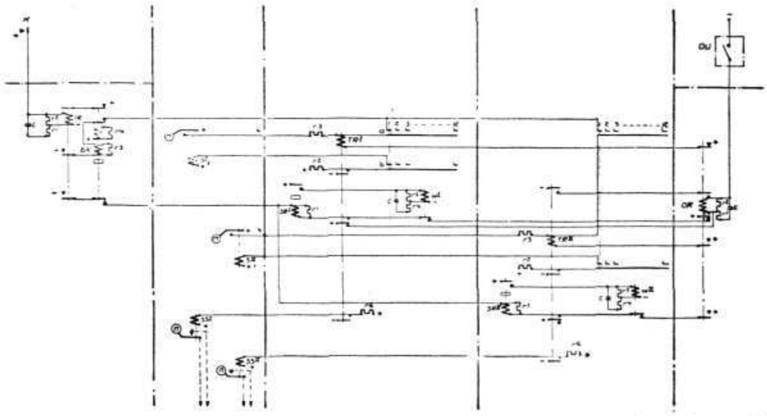
The operation of the part of the system used for the transferring and totalling of the impulses from the meters may be seen from the diagram, Fig. 5.

When the impulse contact *K* in a meter is closed the corresponding relay *IR* will be energized, and at the same time it will become locked over the make contact of the relay *BR*.

The circuit through the stepping relay *SR* is closed over:



X 3195 Fig. 4. Diagram, showing the transmission of the impulses from the meters to the counters.



X 5117 Fig. 5. Diagram, showing the distribution of the impulses from the meters to various counters, for group and sum-totalling.

—, make contact *IR*, break contact *BR*, relay *SR*, break contact (or make contact) *OR*, +.

The stepping relay closes the current through the selector *W*. The stepping magnet of the selector is energized, and the current through the stepping relay will then be broken. When released this relay breaks the current through the selector magnet, which returns to home position and moves the selector one step on. When the selector has been released the current through the stepping relay will be closesd anew and so on. The stepping relay and the selector will consequently operate alternately, and the selector will thus be moved on step by step.

When the selector has reached the position of the first contact field *a*, that corresponds to the meter from which the impulse has been transmitted, the following circuit will be closed:

—, make contact *IR*, one winding of the cut-off relay *BR*, break contact *BR*, make contact in the contact field a, test relay *TR*, make contact (or break contact) *OR*, +.

The test relay *TR* will be energized, but at the same time the current will not be sufficient to cause the cut-off relay *BR* to attract.

The stepping relay will be connected direct to the positive pole over the make contact of the test relay and will remain energized even after the selector *W* has been energized. The selector will therefore remain in this position.

When the test relay is energized the following circuits will also be closed:

—, make contact *TR*, make contact in the contact field *b*, the counter *S* which is connected to the contact in the contact field *b* where the selector is, +;

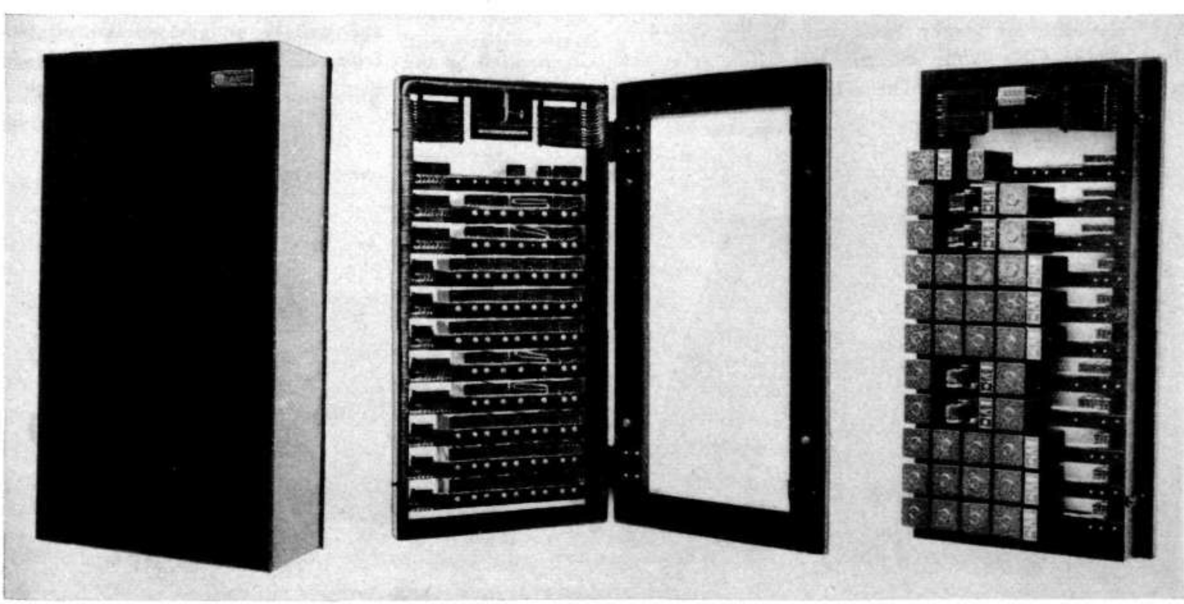
— make contact, *TR*, counter *SS*, +.

The counters *S* and *SS* will be energized and will then count one unit each.

By connecting a counter *S* with two or several contacts in the contact field *b* the totalling of the impulses from two or more meters may consequently be carried out.

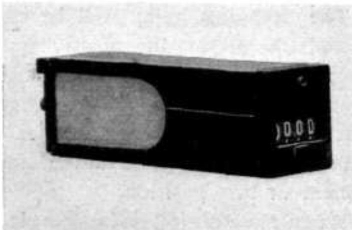
The counter *SS* adds together the impulses from all meters that correspond to this selector. On energizing, the make contact of the counter is closed and an impulse will be transmitted for the remote recording.

When the counter *S* is energized the following circuit will be closed:



X 7053 Fig. 6. Sum-total-meter panel.

The picture in the middle shows the panel turned back for inspection.



X 3197

Fig. 7. Counter for sum-total meter.

+, make contact S, resistance r_3, make contact in the contact field b, break contact BR, make contact IR, —.

The relay BR will then be energized; the test relay TR, which is shunted with the resistance r_3, will remain energized.

On the energizing of the relay BR the following circuit will be closed:

—, make contact IR, one winding of the cut-off relay BR, make contact BR, the other winding of the cut-off relay BR, +.

Both windings of the cut-off relay will consequently be in action, and when energized the relay will break the currents through the relay TR, the relay SR, the counter S and finally the relay IR if the impulse contact of the corresponding meter is not still closed.

When the stepping relay and the test relay are no longer energized the counter SS and the selector W return to home position. The selector will then move on to the next position and remain there until the next impulse arrives from one of the meters.

Regarding the relay IR there are two cases to be considered:

1. the impulse contact K is not closed. The relay will then release and break the current through the cut-off relay. The impulse has then been counted and the relay IR will be prepared to receive the next impulse from the meter;

2. the impulse contact K still remains closed. The relay will remain energized on the energizing of the cut-off relay. As soon as the impulse contact breaks the current through the relay it will release, and this will also be the case with the break relay.

The switching device operates in the following manner: the switching clock OU has a contact, which is closed during one hour, open during the next hour, closed again during the next hour and so on.

As mentioned above, the relays TR and SR receive current over break or make contacts on the relay OR. When this relay is idle the relays TRI and SRI receive current, while the relays $TRII$ and $SRII$ are disconnected. When the relay OR is energized the conditions will be the contrary.

The relay OR is controlled by the clock OU in the following manner: when the contact of the clock closes the circuit:

—, make contact OU, relay OR, break contact TRI, (if TRI is idle), +,

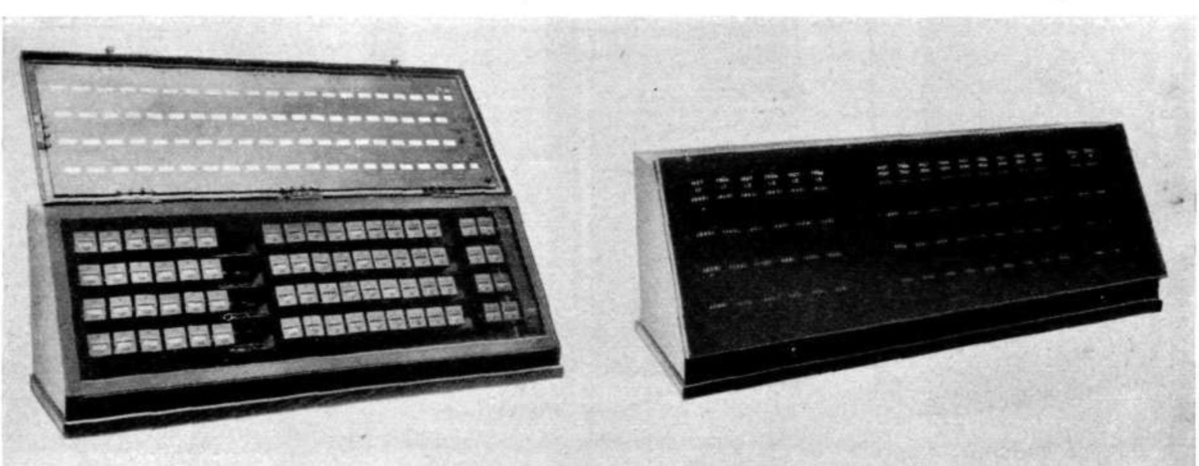
the relay OR will be energized and become connected direct to the positive pole over its own make contact. Should the relay TRI on the contrary be energized, *i. e.*, when an impulse is being counted, the circuit through the relay OR will not be closed until TRI is released, and consequently the counting has been completed.

After one hour the clock will break the contact, and the relay OR will be released, if the relay TRI is not then energized, *i. e.*, because an impulse is being counted; the negative pole will then be connected over the make contact of the relay $TRII$. When the counting has been completed and this relay is released the relay OR will also return to home position.

By this arrangement at the switch-over no impulses can be counted twice, nor can impulses be lost.

The operation of the part of the system that transfers the impulses from the meters direct over the impulse collected need not be described further. The operation in in main the same as that described above and will be understood immediately from closer study of the diagram, Fig. 4.

A. Petersén.



X 7054

Fig. 8. Counter desk for sum-total meter.

Fire-Signalling Installation in Copenhagen

The borough of Fredriksberg is situated in the centre of Copenhagen, and to this borough Telefonaktiebolaget L. M. Ericsson has supplied a plant for fire, ambulance and police signalling, which has recently been put into operation.

X 5154 Fredriksberg Fire Station.

The equipment for fire signalling is made up on the standardized Ericsson system with two Morse receivers. In addition to dealing with fires, the fire brigade is in charge of all ambulance services in the borough. The plant has therefore been provided with special arrangements which allow of the ambulance being called speedily for accidents.

In order to make the greatest possible use of the plant, the police station, which is in the same block as the fire station, has the possibility of calling policemen patrolling or stationed in the streets so that they may put themselves in communication with the station.

The plant contains the following equipment:

23 private fire-alarm boxes;

33 street boxes;

1 alarm board in the fire station with arrangements for receiving signals from the boxes and with equipment for the automatic connection of alarm bells and alarm lights in the station, etc.;

1 signalling apparatus in the police station for making signals by means of lamps at the street boxes.

The signalling mechanisms of the fire-alarm and street boxes are connected in series in four loops the terminals of which have been connected to the alarm board in the fire station. The loops are drawn of armoured underground cable.

Private Fire-Alarm Boxes.

