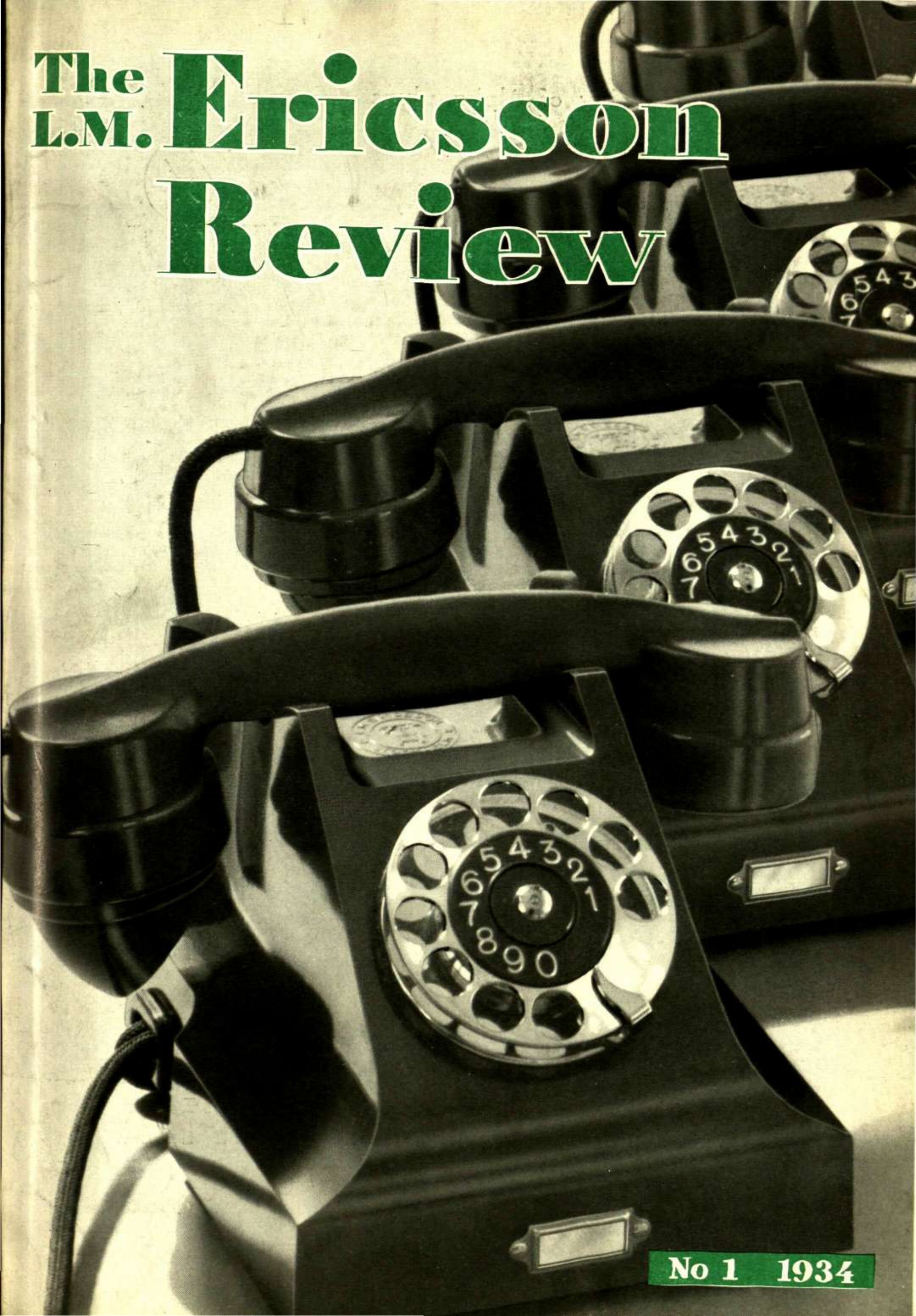
The L.M. Ericsson Review



No 1 1934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The L. M. ERICSSON REVIEW

Responsible Publisher: HEMMING JOHANSSON
Editor: SVEN A. HANSSON
Editor's Office: Kungsgatan 33, Stockholm
Subscriptions: one year \$ 1: 50; one copy \$ 0: 50

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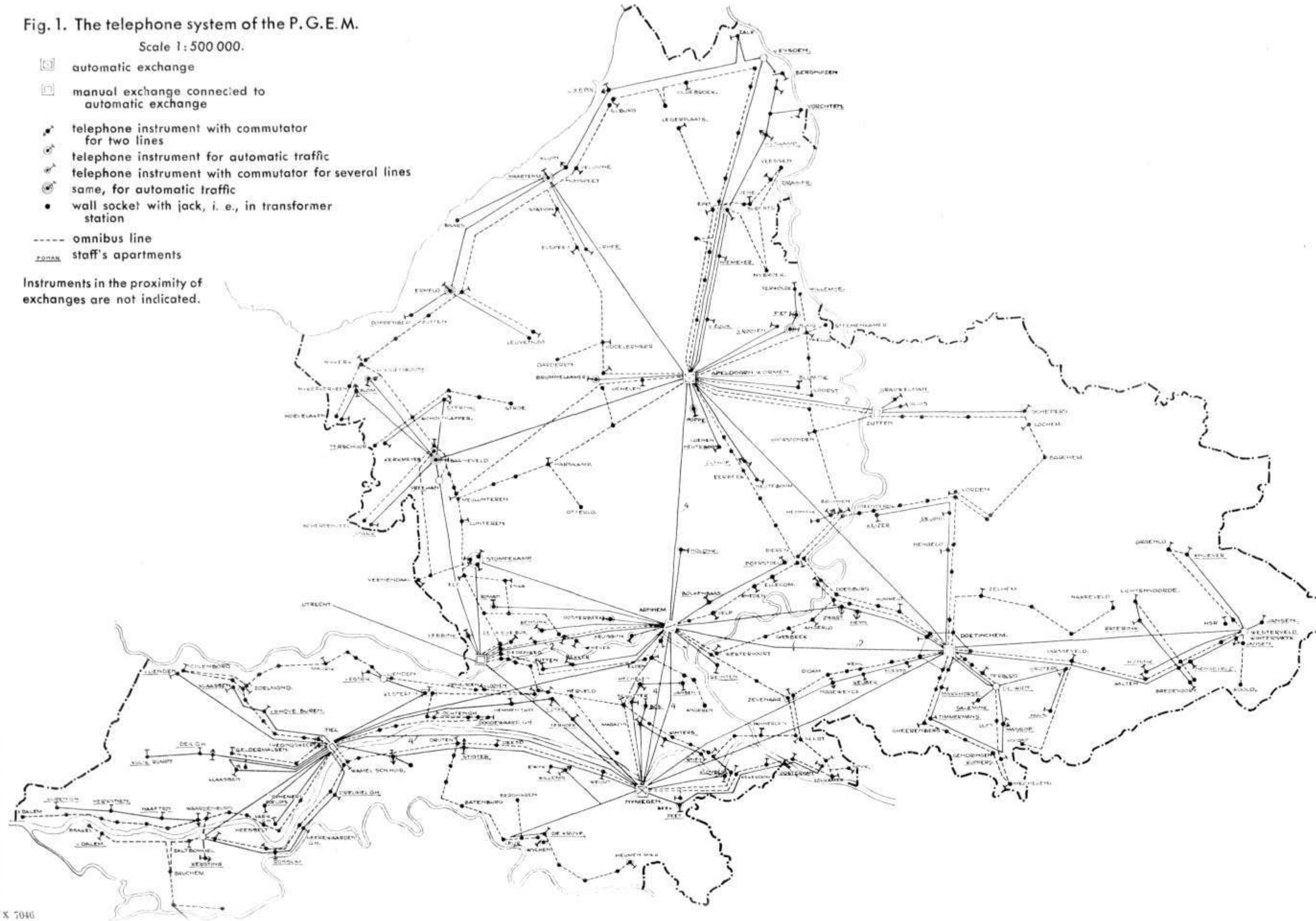
Printed in Sweden
Centraltryckeriet, Stockholm 1934

Fig. 1. The telephone system of the P. G. E. M.

Scale 1 : 500 000.

- automatic exchange
- manual exchange connected to automatic exchange
- telephone instrument with commutator for two lines
- telephone instrument for automatic traffic
- telephone instrument with commutator for several lines
- same, for automatic traffic
- wall socket with jack, i. e., in transformer station
- omnibus line
- staff's apartments

Instruments in the proximity of exchanges are not indicated.

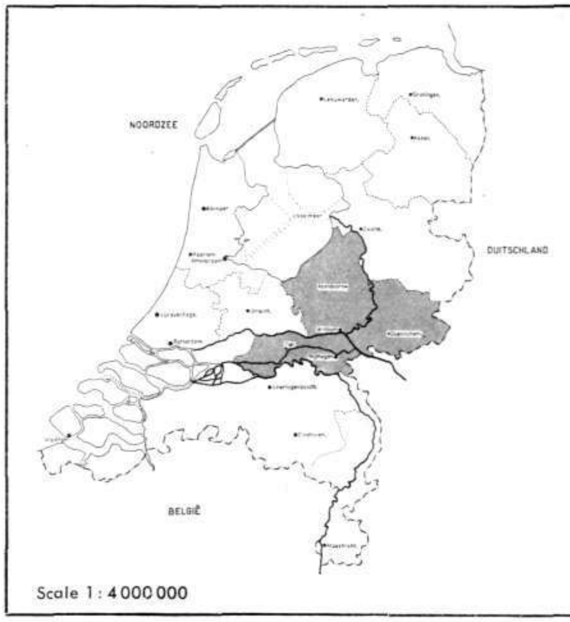


X 7046

A SERVICE-TELEPHONE SYSTEM IN HOLLAND

By A. C. A. HARTMAN,
Telephone Engineer of the P. G. E. M., Arnhem.

The modern telephone system of N. V. Provinciale Geldersche Electricitets Maatschappij, Holland, described in this article has been designed and supplied by Ericsson as regards exchange equipment and apparatus. This extensive system, designed for the needs of a power-supply undertaking, has involved several special problems such as do not present themselves in ordinary commercial systems and which in some cases have required the application of entirely new principles.



X 1246 **Map of Holland.**
Gelderland province shaded.

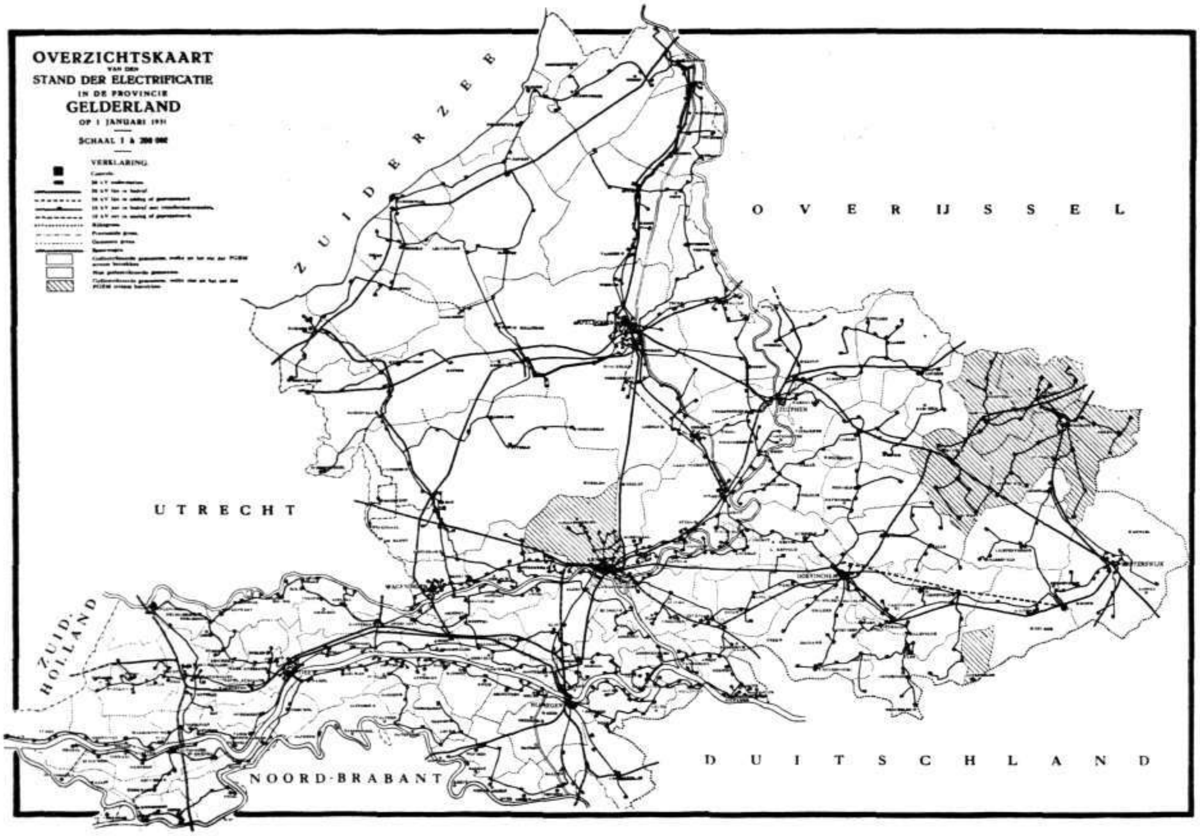
The electricity works of Holland are chiefly run either as municipal enterprises in the big cities or else as great companies which have undertaken the distribution for towns and rural districts.

Holland is divided into 11 provinces. The central representative authority in each province is a governor, the »Commissaris der Koningin». This person is the chairman of a representative body, »de Provinciale Staten», elected by the inhabitants, and of a board of administrators, elected from among the former. These bodies watch over the interests of the province and the electricity works of 9 provinces come under their supervision. This is the case also in Gelderland and as a consequence the above mentioned company has been formed.

The arrangement of the power supply system

X 5095 Fig. 2. The steam power station at Nijmegen.

X 3158 Fig. 3. 70 m crossing pole for 50 kV overhead line, near Arnhem.



X 7047

Fig. 4. The power distribution system of the P. G. E. M.

might be of interest even though the chief intention is to describe the telephone system of the company. The telephone system has of course been arranged to conform to special requirements, and the planning has been closely connected with the organisation of the power supply system.

A steam power station has been built at Nijmegen, Fig. 2. and a new power station is in course of construction there. Nijmegen is thus the centre of the distribution system. A net of 50 kV overhead lines connects the power station with the most important sub-stations, Arnhem, Tiel, Doetinchem, Apeldoorn, Ede and Kootwijk. These stations feed an extensive 10 kV system, which is almost exclusively composed of cables. On January 1st, 1933 it comprised 1 960 km high tension cables of sections ranging from 3×16 mm^2 to 3×95 mm^2.

From the map, Fig. 4, the extent of the system in the province may be seen as well as the intense electrification created. There is practically no place without electric power, though some of the more remote farms have not yet been connected.

From the start the Board of directors were of the opinion that a separate telephone system was necessary for the perfect operation of their extensive power supply system. If this telephone system were to be really useful it had to be set up and maintained by the company itself. The necessary concession for building a 10 kV distribution net was therefore made to include a telephone system for service purposes only.

The required telephone cables were placed in the same conduits and at the same time as the high-tension cables. Later separate telephone cables have been laid in some cases. The cables contain from 2 to 26 pairs; on short distances there are even cables with greater numbers of wires, up to 88 pairs.

On January 1st, 1934 the total length of telephone cable, Fig. 5, was 1 259 km with 6 066 km 0,8 mm and 791 km 1,2 mm double lines. The system is chiefly loaded with loading coils of 178 mH, placed at distances of about 2 000 m. This represents the heaviest loading possible without too high attentuation of the highest speech frequencies. From this it is evident that the intention is not to use repeaters. Though Nijmegen is the technical centre of the system the head office is situated at Arnhem. In addition to the management there is also the main administration department and various centralized departments such as meter, building and telephone departments and stores. The technical management and administration are located in the centres of the districts namely Apeldoorn, Doetinchem and Tiel. Wageningen is a sub-office of the Arnhem district.

The telephone system is used for two purposes:

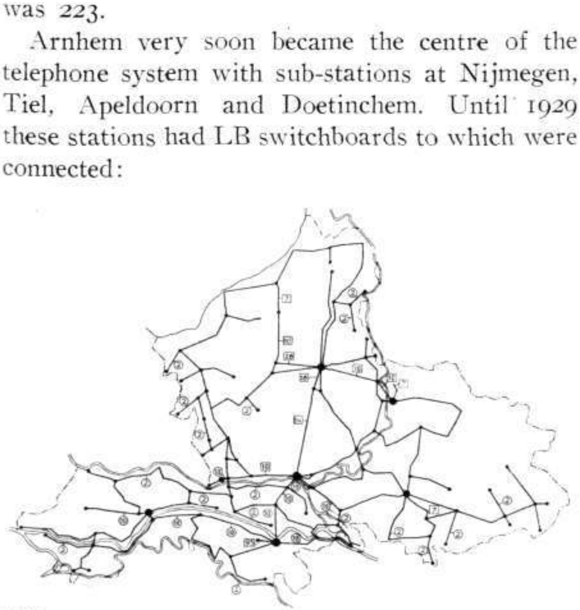
partly as means of communication regarding the technical apparatus of the power supply system for all cases of faults, switchings and recently also for remote control and alarm. Telephone instruments are therefore placed in all power stations, switch rooms and important transformer stations and in the offices and the apartments of the technical staff. Wall sockets are placed in a great number of transformer stations of minor importance,

partly for improving the administrative communication between the head office and the districts; for this purpose the required equipment has been supplied to extend the system.

It is evident that the heavy daily administrative traffic is of great use as all faults on the lines will be reported without delay and consequently the telephone system can be kept up to a high standard of efficiency.

On January 1st, 1934, the number of instruments was: in the offices, the power station and the 50 kV stations, 149; in the apartments, 162; in the 10 kV transformer stations, 91. The number of transformer stations fitted with wall sockets was 223.

Arnhem very soon became the centre of the telephone system with sub-stations at Nijmegen, Tiel, Apeldoorn and Doetinchem. Until 1929 these stations had LB switchboards to which were connected:



X 1248 **Fig. 5. The telephone cable system**

(10) cable with 10 pairs 0.8 mm wire.
(7) cable with 7 pairs 0.8 and 1.2 mm wire.
unmarked: cable with 4 pairs 0.8 mm wire.

telephone instruments in offices, apartments and switching plants;

junctions to the other switchboards;

omnibus lines with connected instruments and wall sockets in transformer stations etc. These lines which are seldom used are connected to a common point at both ends in order to make supervision possible.

Where on account of special conditions it was considered necessary, service arrangements were provided, as for instance in apartments for night staff or in switching plants, in order to have all lines available independent of the switchboards.

The equipment supplied by Ericsson was either of standard design or to suit special requirements.

The system as constructed was very reliable and responded to severe demands, but it proved inadequate for the traffic, which increased steadily. The weak points were the switchboards which were not capable of managing peaks with great traffic intensity and there was moreover inconvenience after office hours. The head-office where there is no staff at night caused most of the trouble, when various places wanted to speak to Nijmegen at any time, the traffic to Nijmegen being chiefly directed by Arnhem.

In 1924 an investigation was begun to discover if the trouble could be overcome by using an automatic telephone system while still maintaining the highest possible reliability. The long cables were a source of difficulty. When in 1928 the Board of Telephones commenced the automatization of the Arnhem telephone system, it became necessary to come to a decision.

The most important condition for the construction of an automatic exchange was the following:

From telephones connected with the automatic exchange over 0.8 mm cables up to 80 km long it must be possible to make connection with a desired number by means of the dial even if the mains should be without tension. In such cases especially it is of importance that the connection be made in a reliable manner.

Although impulsing with DC induction impulses or AC involved great advantages there were other requirements and arrangements for the operation to be taken under consideration. Investigation made at Arnhem showed that a system offered by Ericsson would make possible impulse transmission over at least 100 km 0.8 mm cable circuits with a central battery of 24 V, without appreciable deterioration of the impulses.

The type of telephone used for the impulsing was an ordinary magneto telephone with LB supply for the microphone and dial and condenser in series with the bell.

In this manner it was possible to make the complete automatization so that while reliability and adaptability would be high the cost of maintenance and supervision would be low.

The main principles which have been kept in view are as follows:

as few junctions as possible (automatic or not);

complete independence of the mains;

the automatic equipment must be concentrated at the telephone exchange;

the instruments which are not fixed close to the automatic exchange are arranged for automatic and magneto traffic without special devices;

all apparatus must be as simple as possible.

It was decided to use a DC—CB system. Although we know that by this we do not follow ordinary practice, we are pleased to state after four years' experience that we are most satisfied with the reliability of the automatic system.

The start was made at Arnhem, where the automatic exchange was put in service in the beginning of 1929. Then followed Apeldoorn (partly) and Nijmegen. The next automatic exchanges will be Doetinchem and Tiel.

The Automatic System.

Various kinds of lines and arrangements connected to Ericsson automatic switchboards, Type OL 550, corresponded to our special requirements. It will, however, not be necessary to describe this type of switchboard here.