The private fire-alarm boxes, which have been installed in schools, museums, large industrial buildings, etc., are of Ericsson's standard design Type TH 351, with a press button behind a glass panel for releasing the signalling mechanism and with telephone equipment. In the signalling mechanism there is room for release magnet and supervisory contact to make possible the releasing of the signalling mechanism from a local automatic or manual fire-signalling plant.

The signalling mechanisms have been provided with a special device for transmitting test signals; the number drum has two parallel cog discs which actuate the line springs when the signalling mechanism is released. On alarm only one of the cog discs actuates the contact group. For the transmission of test signals the contact group is removed by pressing a button so that it is actuated by both cog discs. The disc for test signals has an additional tooth, which actuates the line contact-group before the teeth of the other disc, which transmit the code signal of the box. On test signals an extra impulse will consequently be received by the alarm board before the code impulses. By this arrangement a perfectly reliable testing of all parts actuated on alarm signals is ensured, and at the same time the extra impulse prevents the alarm switch of the alarm board from calling the fire brigade involuntarily.

Street Boxes.

The street boxes are designed for use by the public for calling the fire brigde or the ambulance. The boxes are made of sheet-iron in the shape of rectangular pillars mounted on foundations of concrete at all important street crossings.

In the foundation and the bottom part of the box there are arrangements for automatic and manual traffic regulation (not supplied by

X 3253 **Fig. 1. Street box.**

Front, signalling devices; rear, public telephone; top, signalling lantern.

Ericsson), terminal blocks for cable circuits and a microphone battery for the fire-alarm box telephone.

The top part of the box contains at the front devices for fire, ambulance and police signalling and at the back, inside a special door, a prepayement public telephone connected to the telephone system of the city.

Signalling mechanism, relays and telephone equipment for the fire, ambulance and police signalling are fitted together in a small case of sheet-iron, the signal-transmitter-inset, which is put into the street box and is easy to replace in case of breakdown.

The signal-transmitter inset contains two signalling mechanisms with press-button release, one for fire signals and one for ambulance signals. The contact devices of these signalling mechanisms are so made that when both mechanisms are in operation at the same time the contacts of the ambulance mechanism are disconnected and only the signals from the fire-signalling mechanism are received by the alarm board. The ambulance always goes out from the fire station for fire signals. In addition these mechanisms have been provided with test-signal equipment similar to the signalling mechanisms of the private fire-alarm boxes.

Number discs in the two signalling mechanisms transmit code signals composed of four signs. The first sign indicates the character of the signal (fire or ambulance signal) and the three last signs indicate from which box the signals have been given. The three last signs in the two signalling mechanisms of a box are consequently identical. With test signals there is, as stated above, an additional sign before the four usual ones.

The signalling mechanisms have been provided with locking devices to prevent the external door of the boxes being closed when some of the signalling mechanisms are not wound up. In this case the glass panel protecting the press button belonging to the unwound signalling mechanism is broken.

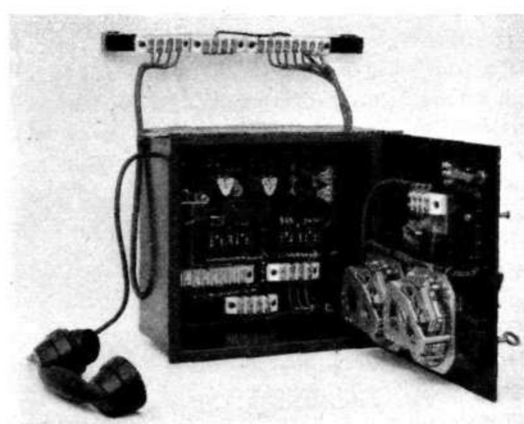
The telephone equipment of the street boxes is the same as in the private boxes, except that the short microtelephone of the fire-alarm boxes has been replaced by a modern bakelite microtelephone.

In the top of the box there is a cylindrical condenser lens of uncoloured glass with lamps for night light, police calling and »scaring» light.

The red night-light lamp indicates the position of the box at night. It is lit from the alarm board, and at the same time two other lamps are lit; these lamps are fitted behind translucent panels above the signalling mechanisms, one being marked *»fire»* and the other *»ambulance»*. For lighting and extinguishing these night-light lamps there are two relays in the box, mounted on a common bracket. The windings of the relays are connected in series in the loop and connected to a rectifier in such a manner that a current impulse through the loop in a certain direction passes through one relay winding and an impulse in the opposite direction passes through the other. When one relay attracts its armature the lamps are switched on by means of wolfram contacts on the relay, which is locked mechanically in this position and is released only when the other relay is energized.

The two relays will attract at a current of 150 mA, and, consequently, they are not actuated by the closed-circuit current (about 15 mA) or by the signal currents for police and reply signals mentioned below.

To make possible the calling from the police station of policemen in the streets there is a blue lamp in the top lantern which is switched on by means of a relay, the police-signalling relay, in the box. This relay is connected in series in the loop together with a relay for reply signals, and the windings of the two relays are connected to a rectifier in the same manner as the relays for night light, so that current in one direction actuates the police-signalling relay and current in the other direction the reply-signal relay. The relays attract at 70 mA, and, consequently, they are not actuated by the closed-circuit current. The current through the night-light relay will of course actuate the police-signalling relay as well, but since in



X 1372 **Fig. 2. Signal-transmitter inset.** X 1371

On the left picture: left, over the signalling buttons, night-light lamps; on the right picture: on the door, signal transmitters; in the box, relays for night light and signalling.

Fig. 3.
Alarm board in the fire station

Right, charging pane and telephone instrument; left, two line panels and telegraph receivers.

X 1381

this case it will only be a brief impulse it is of no importance.

A reply signal is sent out from the fire station after the alarm signal has arrived so as to inform the calling person that the signal has been received. Two lamps in the box placed behind a translucent signboard with the text »*signal received, wait here*» are lit from the alarm board. The lamps are switched on over two series contacts, one being fitted on the above-mentioned reply-signal relay and the other a mechanically actuated contact which is closed when the signalling mechanism has run down. The last-mentioned series contact prevents the lighting of the reply-signal lamps of those boxes in the loop from which alarm signal has not been given. In addition the lighting of the reply-signal lamps is prevented when current is switched on to the night-light relays in the loop.

To facilitate the passage of the telephone currents all relay windings inserted in series in the loop are shunted by condensers.

In the top lantern of the box there is in addition a powerful white lamp or »scaring» light, which is switched on over a mechanically operated contact as soon as one of the signalling mechanisms is started. At the same time an alarm bell in the box rings as long as the signalling mechanism is running. When the mechanism has run down the bell ceases to ring but the lamp will remain lit until the signalling mechanism is wound anew. The lamp and the bell are provided as a protection against false alarm. In addition the lamp indicates clearly the position of the box from which alarm has been given.

All lamps and the above-mentioned alarm bells are fed from the lighting mains, 220 V DC and 127 and 220 V, 50 c/s.

Alarm Board.

The alarm board is designed for the connection of four fire-alarm loops. It has three instrument panels of black enamelled slate fitted in a frame of black polished oak. Two of the panels, the line panels, are provided with instruments for the connection of two fire-alarm loops to each of them. On the third panel, the charging panel, there are arrangements for switching and charging the batteries, measuring the battery voltage and charging current as well as the insulation and resistance of the lines.

On the desk in front of the panels there are two double telegraph receivers, one for each line panel, and a telephone instrument. Under two glass windows fitted in the desk there is a list giving the positions of all fire-alarm boxes.

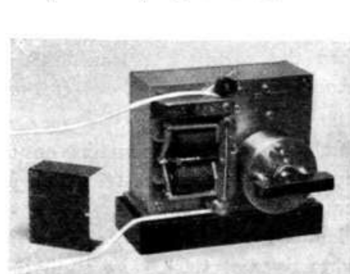
On a separate desk at the telephone switchboard there is supervisory Morse receiver of a stamping type, and there all incoming signals to the alarm board may easily be read. The stamping instrument has two magnet systems for stamping holes in a common paper ribbon, in correspondance with the code-signalling impulses. The windings of the magnets receive current impulses from contacts on impulse relays in the automatic alarm switches; one of the magnets records signalling impulses arriving over the left branches of the line panels and the other those arriving over the right branches.

In addition to the standard equipment the two line panels are provided with devices for lighting and putting out the night lights at the boxes, arrangements for making possible the transmission of calling signals from the police station to the boxes, arrangements for sending out reply signals, with time relay for limiting the length of the signals, and equipment for the automatic interruption of police-calling signals when alarm is given from a fire-alarm box in the loop or when faults occur in the loop.

In addition each line panel has an automatic alarm switch for connecting automatically the corresponding local alarm and signalling circuits when alarm signals arrive from the fire-alarm boxes. The alarm switch is made as a register, which is directed by the impulses of the code signals and then transmits the signals for fire, fire test, ambulance or ambulance test that correspond to the position of the register.

In the upper part of the alarm board there is a lamp board with the following indicating lamps:

lamps for »*fire*, »*ambulance*» and



X 3252 **Fig. 4. Morse receiver with stamping device.**

Fire-Alarm Installation in Helsingfors

Telefonaktiebolaget L. M. Ericsson has received an order for a fire-alarm installation for the new fire station in the Berghäll district of Helsingfors.

X 5156 **Berghäll Fire Station.**

A large number of fire-alarm boxes connected in a signalling system controlled by supervisory current are installed in Helsingfors. The town has expanded considerably during the last few years, and it has been found necessary to build a new fire station in the Berghäll district. In connection with the erection of the new station the fire-signalling system was also modernized.

The new installation, which consists of an alarm board and about eighty alarm boxes, is in the main of Ericsson's normal design, but several improvements have been incorporated.

The fire-alarm boxes, which are similar to Type TH 371, are fitted with arrangements making it possible for the public to give the fire station information by telephone of the extent of the fire etc. After the alarm signal has been sent a reply signal is sent by the fire station, and a flap on the front of the alarm box falls down, giving access to a microtelephone.

The alarm board is fitted with several new devices; at night the doors of the fire station are opened automatically in case of alarm; moreover, code signals are sent to the fire-brigade barracks indicating whether the call is for a chimney fire, ambulance or fire. In addition the lighting of the whole station is switched on in case of alarm.

In order to register the time elapsing between receipt of the alarm signal and departure of the fire brigade, the alarm board is fitted with a chronometer which is set going by the alarm signal and stopped as the fire engines pass contacts in the floor on leaving the station. With a view to facilitating orders to the drivers, a board mounted in the garage indicates the number of the calling alarm box in luminous figures.

The central board is further fitted with a supervisory Morse receiver of stamping type. The signals from this receiver are intended to be transmitted to the central board in the main fire station, which is constructed on another system.

The fire station is now in service, and on one of the very first days of working it received its baptism, signals being received from three alarm boxes in one minute. The new system immediately proved its worth, as the firemen were able to get to the scene of the conflagration very rapidly, a matter of particular importance in this case as the outbreak of fire was at a pyrotechnic factory.

E. Lundgren.

»*test*», which are lit by the automatic alarm switches,

lamps for »*driving spring*» which are lit over a contact device in the corresponding morse instrument when the spring has run down or become faulty,

lamps for »*telegraph paper*», which are lit over contacts on the paper drums, when the telegraph paper is coming to an end,

lamp for »*police signal*», which lights up and flashes as an indication that police signal is sent out from the police station,

lamp for »*charging*», which is inserted in series in the charging circuit.

The telephone instrument fitted on the desk is made of black bakelite and fitted with three press buttons and dial. By means of the press buttons *L1* and *L2* the instrument can be connected to the fire-alarm loops of the two line panels, and by means of the third press button *L-aut* to a local automatic telephone exchange. By this instrument telephone communication can be arranged between the box telephones and the instruments connected to the local automatic exchange.