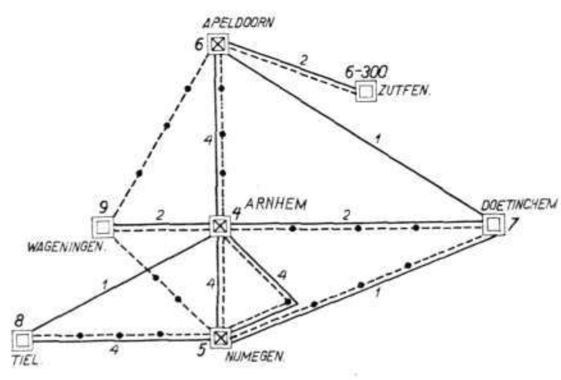
At Arnhem, Nijmegen and Apeldoorn these automatic exchanges have been made for a number of local instruments and exchange lines to the state telephone system and for special lines of various kinds. A manual switchboard has been installed near each automatic exchange with jacks and busy-lamps for all local lines and with single cords and various lamps for the exchange lines. In addition there are jacks, lamps etc. for CB and LB lines and for all special lines required for the traffic.

Fig. 1 shows a diagram of the system with automatic exchanges at Arnhem, Nijmegen and Apeldoorn, and manual exchanges at Tiel and Doetinchem which last are to be replaced by automatic exchanges. In addition there are two small manual exchanges at Wageningen and Zutfen. All exchanges are interconnected by a number of cable circuits. As the manual exchanges are connected to the automatic exchanges the traffic between all exchanges is entirely automatic.

The communication facilities between the exchanges will be described first (see Fig. 6), and the diagrams of the various lines are shown below.

In order to simplify the traffic between and via the exchanges a one-digit exchange number has been given in the directory to each of them. This number is always to be found in front of the number of the instrument. Further each exchange has its own exchange tone according to a certain code.

Communication with another exchange (automatic or not) is obtained by dialling the exchange number in question. If the wanted exchange tone is not received the exchange number is dialled until the exchange tone is received. The subscriber's number may then be dialled. If the desired exchange is of the manual type the exchange digit is repeated until a ring signal, which can be heard by the calling party, is sent out to the manual exchange. This arrangement makes it possible with simple connections for the automatic exchange to select the shortest clear communication, and the subscriber can follow how and by which way the communication is built up.



X 1247 **Fig. 6. Routing diagram of the telephone system.**

4 exchange number

6 automatic exchange.

☒ manual exchange connected to automatic exchange.

☐ direct connection.

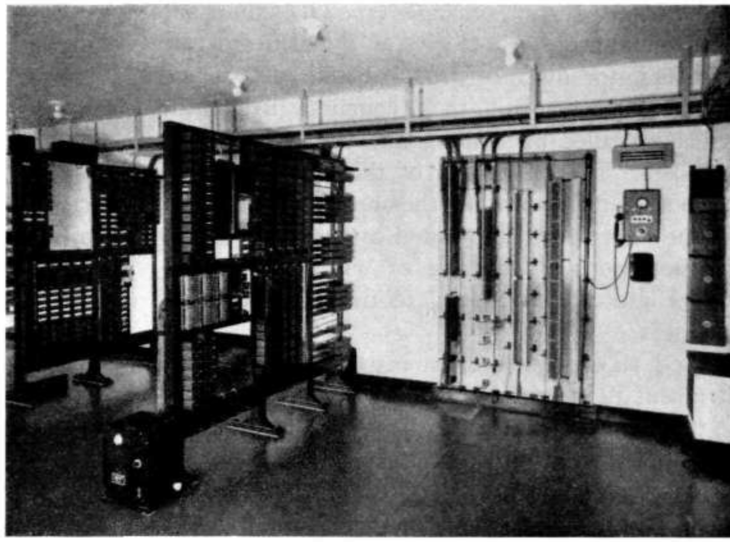
— omnibus line.

--- number of lines.

Fig. 7.

The automatic exchange at Apeldorn.

Left background: junction-line and PBX line-finder bays; left foreground: register, local and special-line bays; middle: on the wall; frame for distribution of individual numbers and main distribution; frame with line fuses; right: line testing box extreme right: pole changer for ringing current; on the floor, rectifier for battery charging.



X 5096

PBX Line Finders.

Selecting the shortest clear communication is performed by the PBX line finder. This line finder cooperates with a special device which blocks the instruments situated outside a certain range for automatic town traffic.

When an instrument at Apeldoorn is to be connected to Tiel the number *8* is dialled; the exchange tone of Arnhem is then heard. By dialling *8* again communication with Tiel is established if the direct line to this exchange is clear. If this line be engaged the exchange tone of Nijmegen is received, and *8* has to be dialled once more.

The PBX line finder also on dialling Apeldoorn, *6*, from the Tiel exchange via Nijmegen allows the exchange tone of Arnhem to be received. This is, however, only possible over a short cable (20 km) between Nijmegen and Arnhem, not over a longer cable (65 km) as this will give inferior speech transmission to Arnhem.

The ordinary traffic is thus directed in the most convenient way, but for special cases, as for instance when cable faults occur, other ways may be used if wanted.

Compared with complicated systems having automatically repeated impulses, which are necessary in public telephone networks, the system used by us in addition to its simplicity gives the advantage that with experience one learns to know by which way the communication is directed, and how far everything is all right. Moreover in special cases it is possible to choose other ways even if these be longer.

The traffic between the districts is carried on by two kinds of lines, one for connection of magneto instruments or switchboards to automatic exchanges and one for communication between two automatic exchanges. The former also allows of automatic traffic to special instruments with LB supply.

During office hours the junction between a manual exchange and an automatic exchange connected to it is used for intercommunication; but outside office hours these junctions are used for the connection of a few instruments of special importance; connections to these instruments are then automatic.

For this purpose such a line has a special number in the directory in addition to the exchange number.

As mentioned above, each exchange is so arranged that each line can be worked in the switchboard without use of the dial. The automatic traffic is usually carried on outside the switchboard, but in urgent cases the operator can always cut in on the calls.

The ordinary apparatus connected to exchanges, such as automatic instruments, CB instruments, magneto instruments without automatic traffic and exchange lines will not be described in this article.

Individual Numbers.

Contrary to usual practice, when, for instance, the persons *A*, *B* and *C* use the same instrument number *51*, and consequently their names stand for this number in the directory, utilizing the possibilities, of the exchange, type OL 550, it has been found preferable to give *A*, *B* and *C* separate numbers, for instance *216*, *254* and *345*. These numbers correspond to a common instrument which is called by dialling any one of the three numbers. The advantage of this system lies in the possibility of dividing the numbers of the staff on the instruments as wanted by means of an interconnection, to one side of which the instruments are connected and to the other side the numbers.

If *A* should move from instrument *51* to instrument *24* the number *216* need only be changed to the latter instrument in the interconnection, no alteration in the directory being necessary.

It is even possible to lead the numbers through an interconnection box with plugs and jacks so that provisional alterations may be carried out quickly.

Operators' Lines.

For incoming traffic each switchboard has a number of operators' lines, which are called by number *1*. Calls cannot be forwarded from these lines by means of cords. Except for information they are used for ordering calls, these being then connected directly via the jack of the orderer.

In cases when the orderer does not know on which circuit he is, *i.e.*, when coming in from another exchange over one of the junctions, this can be tested by the operator by means of a flashlight signal.

Conference Lines.

Each automatic exchange has a special device, to which a number of instruments may be connected by dialling number *311*. Particularly when faults occur in the high tension system has this conference line been of the greatest importance. It has made it possible to clear the fault much more quickly by allowing all leading persons to discuss together at one time. Conference lines from different exchanges can be connected over the junctions.

Morse Lines.

These lines are LB lines with one or more instruments in parallel or LB lines between two switchboards; the latter type of line also acts as omnibus lines for the traffic to the transformer stations. These lines have calling lamps for incoming traffic and can be called automatically for outgoing traffic.

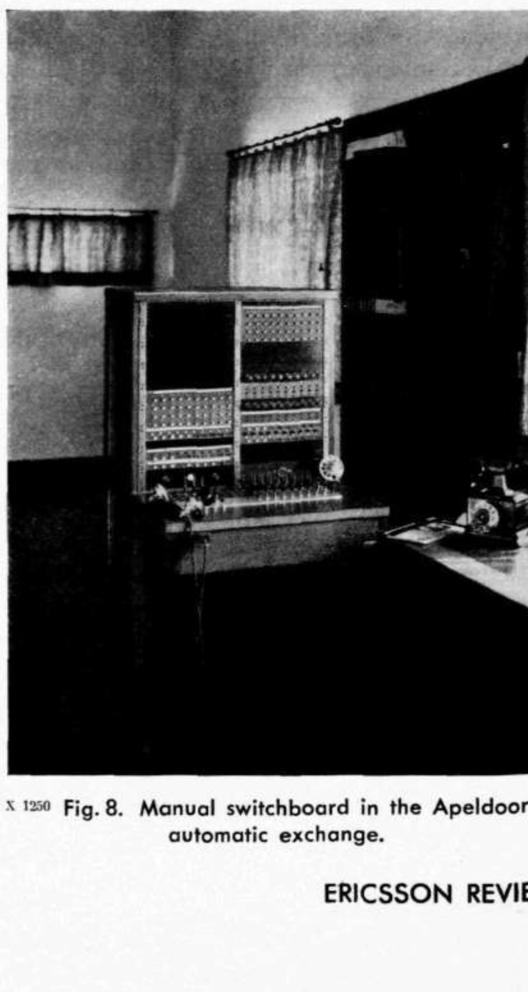
When the number has been dialled a short ring signal is sent out on the line. If a digit is dialled a second time a ring signal is sent out again during the return of the dial. Consequently the signal may be short or long, as wanted, depending on which digit is dialled. The desired code signal is given by means of the dial. Night traffic to other arbitrary lines is possible with outgoing automatic traffic as during day time.

Long Junctions between LB and Automatic Systems.

The long lines for connection between LB instruments or LB switchboards and automatic exchanges have the following properties:

reliable impulse transmission with the 24 V central battery of the exchange over 60 to 80 km 0.8 mm loaded cable circuits;

matching transformer for the speech currents; on one side loaded cable (Z = 1 600 ohm), on the other side automatic exchange (Z = 800 ohm);



X 1250 **Fig. 8. Manual switchboard in the Apeldoorn automatic exchange.**

the line can be disconnected from the automatic exchange by means of a press button, and then becomes an ordinary LB line with calling relay and lamp;

service from switchboards with CB signalling;

supervision of the traffic by means of signal lamps;

night service with outgoing automatic traffic is possible.

Several of these requirements apply even to the other types of long lines, as described below.

Impulse transmission with 24 V central battery must be possible over distances of up to 80 km of 0.8 mm cable circuits.

It has been stated above that the character of the operation made this requirement absolutely necessary. This is why the small disadvantages inherent in this system must be disregarded.

The fact that a faulty cable very soon prevents impulse transmission on account of moisture has proved to be of minor importance to us. The consequence of such a fault will be that the line relays will remain attracted, which will soon give indication of the fault. Especially for the junctions it is a great advantage that when leakage occurs the lines are automatically disconnected at both ends, and that at the same time they are busied, so that other lines will automatically replace the faulty ones.

Fig. 9 shows how impulse transmission is made possible even over cables of 100 km length. The connection *A* operates without and the connection *B* with impulse correction, which proved to be necessary when junction traffic was etablished. The faults of *A* were very small according to oscillograms taken at Arnhem, but at 5 to 10 fold repetition the added faults would have been too great.

It has been shown that the connection *B* in combination with *A* operates in a satisfactory manner over an arbitrary number of junctions. Nor do five instruments in parallel on a party line cause any difficulty for the impulse transmission.

The impulse correction gives a certain shape of the impulses at a certain number of impulses per second, independent of the shape of the incoming impulses.

Matching transformers have been introduced where the characteristic impedance of the loaded cable circuits is considerably higher than that of the automatic exchange and losses would consequently occur. Measurements carried out at Arnhem have shown that great advantages may be obtained by accurate matching.

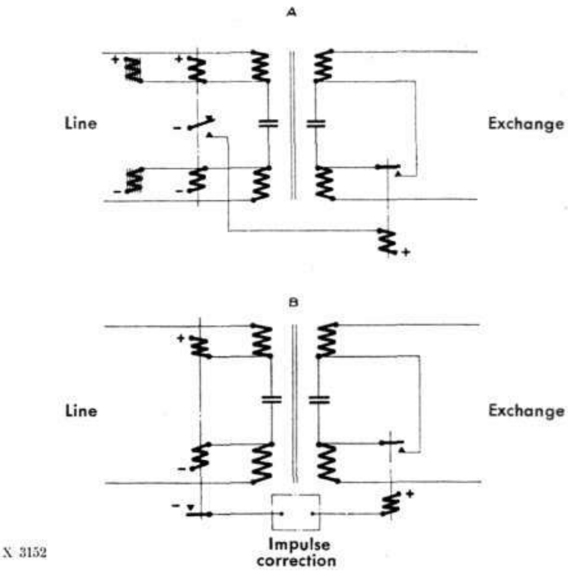


Fig. 9. Diagram of the impulse corrector.
A without impulse correction.
B with impulse correction

In addition it has not been found desirable to connect the long telephone cables, placed side by side with the high tension cables, direct to the automatic exchanges. Moreover, the transformer eliminates the influence of unbalance in the automatic exchange on the line.

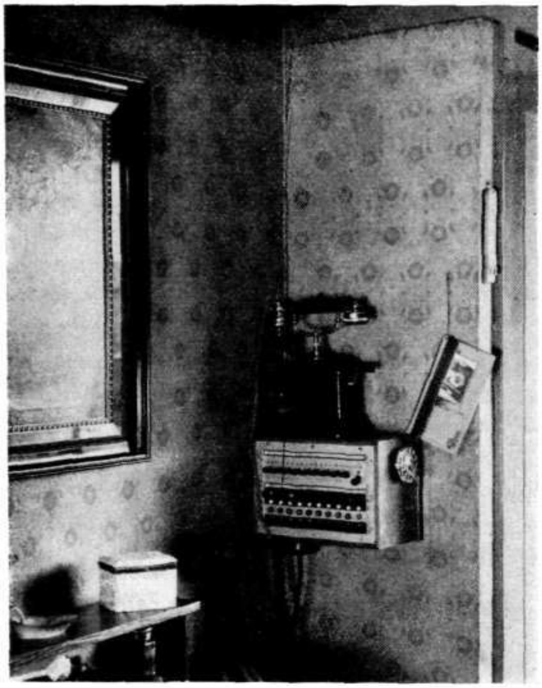
Switch-over to a magneto line is made by pressing a button situated in the switchboard near the line in question. The line is then blocked for automatic traffic, which is convenient in cases where work is proceeding on the cable, and also in those rare cases where, while DC impulsing is impossible on account of faults in the cable, magneto traffic can still be carried on.

Even without technical staff at hand the operator can give assistance if necessary.

The advantage of *CB signalling in the switchboard* in order to break a communication rapidly will be evident.

On account of the double clearing signal which is used on all circuits even over long automatic lines a communication is not broken until the microtelephones of both parties have been replaced. There is also CB signalling in the switchboard when an instrument of another exchange is connected over a junction.

In addition to the calling lamps for the traffic passing the switchboard there are *supervisory and busy lamps in the switchboard* for each long junc-



1249 Fig. 10. Small switchboard, as installed in apartments.

tion or party line. The busy lamp glows when the line relay has been actuated, and the supervisory lamp indicates that the called party has answered.

This is necessary in the first place when a communication with the switchboard includes a junction and an operator's line. As further connections must not be made over the last-mentioned line the operator must know which junction is calling, if such a communication is wanted. By pressing a button at the jack of the operator's line she can cause the supervisory lamp of the junction to flash.

Party Lines.

Among the long lines are reckoned the party lines which have the following properties:

automatic traffic is possible for all instruments by means of the 24 V central battery of the exchange;

5 LB instruments with dials and extra press-buttons may be connected to a 60 km long line;

these instruments are called with an ordinary number, and a special code ring-signal for each instrument is automatically sent out over the line; the signal is periodical and is heard in all instruments;

traffic between the instruments is possible by means of magneto and code signals, without the line being blocked for calls from the automatic exchange and without the switchboard being called;

the switchboard can be called by means of a special short magneto signal.

The following arrangements are provided for the lines:

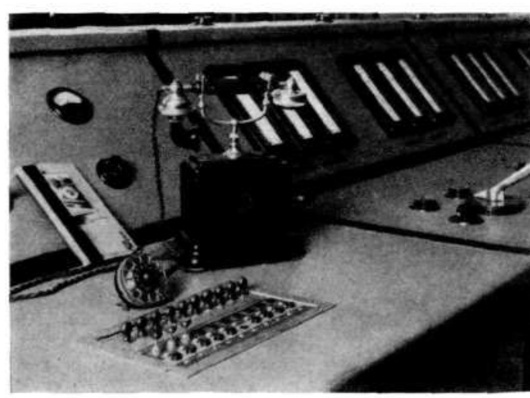
matching transformer,
switching-over to LB line,
night service,
supervisory lamps.

By means of party lines the expensive cable circuits can be utilized in a very economical manner. Still automatic traffic is arranged by simple means for the instruments connected.

Ordinary LB instruments with dial, condenser and press-buttons are used without any special type of connection.

The traffic on these lines is not heavy as the instruments in question are installed to a great extent in the apartments of the technical staff. Consequently, the ring signal, while heard on all instruments, is no inconvenience to speak of, at least not more than when several LB instruments are connected in parallel to one LB line. Secret calls are not necessary, nor even desirable. Indeed, it is an advantage that other persons can hear the signals and can answer if one fitter should be absent.

The arrangements of the exchange are less simple. About 30 relays and 2 rotary selectors are required per line. Each line transmits its own code signals in order to use the right code even the first time. Each instrument connected has its own number in the directory. When this number



X 1254 Fig. 11. Switchboard for LB and automatic operation, mounted on the control board of a switching plant.

is dialled a relay is actuated, which in cooperation with the code selector transmits the corresponding code signal until the call is answered from some instrument. The button is then pressed so that the instrument is switched over to CB connection.

Automatic traffic from the instruments is obtained when the button is pressed. Dialling tone is then heard after a very short magneto signal. A further advantage is that the other instruments are warned not to dial; it is then understood that the other instruments are not to be used with the button pressed.

If a call is made by means of a short magneto signal without the button pressed a calling lamp is lit in the switchboard; the condenser then blocks the DC, and the relay in the switchboard is not actuated. The line can thus also be used as an omnibus line if this should be necessary due to lack of lines.

A long magneto signal without the button pressed does not call the exchange; this is also the case with a short signal followed by a long one. Such magneto signals are used for the traffic between the different instruments on the line. The line relay in the exchange not being actuated the line is not blocked for calls from an automatic exchange during these calls.

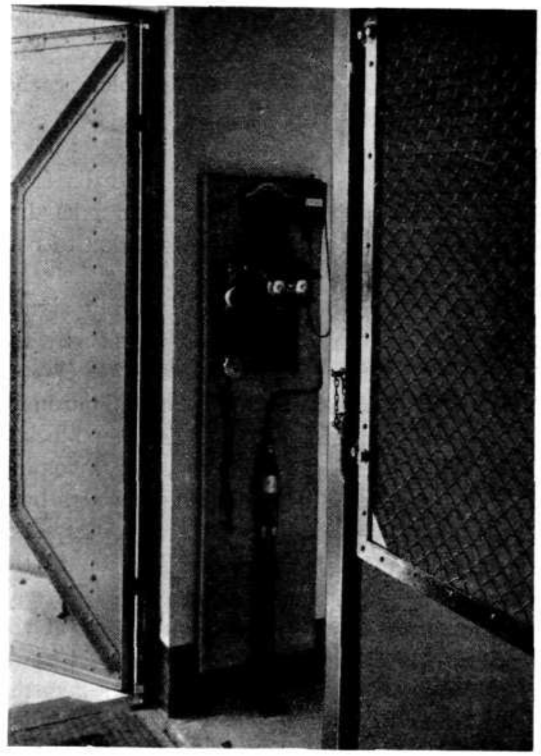
From what has been said above it is evident that by these lines, made specially by Ericsson according to our requirements, we have obtained a very high flexibility which is not inferior to that of ordinary magneto lines. At the same time automatic traffic has been made possible with simple arrangements and at small expense. The cost of the arrangement in the exchange is perhaps not small, but as by this arrangement five instruments have automatic traffic over *one* line the cost cannot be considered too high.

It is certain that these lines will be of great importance in our line system. With them automatic traffic will be possible between places where this was previously difficult to arrange.

Long Junctions between Two Automatic Exchanges.

The requirements for these lines were as follows:

two-direction traffic over one line;
impulsing by 24 V central battery;
matching transformers;



X 1251

Fig. 12. Telephone instrument,
as mounted in a transformer station.

switch-over to magneto line;
possibility of service from the switchboard by CB signalling;
supervisory lamps in the switchboard;
double clearing signal even for traffic through more than two automatic exchanges.

The traffic between two automatic exchanges required junctions which had to be adapted to the exchanges as well as to the operation of the power system.

Two-direction traffic was necessary from the point of view of economy in order to increase utilization. Double clearing signal was necessary to ensure perfect signalling in the switchboard and also to prevent as far as possible a communication through several automatic exchanges being broken off on account of eventual current impulses.

The latter case is of far greater importance in respect of perfect operation than the rare case of an instrument being blocked by the microtelephone not having been replaced at the other end of the line.

Further it is arranged so that the risk of simultaneous testing at both ends of a line is excessively small.

The sets of relays are at both sides provided with groups of relays for incoming and outgoing traffic. In addition there are relays which receive or return signals that the called party has answered.

The line is connected for outgoing calls from the automatic exchange, when its call number has been received. The relays for transmission of corrected impulses are then actuated and at the same time the relays that receive the reply signal, whereby the combination is blocked also by the called party, after he has answered.

A few milliseconds after the combination of relays for the outgoing traffic has been blocked by the calling party, the group for the incoming traffic at the other end of the line has also been actuated and blocks the line there. The impulses received there are corrected and sent on to the automatic exchange.