Signalling Apparatus in the Police Station.

The signalling apparatus consist of four keys and a supervisory lamp fitted in a case of black enamelled sheet-iron. The four keys correspond to the four fire-alarm loops connected to the alarm board. On calls the key is thrown that corresponds to the loop on which signalling is wanted. The policemen communicate with the police station in answer to the calling signals by using the public telephones at the back of the street boxes.

S. Nilsson.

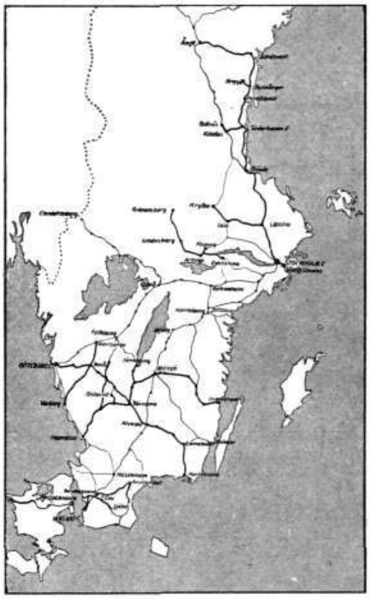
Selective-Calling Telephone Plants in Sweden

Since the Ericsson selective-calling telephone system was introduced about a year ago it has gained much ground, as may be seen from the map, Fig. 1, and the table below. The system in all important features is as described in the Ericsson Review No 1, 1933, but several improvements have been made. The telephone instrument proper is now similar to the Ericsson standard telephone set of bakelite, Fig. 2, and in addition the selector has been redesigned, see Fig. 3.

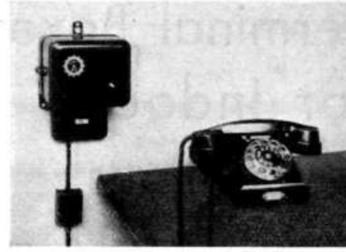
In order to simplify the work of installation, the main telephone equipment and the power plants are supplied completely fitted and wired. Fig. 4 illustrates a station equipment for two selective-calling lines and one automatic power plant for connection to AC mains.

The telephone instrument proper in main being a LB telephone fitted with a dial but without magneto, the possibility of connecting it to several lines has been used to a certain extent and in this case *one* telephone will be sufficient. The switching to the various lines is then carried out by means of keys. In this manner it is possible to utilize the good transmission properties of the selective-calling telephone instrument on other lines having equipment of older types. Ring signals are in this case sent by means of a small transformer which is connected to the lighting mains by means of a press button. The old magneto telephone is then only used as a reserve in case of breakdown at the mains.

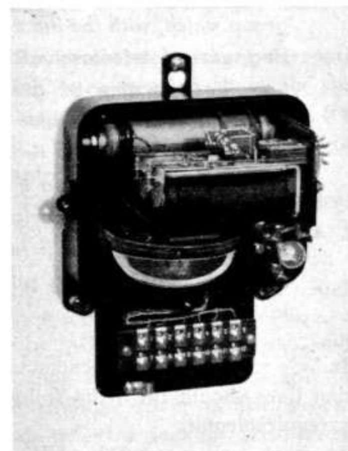
H. V. Alexandersson.



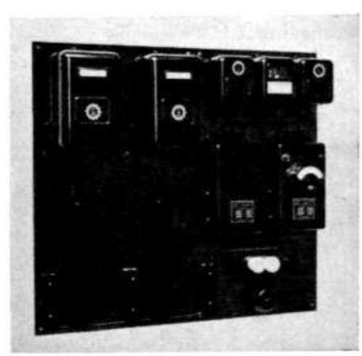
X 3205 **Fig. 1. Selective-calling telephone plants in Sweden, 1/8 1934.**



X 3260 **Fig. 2.**
Telephone instrument with selector unit of new type.



X 3261 **Fig. 3.**
Selector unit,
with cover removed to show the new selector.



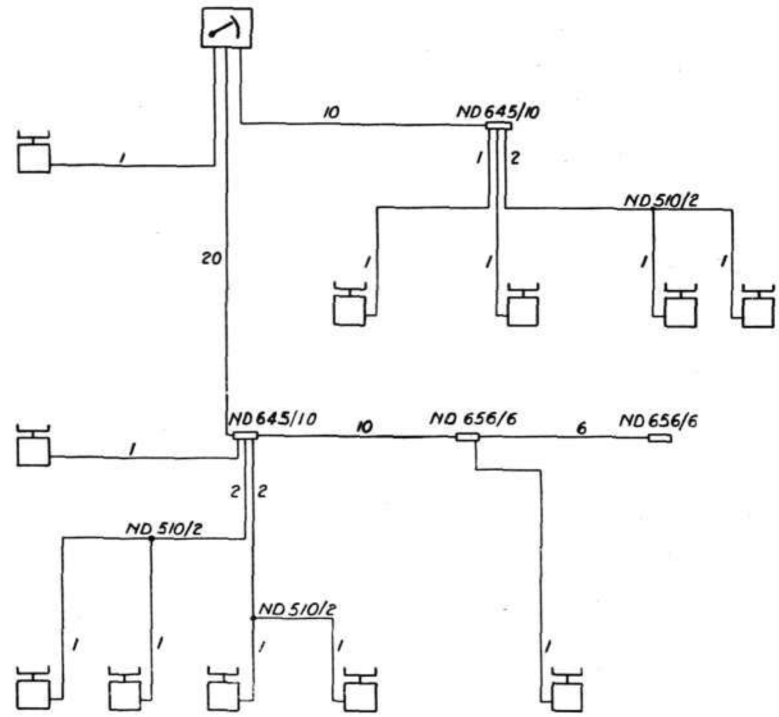
X 3262 **Fig. 4.**
Station equipment for two selective-calling lines, with power plant.
Left, two line equipments with connecting strips; right, automatic power plant for AC containing: top, buzzer generator, charging-control apparatus and commutating relay; middle, rectifier for impulsing voltage and charging; below, connecting strip, fuses and switch.

railway	length of line km	sections	telephones	automatic exchanges	telephones
State Railways:					
Stockholm—Upsala—Gävle	180	4	42	5	40
Stockholm—Upsala—Krylbo	161				
Gävle—Söderhamn—Hudiksvall—Harmånger—Sundsvall—Ånge	348	7	69	3	42
Malmö—Barsebäckshamn—Sjöbo	108	2	28	—	—
Private Railways:					
Göteborg—Småland—Karlskrona	353	3	10	1	6
Östra Skånes Railways	106	3	29	1	5
Grängesberg—Oxelösund	152	3	37	1	16
Nässjö—Oskarshamn	148	3	33	1	5
Halmstad—Nässjö	421	7	80	1	8
Varberg—Borås—Herrljunga	127	3	24	1	—
Stockholm—Saltsjöbaden	18	2	11	—	—
total	2 122	37	363	14	122

The lines are chiefly overhead lines. An exception is the section Stockholm—Upsala—Krylbo which is made as loaded cable.

Terminal Boxes for Indoor Installations

Line material for indoor telecommunication installations differs in many respects from the corresponding material for outdoor installations. Indoor material may therefore be regarded as a separate group which, with the increasing use of telecommunication, has become of great importance. In telecommunication systems the reliability of the distributing material is a very important factor, although sufficient attention is not always paid to it.



X 5152 Network of private automatic exchange.

Indoor material for telecommunication lines should fulfil the following requirements:

1. *simple and inexpensive fitting:* it has proved in practice that the cost of fitting is as a rule one of the heaviest expenses of an installation; the fitting of material bought at a cheap price is in many cases so expensive that it swallows up many times over the saving made on purchasing;

2. *attractive, discreet appearance, small dimensions, simple and invisible wiring:* the apparatus is often installed in managers' rooms, homes, etc., where wiring arrangements of this kind seem out of place, and on account of this they should be as little noticeable as possible;

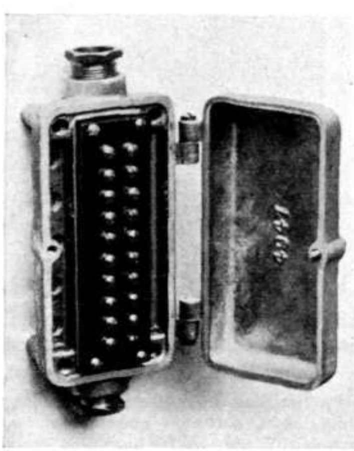
3. *short wiring:* next to the fitting, the cables and other conductors constitute an appreciable expense in the installation, and consequently the employment of a small amount of line material is an economic condition;

4. *few types of terminal boxes, terminal blocks etc.:* this involves: fewer mounting instructions to be learnt; simpler storing; lower prices, as larger quantities of individual types can be ordered;

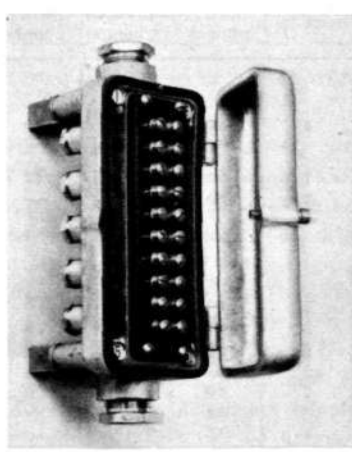
5. *satisfactory insulation and protection against moisture, dust etc.* for the conductors of the cables;

6. *it should be possible to seal* the distributing apparatus so that only authorised persons can have access to the connections;

7. *screw terminals to avoid soldering:* in this manner the following items will be avoided: risk of fire, need for soldering-irons and blow lamps, etc.



X 3240 **Fig. 1. Terminal box, Type ND 645/10,** normal design.



X 3241 **Fig. 2. Terminal box, Type ND 645/10,** extra tight design.

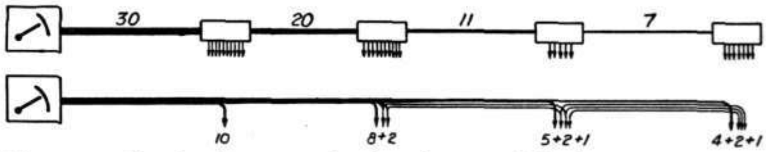
Telefonaktiebolaget L. M. Ericsson has recently completed a series of modern terminal boxes and blocks; this material is based on experience of many years and fulfils all the requirements above stated. It is chiefly designed for indoor installations of cables with cotton insulation and lead sheath, but may also be used for other kinds of wiring. The wires may either be run along the walls or set in the walls in lead plated piping. In the latter case the distributing and connecting points are placed partly in lead coated boxes and partly in special terminal boxes built into recesses, the distributing apparatus being placed in these boxes.

Some types of terminal boxes in this series are shown in Fig. 1, 2, and 5; the terminal blocks being shown in Fig. 8, 9 and 10.

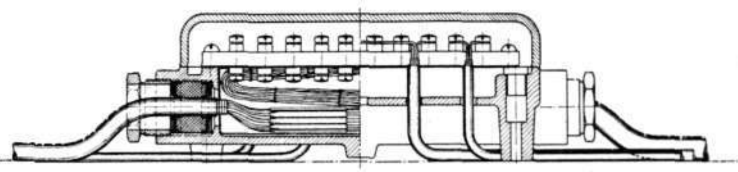
Fig. 3 illustrates how the boxes are used. From this picture it is evident that not only can the boxes be used for end distribution, but a cable from the exchange to the box (max. 30 pairs) can partly be distributed and partly *continue*, say as as 20-pair cable to the next terminal box; in this latter box the cable can be again partly distributed and the rest of the conductors carried on in a smaller cable to the following box, and so on until the end distribution point is reached.