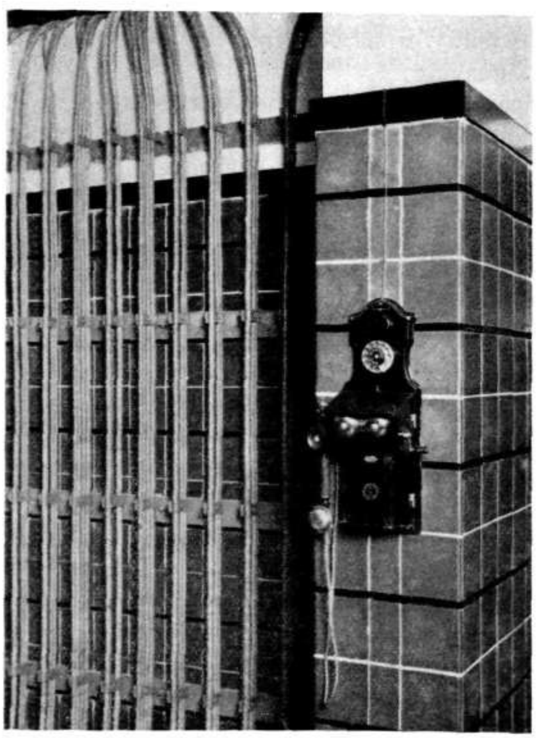
The double clearing signal is arranged at the incoming (called) side by means of a series of relays in bridge connection. By these relays the polarity of the line is changed on reply, by which a polarized relay on the outgoing side is actuated over the line.

In the switchboard there is a number of buttons, lamps and jacks per line in order to make manual service possible.

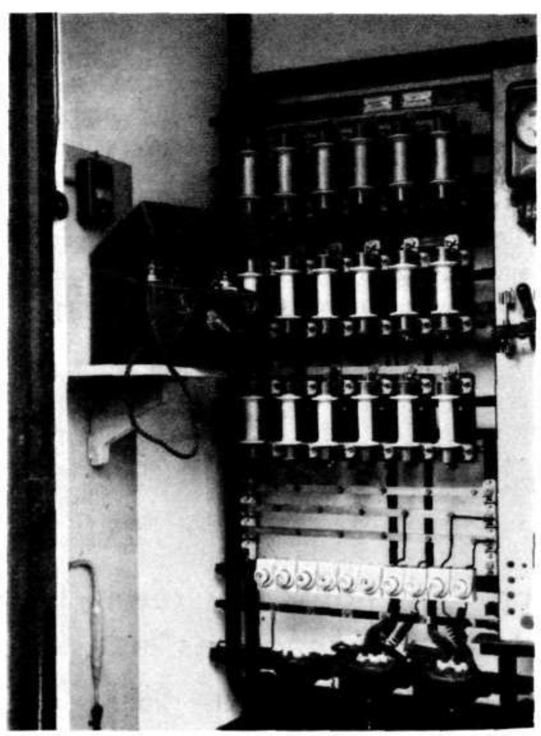
For the switch-over of the line from automatic to LB traffic there is a press button, a lamp and a jack. In addition there is a busy-lamp and a supervisory lamp. The latter lights up when the called party answers. In addition there are jacks for incoming and outgoing traffic and a button for connecting the dial to the line.

We have discovered that if all lines in service at present, *i.e.*, 8 lines between 20 and 65 km of length, are connected on test one after the other, all desired operations can be carried out without faults on the communication obtained. The impulses are then corrected 16 times, and the reply signals are repeated 8 times by change of polarity. In our opinion the number of lines connected after each other may be increased arbitrarily.

It is not possible to give a more detailed description of the various parts of our telephone system without exceeding the limits of an article of this kind. Various small arrangements have therefore not been mentioned. We have only given a general description of the manner in which the requirements for the service-telephone system of a great provincial power station have been fulfilled.



X 1253 **Fig. 13. *LB-instrument with dial,***
as mounted in a switching plant.



X 1252 ***Fig. 14. Portable telephone instrument***
with jack, connected at a transformer station.

THE INTERLOCKING SYSTEM AT THE STOCKHOLM CENTRAL STATION[1]

By T. HÅRD,
First Administrative Engineer of the Swedish State Railways, Stockholm.

X 1257 **The Stockholm Central Station, seen from north.**

In the Ericsson Review No 2, 1933 it was stated that the new interlocking system at Stockholm Central Station had been put in service on March 25th 1933.

The material for this system was to a great extent supplied by L. M. Ericssons Signalaktiebolag and other factories of the Ericsson group. This was also the case with the interlocking systems already in work at the Gothenburg and Malmö Central Stations, which are very similar to the system at Stockholm.

The first part of a description of this system is published below; it treats chiefly the main technical and economical problems and these will found to be of great interest.

In our next issue a large number of illustrations with text showing the construction of the interlocking machine and the details of the signalling system will be published.

The passenger stations of the Swedish State Railways in the three biggest cities of the country — Stockholm, Gothenburg and Malmö — form a special group with similar traffic conditions and arrangements for controlling the traffic. In respect of safety systems also the three stations have developed along the same lines.

In 1925 a new type of safety system for shunting and signalling was completed at Malmö C station, differing from previous installations of the Swedish State Railways by a higher centralization and automatization of signalling both for the trains and for shunting. For the reason that the staff was not used to the new installation disturbance was caused in the traffic when the system was first put in service; however, the trouble ceased in a short time, after the necessary experience had been gained. Except for this disturbance at the start the Malmö installation proved quite satisfactory from both the economical and technical points of view.

The same principles were therefore applied for the Gothenburg passenger station of the Swedish State Railways when this station was rebuilt in 1929—1930 in order to handle the traffic previously managed by the station of a private railway. The system at Gothenburg was put into service without disturbance of the traffic when only the traffic of the State Railways had to be dealt with at the station. Difficulties, however, occurred a fortnight later, May 15th 1930, when on one day the whole of the traffic of the other station was switched over, representing an increase in volume of about 150 %. In spite of the fact that most of the trouble could not be ascribed to the interlocking system this was made reponsible. The inexperience of the staff was this time also though unfairly made the main explanation of the trouble caused on switching over.

As early as 1929 the Royal Board of Railways had decided that the signalling system of the Stockholm C station should by rebuilt in accordance with the Malmö system, and the work was commenced as soon as the Gothenburg installation had been completed. On account of the experience gained at the start with the Malmö and Gothenburg systems, the putting in service of the far greater system of Stockholm C was looked

[1] Summary of a conference given at Oslo in August 1933 before the Northern Railway Officials' Association.

forward to with a certain apprehension. The installation was completed in the beginning of 1933. Great satisfaction was therefore experienced when on the last and greatest of the three systems being put into service there was no disturbance of traffic.

The yard is laid in narrow curves and at the northern end of the platforms it is crossed by a street bridge, the pillars of which have interfered with the planning of the track system.

Arrangement of Tracks.

Fig. 1 shows a map of the railway lines around Stockholm. Stockholm C is situated in the centre, being the main station for express, passenger and mail traffic. The passenger station consists of two parts, the eastern of which is a terminus with 6 platform tracks for northbound traffic and the western a through station with 5 platform tracks for southbound passenger traffic and 1 through track for freight trains.

These are two separate groups of tracks for the shunting of passenger trains: one small group east of the entrance points and one large group west of these points. The tracks for mail and express trains are situated west of the platforms of the Western Yard. Further north in the same part of the yard there are tracks leading to customs depots and provision halls.

The track system of Stockholm C has developed in stages from very small beginnings, and for economical reasons, the arrangements in the densely built parts of the city have been limited to the ground available between the adjoining streets.

The platform tracks are therefore few and short in length; the storage space is relatively restricted and the tracks are so situated that to a great extent the roads for trains and shunting must cross each other.

Entrance Lines.

The entrance to Stockholm C from the south consists of a double track which immediately outside the entrance points crosses a street carrying heavy traffic. On the other side of the crossing there is a swing bridge which, however, is seldom opened.

The railway line is carried on bridges over Lake Mälar and, having crossed the street on the southern shore about 1 km from Stockholm C, it enters a tunnel under the southern part of Stockholm. Near the street-crossing a freight-train track to the harbour leaves the double track, and in addition it is crossed by a shunting track for transferring coaches from one part to another of the harbour situated at each side of the double track. There is further near the crossing a swing bridge which is often opened for the passage of ships.

Near the southern end of the tunnel, about 1 km from Mälarstrand, the double track enters

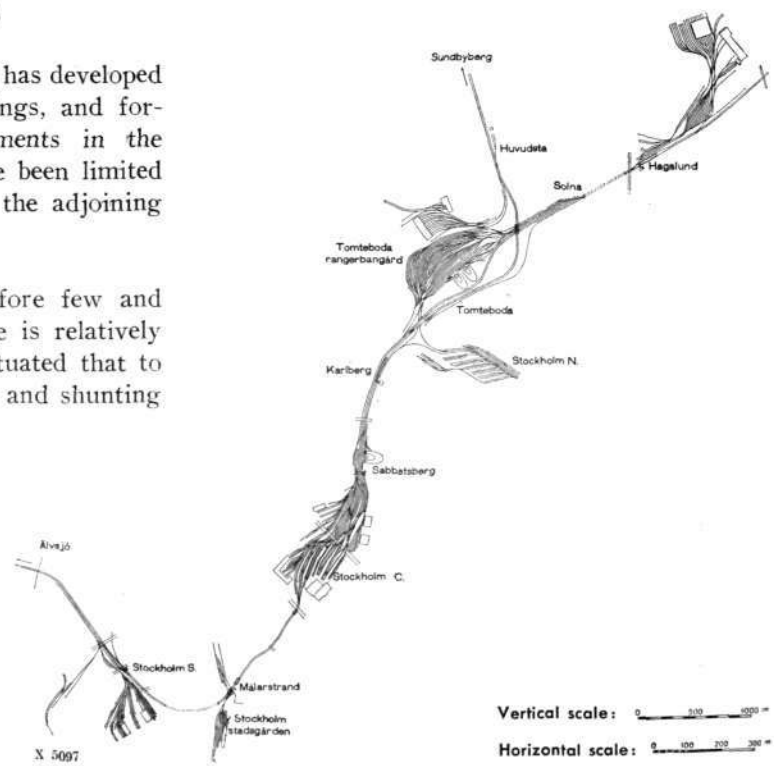


Fig. 1.

Plan of the railway lines around Stockholm.

Stockholm South station, where passenger trains stop. This station is a junction for traffic to and from the southern freight station.

South of Stockholm the double track runs first to Älvsjö where the railway to Nynäshamn on the coast south-east of Stockholm branches off, and thence to Järna where the Malmö and Gothenburg lines divide.

Traffic arriving at Stockholm C from the north is directed partly over a double track and partly over two single tracks, the Eastern and Western side tracks, one on each side of the double track. About 700 m outside the entrance points of Stockholm C the double track is crossed by a shunting road provided for trains crossing from one side track to the other. In this shunting road there are also points for the double track as well, so that trains may be transferred from the double track to the Western side track and vice versa.

The Karlberg station is situated about 700 m further along, and several passenger trains stop at this station for traffic exchange. A further 700 m along the line, at Tomteboda Övre, the double track divides into two double tracks, one to the line of the private company serving Västerås and the other to the North Main Line of the State Railways.

About 1 700 m north of Tomteboda Övre the double track of the North Main Line passes the points at Solna at the northern end of the Tomteboda formation yard and then Hagalund station, from where tracks lead to engine sheds and parking tracks for the long-distance passenger traffic of Stockholm C belonging to the Swedish State Railways. Between Hagalund and Stockholm C a great number of empty trains and single engines are run in addition to the passenger trains of the North Main Line.

On account of the insufficient capacity of the Stockholm C track system Sundbyberg is used as a making-up station for several of the long-distance trains when traffic is heavy; the traffic on the line Huvudsta—Stockholm C is thus increased.

About 1 700 m from Tomteboda Övre the double track of the Västerås line passes Huvudsta station, where the railway net of the private Stockholm—Västerås railway begins. Between Huvudsta and Stockholm C runs the passenger traffic of the Västerås line as well as a number of engines to and from the company's engine sheds at Sundbyberg.

The Eastern and Western side tracks are used for freight trains and engines to and from the Tomteboda formation yard. From points in the Eastern side track near the Karlberg station a track leads to the northern freight station of Stockholm. The Western side track leads to Solna from points at Tomteboda Övre and is also used for empty trains when the capacity of the double track is not sufficient.

Planning of the New System.

Previously there were three mechanical interlocking machines each about 30 years old, one at Sabbatsberg (Cabin I), one at the eastern part of the yard (Cabin III), and one at the southern entrance points. In addition there was a small provisional signal cabin (Cabin II) at the northern entrance points, built in connection with the extension of the yard when all facilities of the existing interlocking machines were utilized. The points at the northern end of the platform tracks of the Western yard were not interlocking and were operated from a post situated near the points and called »Western Yard Post».

For clearing the roads for arrival and departure there were two blocking apparata in the train dispatchers' offices, one for the northern and the other for the southern part of the station.

The safety installation had been altered several times and needed thorough reconstruction. In the program for the reconstruction of the system, of which the main points were approved by the Royal Board of Railways in 1929, the intention was to concentrate the 7 interlocking machines of Stockholm C in one main electric system.

The points at Tomteboda Övre and the lines from there to Huvudsta, Hagalund and Sabbatsberg were operated from an electric signal cabin at Tomteboda, which when built in 1916 replaced 3 small signal cabins.

As the project was developed it seemed advantageous to eliminate the Tomteboda Övre signal cabin and concentrate even this operation at Stockholm C. In this way, in addition to considerable reduction of the staff, a far higher traffic capacity of the heavily loaded double track was believed possible.

For the same reason it seemed advantageous to operate the side tracks and their points from

Stockholm C; formerly one of these points had been operated from Tomteboda Övre and the other from the Karlberg station.

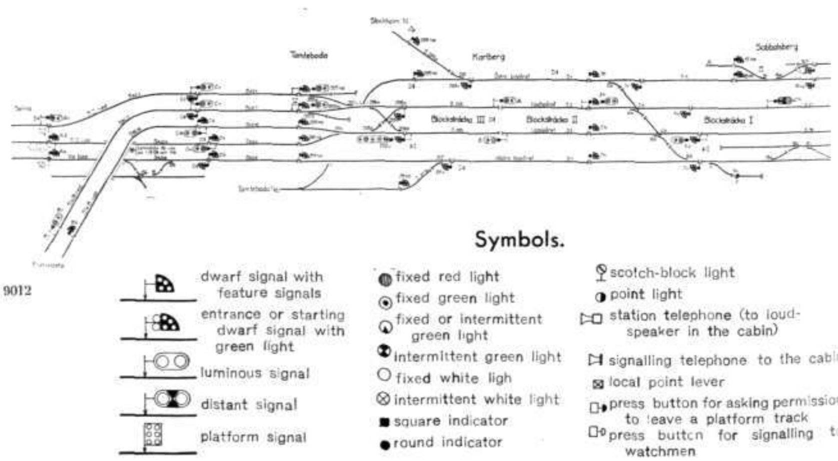
At Mälarstrand there was a 30 years old mechanical signal cabin with section blocking arrangements to Stockholm South and Stockholm C. A separate signal cabin was provided for the operation of the swing-bridge and the street barriers. Although there had to be a certain staff at Mälarstrand to deal with the pivot-bridge and to guard the crossing, the work ought to be performed from one signal cabin which would involve a certain reduction of staff.

In addition the traffic capacity of the double track Stockholm C—Stockholm South with the existing section blocking system had proved insufficient. Difficulties occurred particularly with single-track operation, when running of the trains had to be regulated by means of telephone communication. At Stockholm South an electric interlocking system with automatic section blocking for the line to Älvsjö had been installed a few years before. The advantages of this system could not be utilized to the full until a similar system was installed on the line between Stockholm South and Stockholm C.

Main Points of the New Installation.

Fig. 2 shows the new safety installation in the state in which it was built. In view of traffic conditions the range in question was divided into three main parts, namely Stockholm C and the northern and southern lines. The points at Sabbatsberg were included in the northern lines, and the limit of Stockholm C was put at a suitable distance from the entrance points of the platform tracks. The points at Mälarstrand and the line between Stockholm C and Stockholm South were included in the southern lines. The limit of Stockholm C in this case was put at such a distance that the tracks outside the entrance points could be used for shunting without the line section being disturbed. The extent of the system is shown in the table below, where all apparatus and arrangements are indicated:

	Northern lines	Central station	Southern line
Main signals ... } coloured light signals	14	3	4
Distant » ... } coloured light signals	—	1	4
Home and starting dwarf signals ... } feature light signals	—	24	—
Other dwarf signals } feature light signals	40	18	9
Platform signals	—	18	—
Scotch-block lights	5	4	1
Point lights	—	3	—
Centrally operated points and scotch blocks....................	21	80	7
Other lockable points and scotch blocks	12	3	—
Track circuits	37	94	7
Signal sections with automatic signals	17	—	2
Signal sections with signalling from signal cabin..............	54	194	13
Roads................................	—	132	—
Yard telephones	—	9	—
Signalling telephones	13	3	2
	Signal cabin at Stockholm C.		Signal cabin at Mälarstrand
Signal switches.....................	61		3
Point switches	70		5
Reserve positions	29		4



X 9012

Fig. 2.
The *interlocking plant* at Stockholm C with adjoining lines.

When working out the project it proved advantageous to complete and alter the arrangement of the points. At the southern end the points *136 a/b* and *126 a/b* were provided in order to obtain roads from both up and down lines to all platform tracks. By this arrangement it would not be necessary to change the roads in the yard for single-track traffic. In the northern part of the yard the new points *22 a/b, 30 a/b, 56 a/b* and *116 a/b* were provided, and, further, all single crossing points were replaced by double ones. At Sabbatsberg the shunting road *2a—2b,* which had formerly been situated close to the station, was moved further out.

An important problem was the location of the main signal cabin. There were two alternatives: north of the street bridge or south of the bridge at the northern end of the Western Yard. The latter alternative was chosen because in this way the cabin would be nearer to those groups of points where shunting had proved to be far more intensive and more varied than at the points further north. For the street barriers at the southern street a special post was provided, consisting of a small cabin immediately beside the street crossing. At Mälarstrand a separate small signal cabin was provided, placed on poles in the water so near the swing bridge that the opening and closing of the bridge could be carried out by the staff of the cabin.

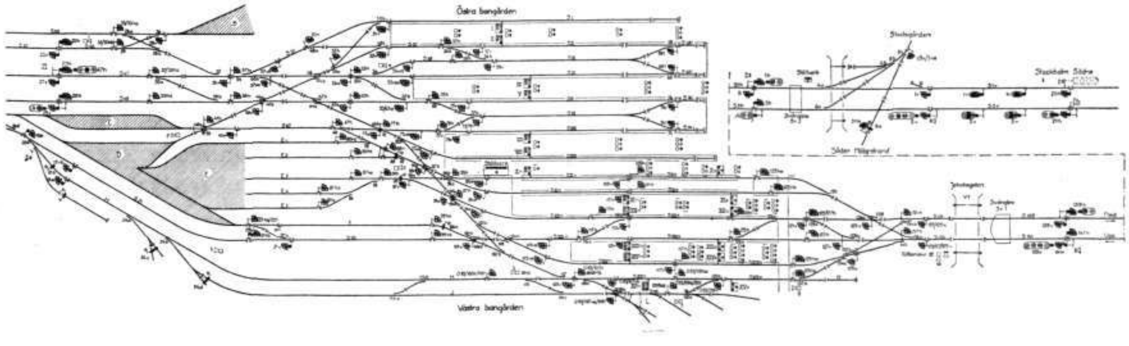
The tracks were divided into *signal sections* with signals for regulating the traffic on the sections. The sectioning was determined by the position of the points, the necessary traffic intensity and the safety requirements. It was made a main rule, that all movements of vehicles into or out of a section should be controlled by clear signal from a fixed signal. The movement should be protected from dangerous train or shunting operations by points not being thrown to the track in question or by fixed signals in stop position. When the points permit several roads between two places it must be possible to use any one of them.

In order to increase the traffic capacity of the Western Yard the platform tracks at this part were divided into two signal sections, so that two trains of a certain length could be placed behind each other at the same platform.

In the groups of points at the ends of the platform tracks, relatively short signal sections were arranged, whereby the shunting work would be facilitated, as the distances to be traversed would be shorter, and the movements could be carried out at shorter intervals.

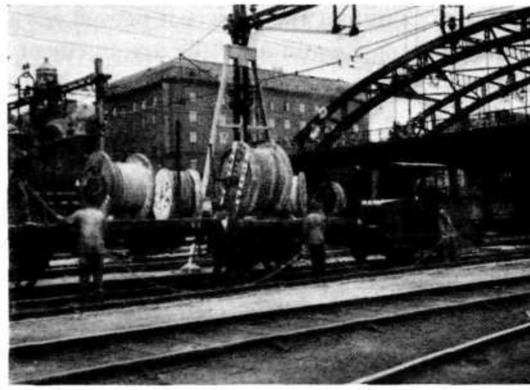
In order to facilitate train movements over these groups of points special signal sections were arranged between the lines and the platform tracks, arrival and departure tracks, made up of combinations of several signal sections lying behind each other.

Each of the side tracks between Stockholm C and Tomteboda Övre was divided into three signal sections for each traffic direction. The same sectioning was carried out for the two tracks of the double track, while the number of sections for the opposite direction was limited to two for these tracks. The tracks between Tomteboda Övre and Hagalund and Solna respectively were each divided into two sections, except for the abnormal traffic direction on the double tracks; for this case only one signal section is



provided. The two tracks between Stockholm C and Stockholm South were divided into two signal sections each for the normal direction and one each for the opposite.