Fig. 3 also shows how, by convenient connection of the incoming, the continuing and the small distributing cables leading from the box, it is possible to arrange parallel connections, internal lines etc. In addition this makes possible the efficient utilization of spare lines.

The following standard types are manufactured:



X 5151 Fig. 3. Diagram, showing the use of the boxes for connecting telephone instruments to a private exchange and for arranging internal lines etc.



X 5155 Fig. 4. Section of box, Type ND 645/10.
Left, joint between the incoming and outgoing cables; right, outgoing 1-pair cables.

Terminal Box, Type ND 645.

The box cast of light-metal (silumine), Fig. 1, has a terminal block of insulating material with double-side screw terminals which are used for connecting the conductors of the main cable and those of the smaller distributing cables.

The incoming cable and the continuing cable are connected in a gland, provided with an extra-tight Gebe packing, see Fig 4. The two cables are jointed together by means of copper sleeves and paper tubes using a splicing pincer, Type NK 200/1.

At an end distribution point one of the packings will be a blind packing.

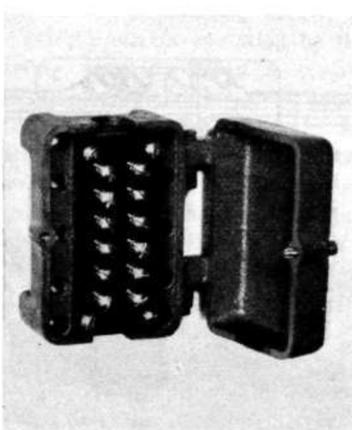
The silumine cover is fixed to the case by a special screw, which can be sealed.

In those cases where a separate earth wire is enclosed in the main cable a boss inside the box is fitted with a special terminal screw for connection of the earth wire.

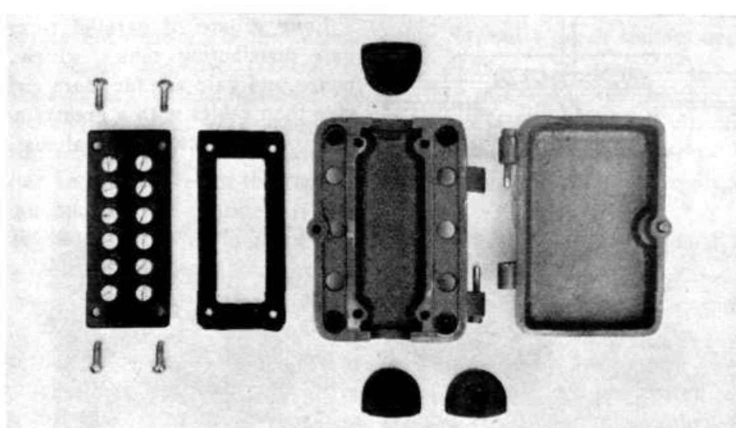
The smaller distributing cables, as a rule 1, 2 or 4-pair cables, are drawn through the 10 holes on the long sides of the box, Fig. 1 and 4. If special tightening is required for these cables, glands with rubber packing are fixed in these holes and the silumine cover is also provided with an extra packing, see Fig. 2.

Terminal Boxes, Type ND 655 and ND 656.

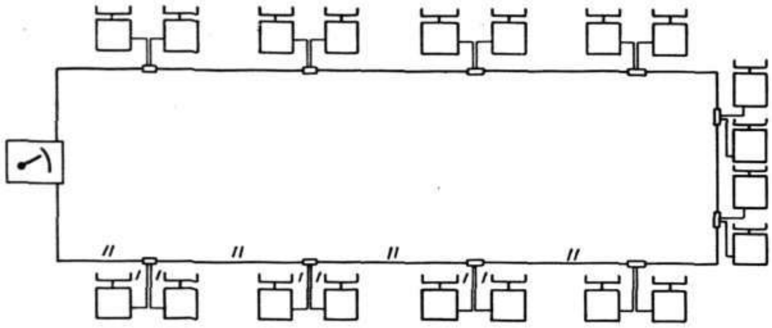
These boxes, Fig. 5 and 6, are similar to those described above. They are made of light-metal, Type ND 655, or of cast iron, Type ND 656,



X 3242 Fig. 5. Terminal box, Type ND 656/06.



X 5149 Fig. 6. Terminal box, Type ND 656/06, dismounted
Left to right: connecting strip, packing, box and cover; top and below, the new rubber packings.



X 5150 **Fig. 7. Diagram, showing connecting on the loop system of telephone instruments to a private exchange.**

and have terminal blocks with double-side screw terminals.

Instead of glands two rubber packings of a new design, Type ND 856 and ND 860, see Fig. 6, are used for the main cables. These rubber packings may be cut so that they need not be threaded onto the cables but may be fitted round the cable afterwards. This will facilitate the mounting in recesses where the space is often very small and it is more convenient to place the cables in open slots than to thread them through glands which have to be drawn tight afterwards.

Packing mounted in this way will give a very tight joint under normal conditions.

The new packings also make possible the use of a through cable from which the distributing lines are tapped, thus avoiding the necessity of jointing to the continuing cable. Through cables are used for parallel connections and in some other cases.

Terminal Block, Type ND 610/2,

This simple distribution block, Fig. 8, with sealable cover is specially designed for the loop system. Its main principles are shown in Fig. 7, and it is chiefly used in stores and offices, where the rooms are along a corridor forming a loop. The loop may of course also lie in a vertical plane. The loop system will in such cases make possible a very elegant method of wiring and considerable saving in wiring material.

Long groups of parallel 1- or 2-pair distributing cables, which per metre and pair are far more expensive than cables with a greater number of conductors, are almost entirely eliminated. One cable of 10 pairs or more is drawn round the loop. From this cable short branches with one or as a maximum two 1-pair cables or one 2-pair cable are tapped.

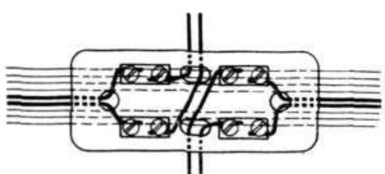
A telephone installation on this system with a 10-pair cable can have 20 subscribers connected.

For ordinary jointing of 1, 2 or 4-pair cables, in cases where sleeves or lead joints cannot be used, or for the distribution of 2 or 4-pair cables into smaller units, use is made of terminal blocks, Type ND 510/1 and ND 510/2, and Type ND 512/4, Fig. 9, all of which are fitted with sealable covers.

For fire alarm installations where 2-pair cables with earth wire are used or where the conductors are of unusually large diameter, blocks, Type ND 530/2, Fig. 10, are used. These blocks have extra heavy terminals, slots for the earth wire and a sealable cover identical with that used on the distribution block for loop systems, Type ND 610/2.

The distributing material described above may be combined in many different ways. The most suitable combination for each case can only be decided after the data available regarding the installation in question have been thoroughly examined.

E. A. Englund & P. Priklonsky.



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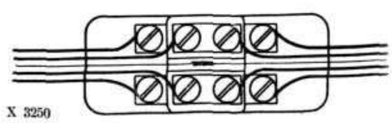

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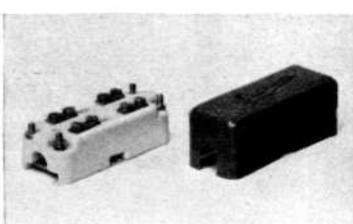
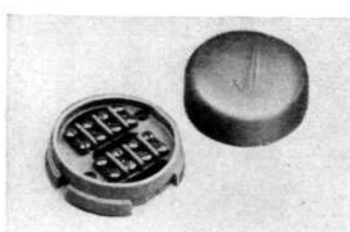
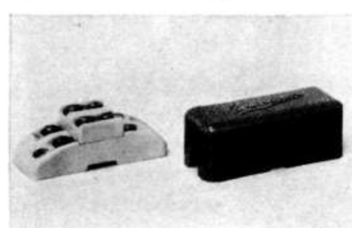


X 3243 **Fig. 8. Terminal block, Type ND 610/2.**



X 3244 **Fig. 9. Terminal block, Type ND 512/4.**



X 3245 **Fig. 10. Terminal block, Type ND 530/2.**

Revertive-Impulse Repeaters for AC

As stated in the article »The Automatization of the Suburban Telephone System of Stockholm» in the Ericsson Review No 4, 1933, revertive-impulse repeaters are used for impulse transmission over the phantomized and loaded cable circuits which constitute the single-direction junction circuits between the Stockholm and Lidingö automatic exchanges.

This is the first plant in the world where selectors for revertive-impulse control are directed by AC over two-wire junction circuits.

As is well known the Ericsson automatic system with 500-line selectors operates with registers and revertive impulses. Under normal conditions this is carried out by a starting current being sent out from the register over one of the speaking wires, after which the revertive impulses are sent back to the register over the other speaking wire from the selector set in operation by the starting current. When a certain number of revertive impulses, determined by the position of the register, has been received, the starting current is switched off and the selector will stop at the next centering position.

Revertive-impulse repeaters on junction lines have to operate with the following signals:

1. forward calling signal;

2. backward reply signal, for ensuring that the junction line is in order and that its group selector is in home position;

3. forward starting signal, by means of which the group selector is started;

4. revertive impulses from the selector to the register for controlling the movement of the selector in the calling exchange;

5. forward stop signal from the register, by means of which the selector is stopped at the desired position;

6. backward reply signal, which is sent out when the called party answers and which prepares for metering;

7. disconnecting signal.

All signals over the junction lines consist of AC impulses. On single-direction lines the calling signal may be combined with the starting signal and the reply signal with the first revertive impulse, if the group selectors which hunt over the lines in question are made so that they leave the line on which the selector has tested and search for a new one, should the test circuit be opened in the meantime. In this case the first starting signal serves as a calling signal and the first revertive impulse as reply signal. If a revertive impulse is not immediately received as a reply on the first starting impulse, the test circuit is opened for a moment, and the connection finds another junction line.

The *starting* signal from the register is repeated in the outgoing repeater and is transmitted as an AC impulse onward over the junction line.

The *revertive impulses* from the selectors are repeated in the incoming repeater and are transmitted backwards as AC impulses over the junction line, after which they are again repeated in the outgoing repeater and forwarded to the register or an intermediate repeater, if any, as DC impulses. This impulse repetition, however, takes a certain time and must be compensated for.

In order to render the compensation independent of the number of junction lines which the revertive impulses have to pass, the repeaters are made so that one extra revertive impulse is added for each junction line. Consequently, each incoming repeater transmits one additional revertive impulse after the starting impulse has been received, and not until then will the selector start and send revertive impulses. When *stop signal* is transmitted by the register, one additional revertive impulse will consequently always have to be transmitted before the selector has reached the correct position. This impulse lies stored in the impulse repetition in the repeaters. The stop signal is only indicated in the outgoing repeater, and not until the next impulse will it be forwarded to the selector or to the outgoing repeater of the next junction line.

The method used for *transferring the stop signal* from the register onward to the selector at the same time as revertive impulsing is carried on is worth special description. This method is based on a differential connection and is illustrated in the diagram.

The relays *UR11* and *IR3* are fed with AC over rectifier bridges; all the others are ordinary relays fed direct with DC. The starting signal from the register is sent out over the resistance *r* and the break contact of the relay *RR8* to the relays *UR5* and *UR1*, which are energized. The first — *i. e.,* extra — revertive impulse is then transmitted backwards from the incoming repeater and causes + to be connectetd to the switching contact of the relay *UR11*. By this the relay *RR7* will be energized over a make contact on the relay *R1* and a break contact on the relay *UR11*. The repetition of the starting signal over the junction line is not illustrated in the diagram, nor is the connecting process for transmitting the additional reply impulse.

The revertive impulses are repeated by the relay *IR5* in the incoming repeater and the relay *UR11* in the outgoing repeater. When the revertive-impulse selector in the register has moved on to the right position, *i. e.,* the translation has been completed, the relay *RR8* will be energized and the relay *UR1* released.

In the Ericsson system one closing and one breaking of the current in the revertive-impulse loop is reckoned as one impulse. There are consequently two possibilities: either the line is live or it is dead when the the translation of the register is indicated in the outgoing repeater.

If the line is live when the current impulse ceases, *i. e.*, when the next impulse arrives, a stop signal may be sent forward over the line. This is carried out during the release time of the relay *UR6*, after the relays *UR11* and *UR5* have been released. The relay *IR3* will then be energized and the relays *IR4* and *RG2* released, after which the selector will stop.

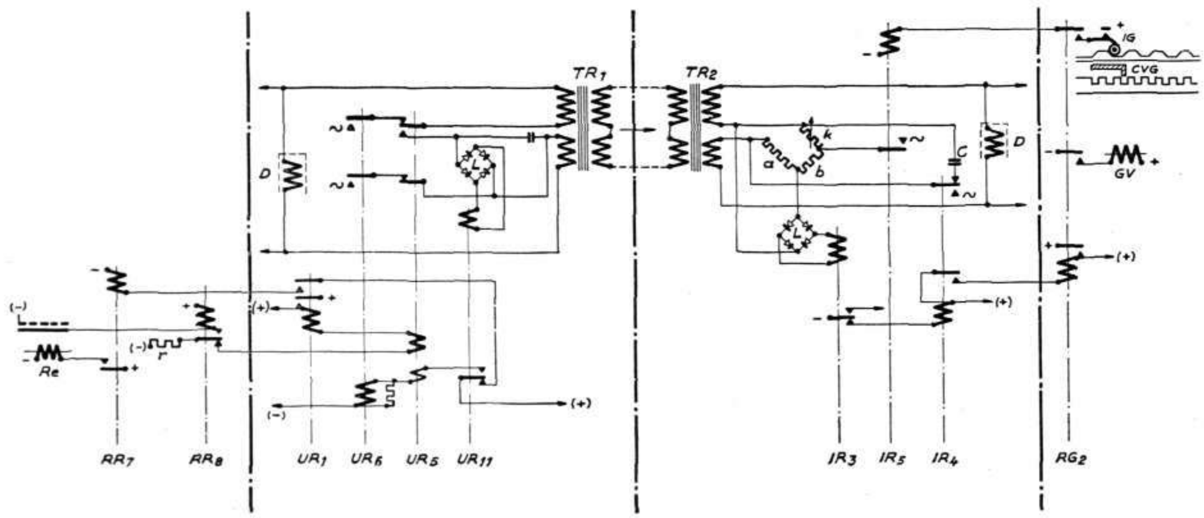
If, on the other hand, the line is dead when the relay *RR8* is energized, the relays *UR11* and *UR6* will be released which will cause the two relays *UR5* and *UR1* to be released, Stop signal will then not be transmitted to the selector until during the next impulse, *i. e.*, when AC is again sent out over the line from the incoming repeater. In this case the stop indication consists in the exchange side of the transformer *TR* being left open. The connecting process will then be as follows: the supervisory relay *IR3* lies in an AC bridge, the ratio resistances of which are *a* and *b* and the line balance *k*. By adjusting the resistance in the relay *IR3* to a suitable value it is possible to render tension and curren on the line side of the AC bridge almost completely of equal phase, and the balancing may be carried out by means of an ohmic resistance. When the relay *UR11* is disconnected by the relays *UR1* and *UR5*, the line will, however, become heavily capacitive, the balance of the AC bridge will be disturbed, and current will be switched on by the relay *IR3*. The relays *IR4* and *RG2* will be released, after which the selector *GV* will stop.

The *reply signal* when the called party answers is repeated and transmitted by the incoming repeater as an AC impulse backwards over the junction line.

The *disconnecting signal* after the close of the conversation consists of a long AC signal.

The AC signals must be limited to the junction line, partly to protect the operating relays inserted behind the line equipment, and partly to protect the subscribers from acoustic shocks. For this purpose each repeater has been provided with a filter which lets through only the frequencies above 200 c/s. This filter is composed of a low-resistance choke *D* and a condenser *C*, which is inserted during conversations in the mid-point of the transformer and shunts the relay *UR11* or *IR3*.

K. Lundkvist.



X 7062

Diagram of revertive-impulse repeaters for AC.

a, b	ratio resistances	IR 3	signalling relay	RR 7	revertive-impulse relay
C	filter condenser	IR 4	starting relay	RR 8	translating relay
CVG	centering hook	IR 5	revertive-impulse relay	TR 1, TR 2	line transformers
D	filter choke	L	rectifier bridge	UR 1	starting relay
GV	group selector	Re	register selector	UR 5, UR 6	operating relays
IG	revertive-impulse contact	RG 2	starting relay	UR 11	signalling relay

New Measuring Instruments

Universal Attenuation Measuring Set, Type ZB 465.

X 3204 Fig. 1. Attenuation measuring set, Type ZB 465.

A very useful instrument for measuring attenuation and phase shift has been designed by Ericsson, Stockholm. The instrument is shown in Fig. 1. It contains a non-distorting attenuating network, which is variable within the range 0—13.1 neper in steps of 0.01 neper, and a phase-shifting network, by means of which the phase of the output voltage of the attenuating network may be shifted without alteration of the peak value. By means of one four-way dial and three dials with readings in an auxiliary quantity η, variable within the range 0—1.11 in steps of 0.001, the above-mentioned output voltage may be phase-shifted 2π.

The phase angle, which will be indicated by a_A may be calculated in the following manner:

1st quadrant

$$a_A = 2 \operatorname{arctg} \eta$$

2nd quadrant

$$a_A = \pi - 2 \operatorname{arctg} \eta$$

3rd quadrant

$$a_A = \pi + 2 \operatorname{arctg} \eta$$

4th quadrant

$$a_A = 2\pi - 2 \operatorname{arctg} \eta$$

Special tables, which are supplied with the instrument, allow for a convenient calculation of these data.

The fact that the measuring frequency is not contained in the formulae for the phase angle depends on the phase-shifting network being adjusted for each frequency by means of three dials with readings in c/s. In addition the instrument contains two variometers with dust-iron cores, one transformer, a number of keys, matching resistances and terminals. By means of these parts various measuring arrangements according to bridge and compensating methods may be composed. All measurements are carried out by adjusting the sound minimum, and the attenuation and the phase angle are varied successively until the earphone or the valve voltmeter is dead. The instrument is suitable for:

delivery tests of lines, repeaters, filters, transformers, etc.;

the following measurements may be carried out:

1. measurement of the image attenuation,
2. measurement of effective attenuation,
3. measurement of gain,
4. measurement of echo attenuation,
5. measurement of cross-talk attenuation,

technical and scientific investigation of various kinds;

in addition to measurements 1—5 it is possible to carry out:

6. measurement of image phase angle,
7. measurement of effective phase angle,
8. measurement of transmission time and velocity of propagation,
9. measurement of the distance to a reflexion point,
10. measurement of the distance to a point where cross-talk occurs,
11. measurement of the effective attenuation of a line without using auxiliary line and without instrument or skilled staff at the far end of the line.

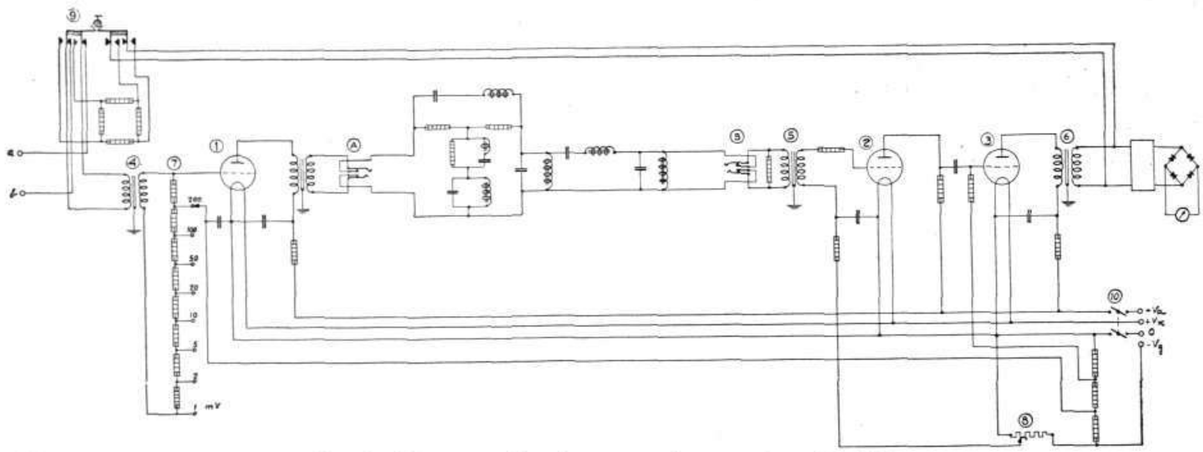
Measurement 11 evidently ensures that all lines from the central point of a line system can be checked by means of only one instrument of this type placed at a central point, and that only one skilled person is required for the checking. The usual measurements require, as will be known, instruments and skilled staff at both ends of the line.

The instrument and its application will be treated in more detail in a future article.

Noise Measuring Set, Type ZB 175.

A noise voltage induced on a telephone circuit is as a rule composed of several different frequencies. When measuring a noise voltage, the frequencies composing this voltage must cause a deflection on a measuring instrument, which is proportional to its disturbing effect on telephone conversations. After a series of intelligibility tests the CCIF has prescribed a curve, which reproduces the disturbing effect as a function of the frequency. Earphones of the usual type have been used in the tests, and, consequently the curve shows the total sensitivity of the ear and the earphone to induced noise voltages of various frequencies. Ericsson, Stockholm, have now designed a noise measuring set, which follows the desired curve as stated by the CCIF.

Fig. 2 shows the diagram. The instrument consist of an amplifier and a filter. Since the instrument should not act as a load on the telephone circuits to which it is to be connected in parallel, its input impedance has been made about 20 000 ohm. The input transformer *4* is terminated by a high-resistance potentiometer *7* for regulating the sensitiveness from 1 mV to 200 mV. The filter has been inserted between the valves *1* and *2*. After the filter there is a grid transformer *5* and two valves in resistance-condenser connection; the valves are matched to a cuproxide-rectifier instrument by means of the transformer *6*. This arrangement ensures that the input impedance may be kept high, that the filter may be designed



X 7061

Fig. 2. Diagram of noise measuring set, Type ZB 175.

1—3 amplifier valves
4 input transformer
5 grid transformer
6 output transformer
7 potentiometer for regulating the sensitivity
8 grid-bias potentiometer
9 gain-adjustment key
10 battery switch
A, B jacks for using the instrument as a valve voltmeter

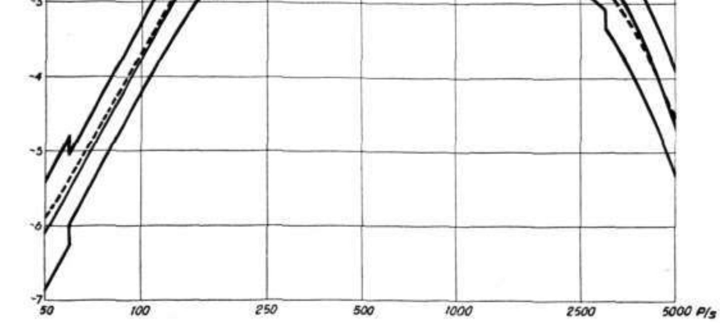
for an image impedance which gives suitable value of the included parts, and that the voltage fed to the filter will be low.