Automatic signalling was arranged for the signal section on the line where there were no points. The intention was to reduce the work of the staff and make possible shorter intervals between trains by means of a more rapid clearing of the signal sections for the following trains. Even the automatic signal sections were, however, placed under the supervision of the signalling staff, as a change of the traffic direction on a track would have to be arranged by the staff.



X 1256 **Fig. 3. Cable laying.**

Signalling Systems.

Entrance to the signal sections both on the lines and in the range of Stockholm C is regulated by *dwarf signals,* which show two uncoloured lights arranged in different positions in relation to each other. »Stop» is indicated by two lights side by side, »caution» by the left light being situated somewhat higher than the right one and »clear» by one light above the other.

For the entrance roads to Stockholm C special signalling was arranged on the dwarf signals at the station limits *(home dwarf signals)* consisting of a green light below the uncoloured lights. A continous green light on a home dwarf signal shown at the same time as »clear» by the uncoloured lights means that all signal sections of the entrance road are clear. Intermittent green light is used instead of fixed for *shortened road, i.e.,* all signal sections except the last section of the platform track.

Corresponding signals for departing trains have been arranged on the dwarf signals regulating the traffic from the platform tracks *(starting dwarf signals).* Intermittent light is used when the signal sections of the road are clear only to the station limit and fixed green light when the first signal section of the line is also clear.

The position of dwarf signals can be clearly seen at a distance of 200 m, which is considered sufficient for a speed of 30 to 40 km/h. Where greater speed is used or where the signals are required to be visible at a greater distance, the dwarf signals are combined with *main signals* showing a green or a red light placed above the dwarf signals, and which can be made out at a great distance.

In this system the main signals are thus regarded as supplementary to or repeating signals for the dwarf signals which are the fundamental means of signalling. When the dwarf signal indicates »stop» the main signal shows a red light. When the dwarf signal is switched over to »clear» the main signal shows a green light, if the clear signal does not belong to a signal section where a reduction of speed or special attention is necessary. In such cases the dwarf signal only indicates »clear», while the main signal continues showing a red light. Red light is always shown on the main signal when »caution» is shown on the dwarf signal.

»Clear» on a dwarf signal or green light on a main signal means that all points in the signal section are in the right positions, that danger signals indicate »stop» and that the section is free from vehicles.

»Caution» on a dwarf signal means that the points are in the right positions and danger signals in »stop» position, but that there may be vehicles in the section or close to it.

The feature »caution» is of great importance for shunting work during which movements have to be carried on near sections occupied by vehicles. As a rule only the feature »clear» is used for train movements. »Caution» may be used also for trains when faults occur or when trains have to be directed to tracks already occupied by vehicles.

In the range of Stockholm C it was arranged with regard to the shunting work that »caution» should always be shown on dwarf signals when the signal lever is switched over, if »clear» signal cannot be indicated immediately. If the latter is the case, »clear» is automatically indicated instead of »caution».

For the signals on the lines where the traffic as a rule consists of trains, it was arranged so that the feature »caution» cannot be shown if the section is occupied, unless a locking button on the signal lever is kept pressed.

All points of the signal sections in Stockholm C and the northern lines are operated from the signal cabin of Stockholm C with the exception of a few points in the Western side track leading to parking tracks which are only provided with point locks, and the points of the southern line which are operated from Mälarstrand.

A number of points in the through track of the Western Yard are operated both from the signal cabin and at the points themselves by means of levers. Permission must, however, be obtained from the signal cabin before these levers can be used. The dwarf signals of the signal sections in which the points are situated then indicate *»out of service»*, which means that shunting may be carried on without intervention of the signal cabin. This signalling feature consists of lights of different colours, of which the right one is situated higher that the left.

Track Circuits and Their Application.

The supervision of the extensive interlocking range is carried out by means of *track circuits.* These circuits are used for three different purposes:

to operate a track diagram, which shows the staff where trains and vehicles are situated;

to ensure automatically that the entrance signals of the signal sections do not indicate »clear» when the sections are occupied by vehicles;

to prevent the points being thrown over too soon;

the division of the track into track circuits, *i.e.* electrically insulated sections, through which the track current passes to the track relays, must take account of all these points of view.

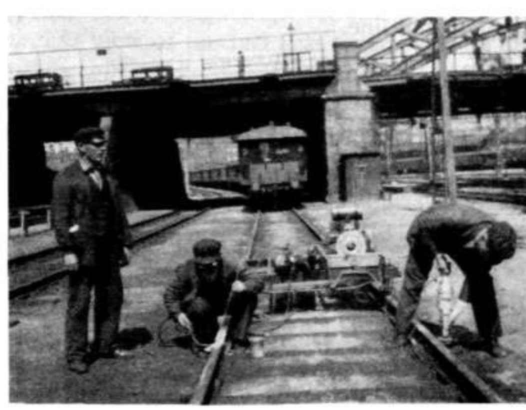
The indications on the track diagram are by means of lamps which light up and go out as the track relays change position.

The signals are operated by the first track circuit of the signal section. A signal in »clear» position will therefore change when the first axle of a train has passed. The signals on the line are changed to »stop» and the signals in Stockholm C to »caution», according to the different methods applied for the operation of signals on the line and in the yard.

In order to prevent points being thrown over too soon the principle is applied for signal sections on the lines that a signal lever switched over must not be put back until the expected train has arrived and the engine has passed the signal. The release occurs when the train enters the first track circuit of the signal section. The signal lever can then be put back but the points of the section are still locked by the influence of the train and are not released until this can be permitted from a safety point of view.

A similar system is used for the entrance and starting roads over the points of Stockholm C, *i. e.*, when signalling is made with green light on the entrance and starting dwarf signals.

For practical reasons it was necessary to avoid the locking of the signal switches in thrown position (track locking) for movements in connection with shunting work. The locking of the points by individual locking of the point switch was, however, arranged in all cases where the signal is passed by vehicles when the switch has been thrown. If a signal switch is thrown back before the signal has been passed there is of course a certain risk if immediately afterwards the points are thrown over from the signal cabin without the staff having ascertained whether the stop signal has been obeyed or not. For the groups of points situated far from the signal cabin special time relays have been provided in connection with the signal switches. These time relays will hold the points of the signal section locked for a certain time after the signal switch has been thrown back.



X 1255 **Fig. 4. Welding of the connections at the rail joints.**

In the group near the signal cabin, where there was a great need for liberty of motion, this delay was not introduced. The suitable time for throwing back the signal switches when shunting is determined by the shunting staff in accordance with general orders.

Communication Arrangements.

The Stockholm C interlocking system is of the master type. The operation of the signals is thus commanded by the interlocking system. For the information of the platform staff, particularly the train dispatcher, special platform signals have been installed, which indicate when a train is arriving or when the road is clear for departing trains. Arrivals are indicated by a red light towards the platform and departures by a green light; the latter indicates by its position in the signal to which track the road is leading.

In order to call the attention of the signal cabin when a train is ready to start there are press-buttons on the platforms connected with signal lamps in the track diagram in the signal cabin. The signalling staff need therefore not clear the roads earlier than is absolutely necessary.

Communication between the signal cabin and the train dispatcher is carried on by the telephone. For information between the signal cabin and the staff in the yard there is a special telephone system with loud-speakers and microphones in the signal cabin, so that calls can be exchanged without interruption of the work at the interlocking switchboard. There is also a special signalling telephone system for giving orders to the engine crews on trains that have been stopped at the fix signals on the line.

Connecting-up the Interlocking System.

The interlocking system was put in service in three stages. On the night of March 16th to 17th all devices on the lines north of Stockholm C were switched on, by which 21 machine driven points, 12 locking devices, 54 signals with 37 track circuits were put into service. The work had been prepared during the four previous days, and during this time the old section-blocking system and the signal cabin at Tomteboda were put out of service and replaced by telephone information and personal inspection of the roads.

On the night from March 20th to 21st the signal cabin at Mälarstrand and the lines south of Stockholm C were switched on, by which 7 more points operated from the central signal cabin, the interlocking of the pivot-bridge and 17 signals were put in service. The old safety system was kept in service all the time and was not disconnected until after the last train of the 20th. The work was rather difficult as the electric circuits at Stockholm South had to be rearranged in a few hours of the night.

At this time there remained at Stockholm C 80 point-machines, 127 signals and 94 track circuits to be switched on. The signals and the track circuits had been completed previously as well as about 20 points which were not in use at this time or which could be thrown over by hand-levers. The remaining 60 points were connected in four hours of the night from March 24th to 25th. The complete system was in service for the first train of the 25th. Fifty-seven men took part in the connecting work, and these were divided in two gangs with written instructions regarding what each man had to do.

The signalling staff had previously received careful tuition and had been trained in practice for a few weeks. During the training the signalling with the dwarf signals was carried on as if the system was already in service but the points were still operated in the old manner. The shunting and engine staff were ordered to respect also the new signals. Two signalling systems were thus in service during the training time.

As a result of this training the switching-over from the old to the new system was done without any sudden change and the work went on as usual. The only difference was that the old signals and signal cabins were put out of service from March 25th, when also the operation of the points was taken over by the interlocking system.

Cost of the System and Reduction of Staff.

A summary of the cost of installation of the point and safety signalling system at Stockholm C with lines to Huvudsta, Solna and Stockholm South is given below.

Material.		
1. Interlocking machine, track diagram, relays, signals, operating machines for points and street barriers, transformers, condensers, rotary converters and rectifiers, switchboards, telephones and installation material	505 000	
2. Underground cables, cable fittings and connecting wire	155 000	
3. Tools and parts for provisional arrangements	16 000	676 000
Wages.		
4. Fitting, excluding work on cables (80 000 hours at Sw. Kr. 1: 80)	144 000	
5. Laying and fitting of cables (44 000 hours at Sw. Kr. 1: 75)	77 000	
6. Supervision of the work, watchmen, stores, provisional arrangements, holidays, illness, etc. (50 000 hours at Sw. Kr. 1: 70)	85 000	306 000
Buildings.		
7. Signal cabins		60 000
	Total Sw. Kr.	1 042 000

Two thirds of the total cost, Sw. Kr. 1 042 000, is represented by material and about one third by wages paid by the Swedish State Railways direct to fitters and workers. The average wages have been Sw. Kr. 1: 75 per hour; this average includes piece-work, over-time and night work as well as the wages of fitters with special qualifications.

If each point, scotch block, signal, operating machine for street barriers and interlocking device for swing bridge is considered as a unit there are 464 units in the whole system, and the installation cost per unit was Sw. Kr. 2 250. For purposes of comparison it may be mentioned that the Gothenburg system with 216 units cost Sw. Kr. 464 000 or Sw. Kr. 2 150 per unit.

The changes in staff due to new safety system are shown in the table below.