Suitable matching of the indicator instrument to the output valve ensures that the deflection rises practically with the square of the input voltage; consequently, the instrument may be calibrated to read the rms value of the voltage, as has been prescribed by the CCIF. The instrument is graduated in mV, and by regulating the potentiometer *7* the sensitivity may be varied so that full deflection of the instrument represents 1, 2, 5, 10, 20, 50, 100 and 200 mV at 800 c/s. With regard to disturbing effect the various frequencies are compared with a voltage of the frequency 800 c/s.

Fig. 3 shows the sensitivity curve prescribed by the CCIF as well as allowances and the corresponding curve measured on the noise measuring set. The measured curve follows the prescribed curve closely, as may be seen from the illustration. When manufactured the instrument is adjusted with a 800 c/s current of known intensity; consequently, the amplifier will have a definite amplification, and the adjustment will be valid as long as this amplification remains. The adjustment of the correct amplification is then made by pressing the key *9*; the amplifier is then fed back over an attenuating network. By alteration of the grid bias of the valve *2* by means of the potentiometer *8*, the amplification is adjusted to the correct value; when this value is reached the amplifier will start to sing, and the instrument will give a deflection.

The required filament tension is 2 V, and the total filament current will then be 0.4 A. An anode battery of about 110 V is required for the anode and grid tensions. The total anode current will be 8—10 mA.

Fig. 4 shows the complete noise measuring set. It is made as a portable instrument and fitted in a case of 324×264×250 mm including the lid. The jacks *A* and *B* permit the disconnection of the filter so that the instrument may be used as an ordinary valve voltmeter. This may be carried out either by using the input terminals *A*, which will give an input impedance of about 20 000 ohm and a maximum amplification of about 7.5 neper, or by making the input at *B*, which will give an input impedance of 600 ohm and a maximum amplification of about 6 neper. If a suitable attenuating network be inserted between



X 5121

Fig. 3. Sensitivity curve of noise measuring set.

a curve prescribed by the CCIF
b allowances prescribed by CCIF
c curve measured on Type ZB 175

X 3229 **Fig. 4. Noise measuring set, Type ZB 175.**

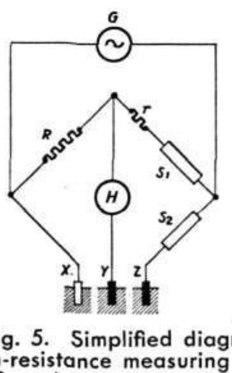
A and *B* the adjustment may remain the same and the instrument may then with sufficient accuracy be used as a direct-indicating instrument for the measurement of low voltages.

If the noise measuring set is to be used for the measurement of generating noise tensions, a complementary filter varying with the frequency must be inserted.

Earth-Resistance Measuring Set, Type ZA 140.

The principles of the earth-resistance measuring set are shown in Fig. 5. The measurement is carried out by varying the resistances *R* and *r* successively until a sound minimum is obtained in the earphone *H*. The following equation will then be valid:

$$\frac{X}{R} = \frac{Z + S_2}{r + S_1} \qquad \text{I}$$



X 3224 **Fig. 5. Simplified diagram of earth-resistance measuring set.**

G	buzzer
H	earphone
R, r	variable resistances
S_1, S_2	impedances
X, Y, Z	earth resistances

But *X*, *Z*, *R* and *r* are practically entirely real and S_1 and S_2 entirely imaginary. Consequently the following relation will be obtained:

$$\left.\begin{array}{l} X \cdot r = Z \cdot R \\ X = R\dfrac{S_2}{S_1} \end{array}\right| \qquad 2$$

For the case when $S_1 = S_2$ we get

$$X = R \qquad 3$$

From equation I it is evident that if

$$\left.\begin{array}{l} S_2 >> Z \\ S_1 >> r \end{array}\right| \qquad 4$$

the measurement will become practically independent of *Z* and *r*. If consequently the impedances S_1 and S_2 are made very great the resistance *r* may be dispensed with and the sound minimum may be adjusted by means of the resistance *R* only.

The increase of the impedances S_1 and S_2 will, however, reduce the measuring current, and consequently the accuracy. This inconvenience is however avoided by joining the impedances S_1 and S_2 to a differential choke coil.

Fig. 6 shows the diagram of the complete measuring arrangement. The measuring ranges obtainable by means of the resistances R_1 and R_2 and the key *O* are

0—2 ohm
0—20 ohm
0—200 ohm.

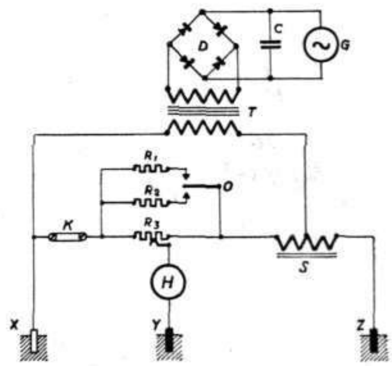
The earth-resistance *X* to be measured is read directly on the scale of the slider of the resistance R_3, except for one multiple of 10, which is determined by the position of the key *O*.

For greater resistances than 200 ohm the short-circuit *K* is opened and additional resistances are inserted.

The rectifier bridge *D* serves to double the frequency of the buzzer from 400 to 800 c/s

The inevitable acoustic disturbance from the buzzer will thus be less troublesome, as the ear will be able to distinguish it easily from the measuring frequency. In those cases where there is other loud accoustic disturbance, *e. g.*, street noise or engine noise, the earphones may suitably be replaced by a valve voltmeter.

The instrument is shown in Fig. 7.



X 3225 **Fig. 6. Diagram of earth-resistance measuring set, Type ZA 140.**

C	condenser
D	rectifier
G	buzzer
H	earphone
K	short-circuiting link
O	*key for selecting the measuring range*
R_1, R_2	range resistances
R_3	variable resistance
S	differential choke coil
T	transformer
X, Y, Z	earth resistances

Line Transformer, Type RM 550.

Ericsson, Stockholm, have designed a new line transformer, Type RM 550, which as far as possible fulfils all requirements set on a perfect line transformer.

The core has a toroïdal shape and has been fitted in a black enamelled cover of the dimensions 115×115×49 mm. Each winding is divided in two parts, and each part is connected to two terminals; the mid point of each side will consequently be accessible. Fig. 8 shows the complete transformer.

X 3226 **Fig. 7. Earth-resistance measuring set, Type ZA 140.**

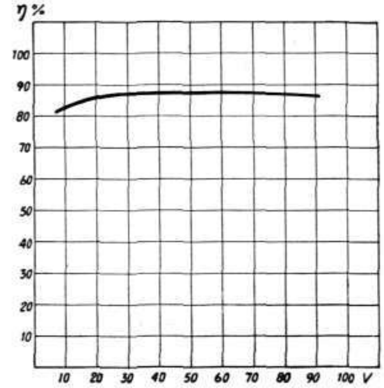
X 3223 **Fig. 8. Line transformer, Type RM 550.**

The properties of the transformer at voice frequency are presented in the curves, Fig. 9, which show the effective attenuation measured according to the prescriptions of the CCIF (Appendix Bc 3, No 3) who prescribe that the attenuation at frequency range must be $\leq$ 0.08 neper (0.7 db) when the input is varied between 1 mW and 50 mW. The minimum attenuation is 0.045 neper (less than 0.4 db) and, as may be seen, the frequency range is very wide.

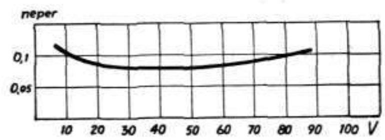
The properties of the transformer at ringing frequency cannot be obtained from one measurement only. The CCIF prescribes that the power efficiency must be greater than 55 % when the transformer is terminated by a resistance of 2 000 ohm on the line side and the voltage on the primary side is 45 V.

Since in actual service a line transformer will operate with tensions of varying voltage (10—90 V as an average at ringing frequency) it is of importance that the transformer has a high efficiency within the whole of this range. Fig. 10 shows the power efficiency as a function of the voltage on the primary side of the transformer at 20 c/s. Within the whole range the efficiency is higher than 83 %. Since, however, a measurement of the power efficiency does not take into account the attenuation produced by the reactive current in the transformer, a measurement of the effective attenuation has been carried out at 20 c/s with the transformer matched to 2 000 ohm. In other respects the measurement is similar to the one made at voice frequency. Fig. 11 shows the effective attenuation as a function of the voltage on the primary terminals of the transformer. For the greater part of the voltage range the attenuation lies below 0.10 neper (0.9 db).

All curves shown have been measured on Type RM 550. At voice frequency the figures will be the same for all the types. At ringing frequency, both of the Types RM 550 and RM 553 will, when terminated or matched to the same impedances, operate under different conditions. A suitable choice of inductance and losses enables all types to give results which differ but little from those mentioned above.



X 3227 **Fig. 10. Power efficiency of Type RM 550, 800/800 ohm,**
as a function of the primary voltage at 20 c/s, matching impedance 2 000 ohm.



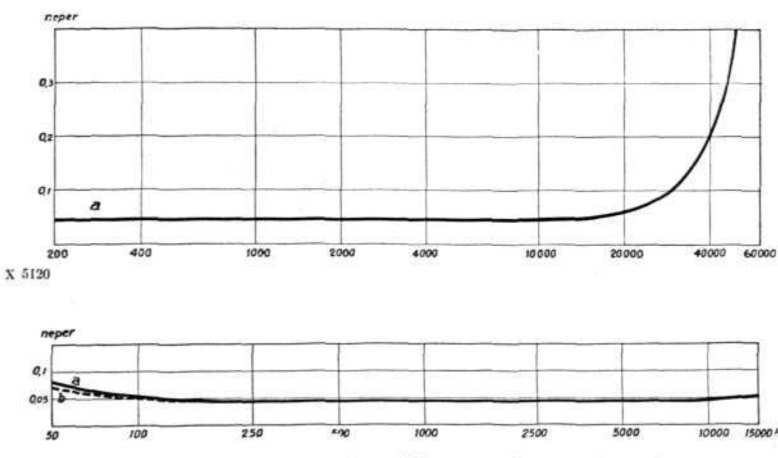
X 3228 **Fig. 11. Effective attenuation of Type RM 550, 800/800 ohm,**
as a function of the primary voltage at 20 c/s, matching impedance 2 000 ohm.

The two halves of the transformer's winding are balanced with an accuracy which makes the side-to-phantom cross-talk attenuation higher than 10 neper (87 db) at 1 000 c/s.

By impregnation and filling under vacuum extremely good insulation properties are obtained. At 250 V DC the transformers have an insulation resistance greater than 10 000 megohm between the windings and between the windings and the cover. Measurements have shown resistances of the magnitude of 500 000 megohm.

The voltage test is made with 2 000 V, 50 c/s, between the windings and between the windings and the cover.

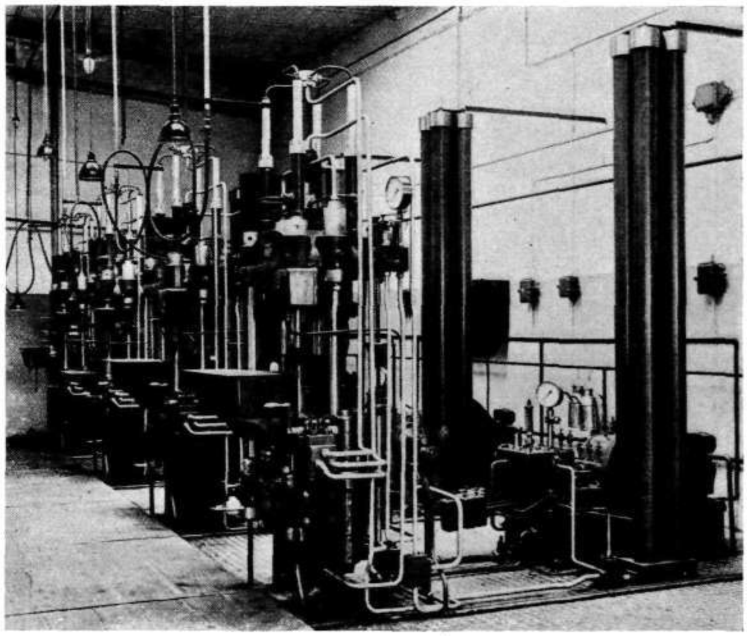
T. Laurent & K. Styrén.



X 5147 **Fig. 9. Effective attenuation of line transformer, Type RM 550, 800/800 ohm,**
measured according to the prescriptions of the CCIF.
a at 1 mW b at 50 mW

Hydraulic Moulding Presses

A.-B. Alpha, manufacturers of moulded products of various kinds, is in daily touch with the multitude of problems which arise in the design and manufacture of moulds and of hydraulic presses for plastics. On the basis of the experience thus acquired, Alpha has developed a new hydraulic moulding press which is described in the following article.



X 5148

For the moulding of the quick curing bakelite powders now generally in use, and which generally do not require any cooling, Alpha has developed a semi-automatic control gear of utmost safety, which is now brought on the market after having been submitted to extensive tests in the works.

The presses are made for capacities of 75 t, Type 74 A 314, and 95 t, Type 1 H 343. In both types the stroke of ram is 250 mm, the maximum opening 765 mm, and the platens have the dimension 400×470 mm.

The presses are made with a lower movable platen and push-back cylinders between the side rods. The presses can be furnished in two different types depending upon the hydraulic system adopted.

High-Pressure System.

The press for 95 t, Fig. 1, can be connected either to an existing hydraulic system for 200 kg/cm² or to an individual three-stage plunger pump with pressure accumulator, Fig. 2. The quick closing of the press is obtained by two closing side-rams. This design offers economy in the use of high-pressure liquid as well as in the installation costs for the pipe lines.

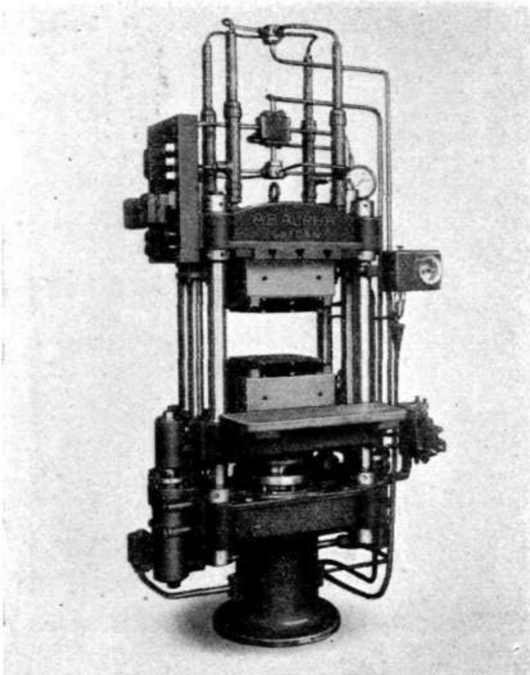
High and Low-Pressure System.

The press for 75 t is intended to be operated from a common central hydraulic system supplying low pressure of 50 kg/cm² for quick closing and opening, and high pressure of 200 kg/cm² for final closure of the mould. The low and the high pressure both act on the main ram.

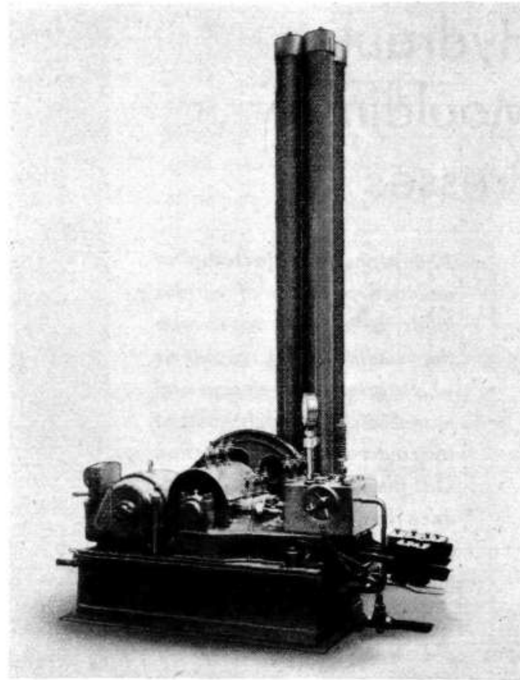
By the use of the semi-automatic controlling device great advantages are obtained: on the one hand the curing time is adjusted by the foreman for each article, and cannot be interfered with by the moulder; on the other the moulder's work is reduced to a minimum, so that in most cases he can attend to several presses one after the other. This means uniform quality and low cost.

After he has cleaned the mould and filled it with powder, the moulder has only to turn the knob outside the glass of the control box, Fig. 3, until it reaches a stop, the position of which can only be set after removal of the glass which is locked by key. When the knob is turned a governing valve inside the box is opened, and by the influence of water pressure from the water-supply mains or a special water-pump upon the diaphragm-controlled high-pressure valve, Fig. 4, high pressure is introduced into the two closing cylinders. The press then closes in a second or two. At the same time the main cylinder draws liquid from a prefilling container below the bedplate of the pump. Just before the stroke is finished a throttle-valve, which can be set at will, reduces the speed of closing. In the case of a press for high and low pressure system the only difference is that the diaphragm-controlled valve, Fig. 4, introduces low pressure directly into the main cylinder for quick closing.

Due to the heat from the mould the bakelite powder fluxes. During the closing period, the press by its movement, in conjunction with a vertical rod, automatically governs a spring-balanced regulating valve, Fig. 5, which admits high pressure gradually into the main cylinder. The high pressure is thus applied at the right moment and the complete closing of the mould takes place very smoothly, which is of great value for the protection of expensive moulds. The regulating valve also allows a certain regulation of the total pressure applied on the mould. Such regulation can also be obtained by the pump.



X 1370 **Fig. 1. Semi-automatic hydraulic moulding press, 95 t,**
with time control, hydraulic ejectors and electric heating equipment.

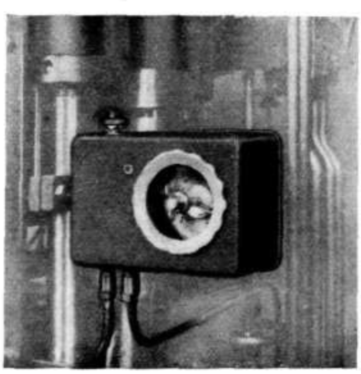


X 1369 **Fig. 2. Three-stage plunger pump,**
with prefilling tank and pressure accumulator.

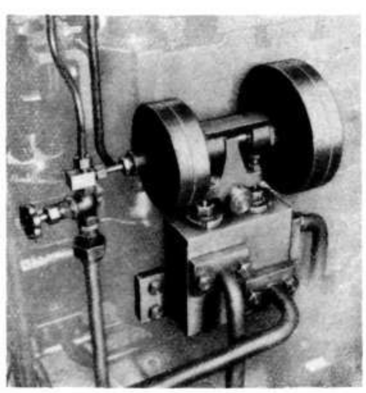
When using the press for two hand moulds of different thicknesses, which are placed in the press alternately, it is possible to arrange by means of a special device that the regulating valve, Fig. 5, is operated at the moment required by the thickness of each mould.

The control box, Fig. 3, contains an alarm clock, allowing a setting from 1/2 to 30 minutes. When the time set in each case has elapsed the clock closes the governing valve so that the diaphragm valve releases the high-pressure liquid from the main cylinder. By means of high pressure in the two push-back cylinders, the press opens, at first slowly, due to the action of the throttle valve, so that the mouldings are not damaged, then rapidly.

The time-setting device of the control box can be disconnected, in which case the closing and the opening of the press is operated by hand by means of the knob on the top of the control box, Fig. 3. This is especially convenient for preliminary work, when setting up moulds in the press etc.



X 3247 **Fig. 3. Automatic time-setting control box.**



X 3348 **Fig. 4. Diaphragm-controlled high-pressure valve.**

The ejection of the mouldings can be made by a mechanical device which comes into action when the press opens. The double-acting hydraulic ejection device with four cylinders at the top, operated independently by a lever-type valve located to the right, Fig. 1, is to be recommended, as the ejection can then be made more smoothly and at the discretion of the moulder.

A pressure liquid of special fireproof oil emulsion in water should be used. The cylinder housing, as well as the top of the press, are of best Swedish cast steel. They are submitted to severe tests before delivery.

Electrically heated platens and moulds are often preferred. It permits the automatic switching on of the current to the mould some hours before the work begins, and permits of very accurate control of the temperature, of great value especially for light coloured powders.

Ericsson Technics

A special number of the Ericsson Technics was distributed to the members of the Meeting of the Technical Reporters of the CCIF in Stockholm in June last. This number contained the Ericsson Technics No 5 and 6, 1933 (see Ericsson Review No 1 and 2, 1934) and No 1 and 2, 1934. These papers have also been published separately.

Ericsson Technics No 1, 1934.

T. Laurent: A Selective Echo Suppressor.

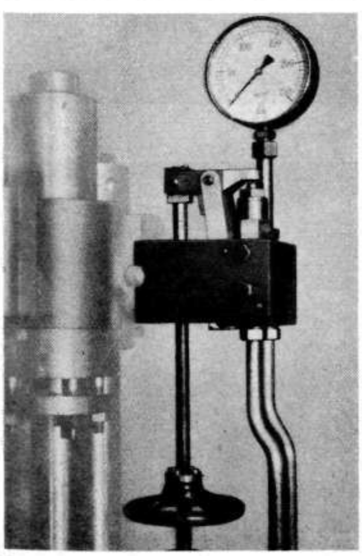
The carrier transmission of telegraphy and telephony on cable circuit is one of the foremost problems of the day in the field of long-distance telecommunication. Carrier transmission is designed to effect more economical operation on lines covering very long distances, which are very expensive per unit of length in view of the necessity of considering the propagation time. One of the difficulties encountered in this respect is the suppression of the echo which cannot be carried out with existing methods in telephone communications with simultaneous super-audio telegraphy. A new selective echo suppressor developed by Telefonaktiebolaget L. M. Ericsson has, however, given very good results. The principles and design of this suppressor as well as the results obtained are described in this article.

Ericsson Technics No 2, 1934.

G. Swedenborg & F. Markman: Propriétés électriques et équivalents de référence du nouveau poste d'abonné Ericsson.

The following paper deals with electrical properties of the component parts which ensure the efficiency of the new Ericsson bakelite telephone instrument. Formulae for the impedance of the instrument in speech position and for the sending and receiving current are given. The results of tests on transmission efficiency — covering the transmitting and receiving reference equivalents under different working conditions, the reference equivalent of sidetone and the articulation efficiency—carried out at the SFERT Laboratory in Paris are also given for three types of telephone instruments for use on different systems. The equivalent attenuation due to current-supply loss in the transmitter at different local-line resistance has been cal-

culated from the values of the transmitting reference equivalents obtained; the sending efficiency tests have been made by a method which gives directly the equivalent attenuation in question. The influence on the sending efficiency of the distance between the speaker's mouth and the mouthpiece, and the bridging of the impulse springs of the dial by a condenser in series with a non-reactive resistance are discussed. The volume of sound from the bell has been determined and from the curves obtained it is demonstrated that the calling signal of the new type of telephone instrument is at least as good as that of older types.



X 3246 **Fig. 5. High-pressure regulating valve.**

The sheet-iron switchboard comprises switch for hand-operation, time switch, fuse plugs, contactors and wall sockets for the connection to the moulds. In addition there are two intermediate relays, connected by wall plugs to thermostats, which allow of the automatic regulation of constant temperature between 100—200° C.

The heating of the platens and the moulds is made by built-in electric heating elements, which can easily be replaced if damaged or if another heating capacity is desired.

Heating platens and moulds can be delivered for heating by steam or by superheated water if preferred.

In case automatic operation of the moulding press is not required, the closing and opening of the press can be effected by means of a hand-operated valve. Such valves are also used for operating hydraulic ejectors and presses for opening hand moulds.

Special presses have been developed for opening hand moulds. They are either hand operated or hydraulic and are very useful for their purpose. Various machines for finishing the moulded articles have also been designed.

H. Berlin.

The CCIF Visits Ericsson

The Technical Reporters of the CCIF held a meeting at Stockholm in June this year on the invitation of the Swedish Royal Board of Telegraphs.

In connection with the transactions several demonstrations and visits were made, part of which were arranged by Telefonaktiebolaget L. M. Ericsson.

Sieverts Kabelverk was visited on June 7th, special interest being shown in the departments for manufacturing telephone cables and condensers and in the test rooms.

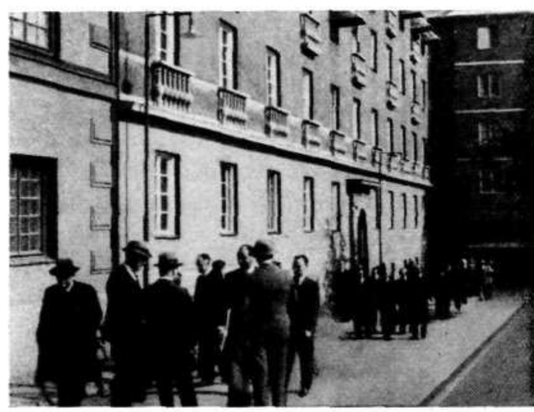
On June 13th an exhibition arranged at the head office of Telefonaktiebolaget L. M. Ericsson was visited. This exhibition was composed partly of telephone material, *e. g.*, telephone instruments for various purposes, automatic switchboards for rural automatization, selective-calling telephone systems, partly of material for long-distance telephony *e.g.*, single-channel carrier-telephone systems, carrier-telegraph systems, two-wire and four-wire repeaters, audio-frequency signal repeaters, loading-coil cases, etc., partly of measuring instruments for laboratory and line measurements and, finally, of some special apparatus, as a frequency-selective echo suppressor, photo-electric talking machine, etc.

After this demonstration the largest automatic telephone exchange in Europe, the »Söder» exchange in Stockholm, was shown; this exchange has been built on the Ericsson machine-drive system with 500-line selectors. The exchange attracted great interest among the visitors on account of its compact structure and its reliable operation, as evidenced by the remarkably low cost of maintenance less than 3s. 3d. ($0.80) per subscriber per year.

Later in the day the members took part in an excursion to Saltsjöbaden, famous bathing resort outside Stockholm, at the invitation of Telefonaktiebolaget L. M. Ericsson. After dinner a film was shown illustrating the Ericsson telephone activities in Mexico. The return by steamer through the Stockholm archipelago in the bright Nordic summer night will certainly remain a most pleasant memory for the visitors.

Russian Commission Visits Ericsson

During the time May 10th to 22th Telefonaktiebolaget L. M. Ericsson was visited by a Russian commission with two directors of the State Telephone Works »Krasnaja Zarja» at Leningrad, which on behalf of »Glavesprom», the Chief Administration of the Telecommunication Industry in the USSR, studied the manufactures of Ericsson for two and a half weeks. Visits were paid to the Ericsson works, the automatic exchanges on the Ericsson system in Stockholm, etc. Finally the commision studied the research work carried out by Ericsson in the different spheres of telecommunication technics.



Members of the CCIF outside the »Söder» automatic exchange.

X 1375

X 1376 Demonstration of measuring instruments.

X 1374 Single-channel system shown in operation.

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FOR
IMPROVING THE POWER FACTOR

direct connection of the condenser to the motor brings the following advantages:

the capacitive power is switched on and off simultaneously with the motor

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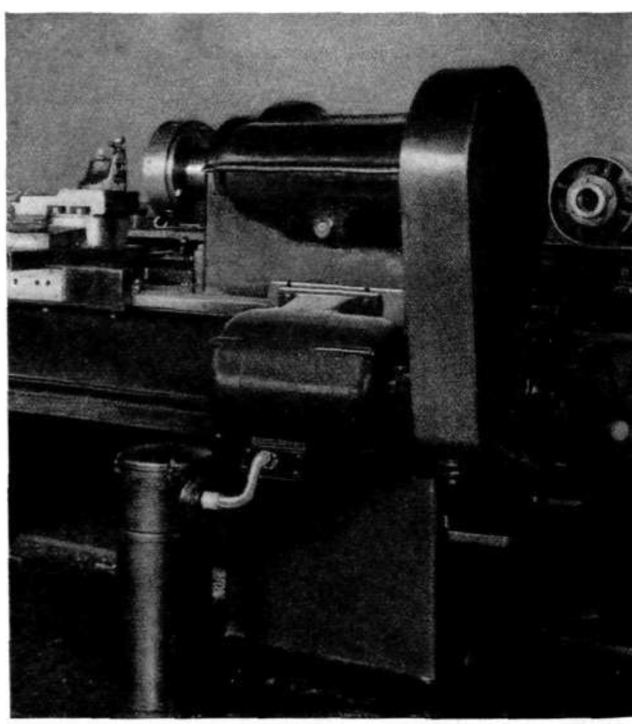
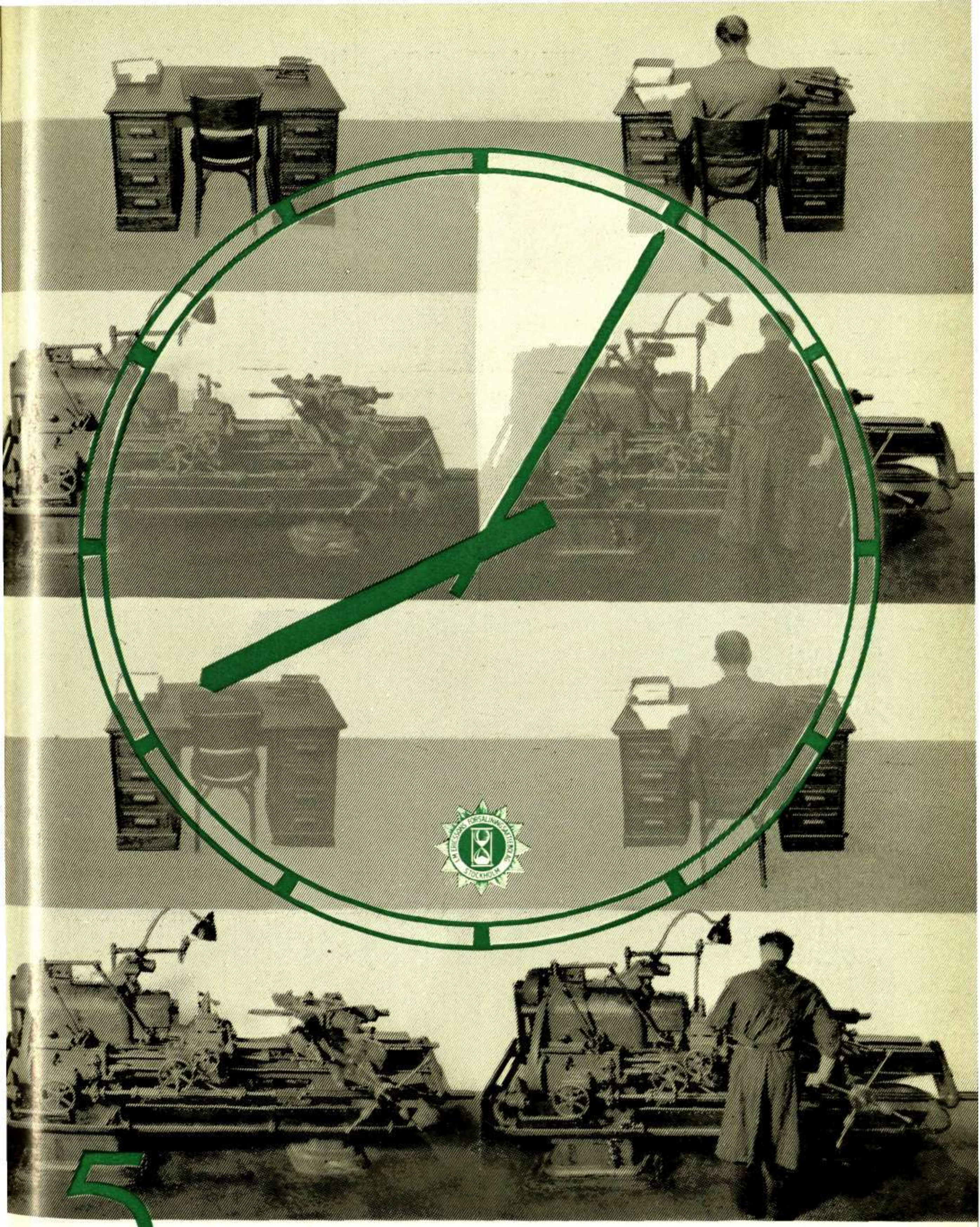


SIEVERTS KABELVERK



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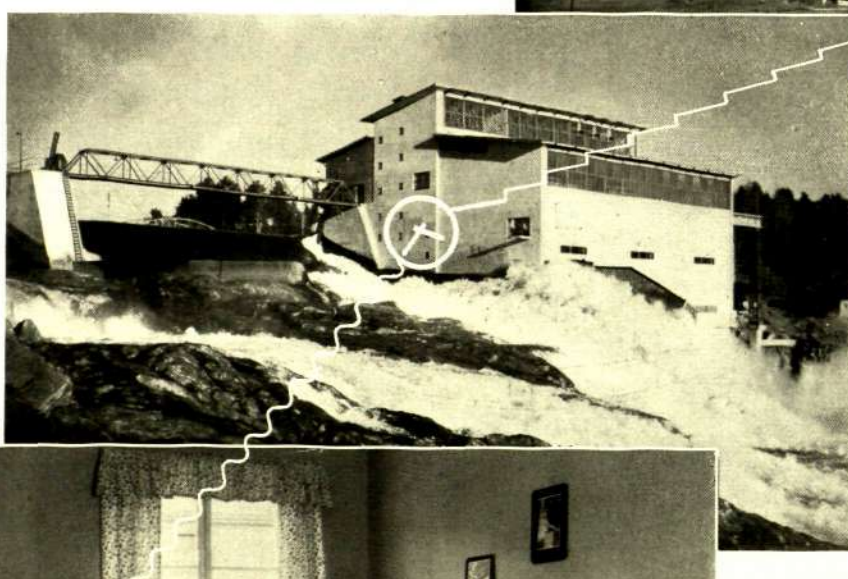

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Telefonaktiebolaget L. M. Ericsson