	Staff for train dispatching, signalling, engine shunting and maintenance			
	Before	Now	Reduction	Increase
Traffic department:				
Tomteboda Övre	7	3	4	—
Karlberg	4	3	1	—
Stockholm C:				
Signal cabin I (Sabbatsberg)	5	—	5	—
Signal cabin II	3	—	3	—
Signal cabin III	10	—	10	—
Signal cabin IV	4	3 watchmen	1	—
Eastern Yard	4	3	1	—
Western Yard	13	8	5	—
New signal cabin	—	17	—	17
Southern end of the yard	3	3	—	—
Northern train dispatcher's room	6	6	—	—
Southern train dispatcher's room	5	5	—	—
Mälarstrand	7	3	4	—
Stockholm South	6	3	3	—
Line Department:				
Repair staff	8	8	—	—
	85	65		

The saving of staff thus amounted to 20 men on August 1st 1933, which corresponds to about Sw. Kr. 80 000 per annum. A calculation of interest regarding this saving is given below.

It should be observed that the staff is to work to the time table of May 15th which was introduced only about a month after the system had been put into service. On account of the uncertainty as to what influence the system would have on the work the staff will probably be too large rather than too small. When the staff is fully trained it will probably not be necessary to have 17 men in the new signal cabin, which means 6 or 5 men per gang. This staff can then probably be reduced by 4.

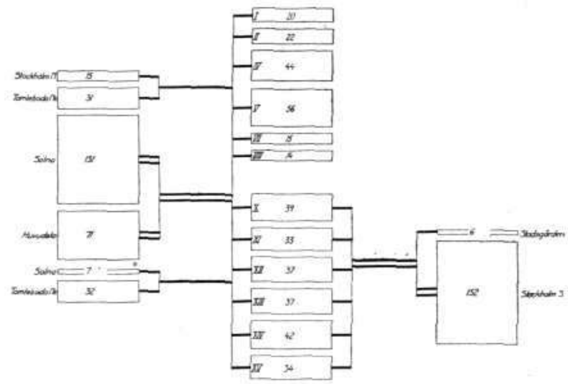
	Annual cost	
	Increase	Decrease
4.24 % interest on Sw. Kr. 1 042 000	44 200	—
Consumption of electric power	5 800	—
Cost of material for maintenance	—	—
Cost of staff for operation and maintenance	—	80 000
Total Sw. Kr.	50 000	80 000

The annual profit with the reduction of staff by 20 men already made is Sw. Kr. 30 000 and in addition an increase has been obtained in traffic capacity and safety.

Eight men remain of the 13 men at the Western Yard; of the work carried out previously there is only left the coupling of the engines when shunting, while all inspection of roads, throwing-over of points and signalling has been eliminated. In the Eastern Yard and at the southern starting points there are 6 men in all for the same kind of work with the shunting of the engines; the effective work of this staff during an 8 hours' shift can probably be counted in minutes. By a better organisation of the work and by spreading more widely over the yards, the whole staff for shunting engines can probably be reduced by at least 6 men more. This reduction is relatively small in view of the fact that there are 3 shunting engines with corresponding shunting gangs working in the yard, costing about Sw. Kr. 360 000 a year. Also for these shunting groups the improved arrangements for the operation of points and signals will have brought about a higher efficiency which after some time should make further savings possible.

Other figures in the table that are worthy of note are those relating to train dispatchers. According to the table the same number of staff as before is used though the work connected with the station-blocking apparatus has been eliminated and the responsibility for keeping the lines clear has been transferred to the automatic equipment. By combining the two train dispatcher's offices in one, two assistants will be saved. By relieving the train dispatchers of certain kinds of routine work such as giving starting signals to local and empty trains, it should be possible to reduce the number of train dispatchers from 7 to 4.

Even at Stockholm South, Tomteboda Övre and Karlberg it will be possible to make certain reductions. In addition to the reduction of 20 men already made, as stated in the table, a further reduction of 14 to 15 men will be possible when all facilities for rationalizing the work are utilized. The savings for amortization of the installation cost, which is Sw. Kr. 31 000 at a reduction of 20 men, will increase to three times this amount with a reduction of 15 men more.



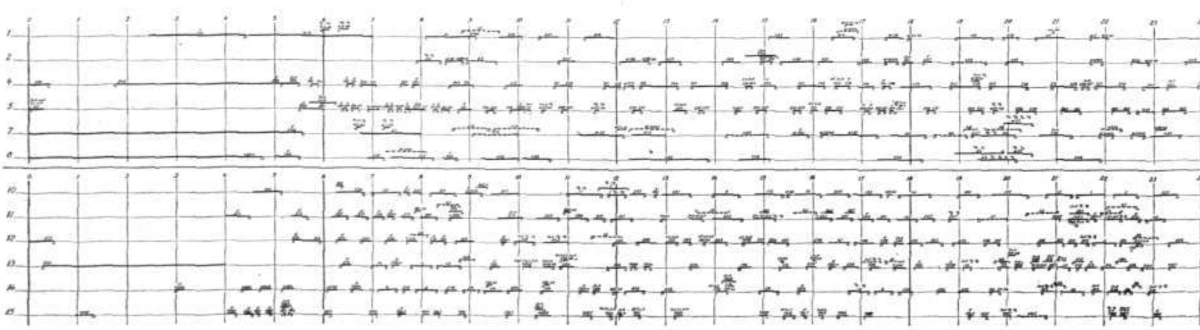
X 1258 **Train frequency on the tracks and adjoining lines at Stockholm C.**

Amount of Traffic.

Fig. 5 gives in graph an indication of the train frequency on the train tracks and the adjoining lines of Stockholm C. The diagram gives the ordinary traffic on the day of the week when traffic is at its heaviest. The number of arriving and departing trains on the adjoining lines is 445 in all, of which 270 are passenger trains and the remainder consists of freight trains, empty trains and single engines.

In addition to these trains there are a great number of shunting movements, which are carried out on the train tracks of Stockholm C without reaching the lines. The number of such shunting movements is about 825 per day, according to the shunting plan of Stockholm C. A new shunting movement is counted after each change of direction or road, so that for instance a shunting movement requiring one drawing-out and one reverse movement is counted as 2 movements in the above figure. Shuntings on the parking lines are not included in the above figure, which refers only to movements on the tracks operated from the signal cabin.

Fig. 6 shows a plan of the utilization of the platform tracks during the day. From the plan it may be seen that practically all traffic is carried on between 4 a.m. and midnight. During this time there are thus more than 1 200 train and shunting movements in the interlocking range, *i.e.* an average of one movement a minute.



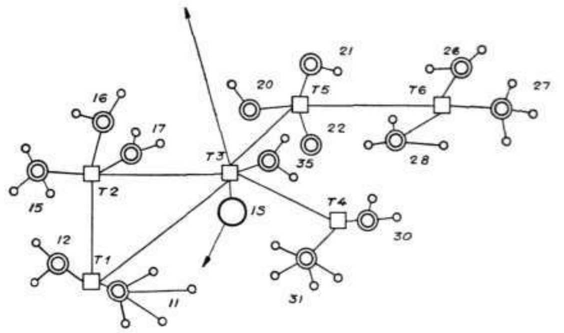
X 7048 **Fig. 6. Plan of the utilization of the platform tracks at Stockholm C.**

The tracks are represented by horizontal lines and the hours by vertical lines. The presence of a train or an engine on the platform tracks is indicated by heavy black lines, the ends of which indicate the time of arrival or departure of the vehicle from the track. The figures at the ends of these lines indicate the time of arrival and departure in case the movement is made as train.

AUTOMATIZATION OF RURAL DISTRICTS —

WITH SPECIAL REGARD TO CONDITIONS IN DENMARK.

A brief summary of the lecture given by Telefonaktiebolaget L. M. Ericsson in Copenhagen on February 15th 1934 is here given. The lecture was delivered at the invitation of the Electrotechnical Section of the Society of Danish Engineers, in view of the present project for automatization of rural districts in Denmark.



X 1267 District automatized on the transito system.

T_1—T_6 are transito exchanges which switch through the traffic between the exchange groups, which are indicated by the exchange numbers. The exchange groups consist of a junction exchange and the terminal exchanges connected to it.
The arriving automatic traffic from other districts is switched through by the transito exchange T_3, and the long-distance traffic by the the long-distance exchange IS.

At the present time no technical difficulties are involved in automatizing the whole telephone system of a country so that each subscriber may set himself up a connection with any other subscriber in the country. Practical and economical reasons, however, prevent such projects being realized. Call numbers of subscribers would become long and complicated, and, in addition, the automatization of long interurban lines could hardly be an economic proposition. For the present it is therefore advisable to be content with automatizing the traffic inside the various telephone areas and between adjoining areas and perhaps also, on certain important traffic routes, between the centres of areas that are not adjacent.

Number System.

The most suitable number system for the automatization of great districts will be a system with *open direction numbers.* This system requires that only the subscribers in one local system, which may be composed of one or more exchanges, are given call numbers in the same number series. When setting up a connection to a subscriber connected to an automatic exchange outside the local system of the caller two or three digits forming the direction number are dialled before the subscriber's number. The direction number indicates to which local system the desired subscriber belongs. This number system is also the one more nearly approaching the system employed in manual telephone service, the name of the place in the manual system being replaced by the direction number in the automatic system.

Rate System.

When automatizing interurban traffic the charging of the calls must also be carried out automatically. The junctions are therefore provided with *time-zone counting* devices, which are adjusted automatically in various ways in accordance with the connections set up and emit to the subscribers' meters a number of impulses corresponding to the length of the line and the number of call periods.

If the local rate is of such a nature that the charges are a linear function of the number of calls made, both local and interurban calls may be recorded by the same meters. To make such a method of charging possible in Denmark would require alteration of the present rate system. If for some reason or other it is not desirable to make the local and interurban rates dependent on each other, each subscriber's line may be provided with two meters, one for local calls and one for interurban calls.

Lines.

One of the conditions necessary for carrying out automatization of rural districts is that there is a sufficient number of junctions between the different local line systems, so that cases when calls cannot be put through on account of lack of junctions will be the exception.

From the above it might be supposed that the automatization would call for an increase of the number of junctions. However, since it is possible to connect the junctions in groups in an automatic system, ensuring better utilization, and to install small automatic exchanges at places where it would not have been economic to have manual exchanges, the number of junctions available will often be found sufficient for automatic traffic. In this way the subscribers' lines may be made shorter and lines rendered superfluous may thus be used as junctions between the exchanges.

The Transito System.

In the Ericsson system for the automatization of rural districts, the transito system, the districts are divided into two groups of line systems: exchange groups and transito line systems. An *exchange group* comprises one or more exchanges between which the traffic is carried on without direction numbers. This group of exchanges is connected to the nearest transito exchange over one single group of junctions. A *transito line system* comprises several transito exchanges, which carry on the traffic between different exchange groups. No subscribers' lines are connected to the transito exchanges. The interurban exchanges are connected to the transito exchanges and are thus in connection with the whole district.

By this radical division of the rural automatic system into two systems the local exchanges may be planned and built perfectly independent of other local exchanges and without regard to the intercommunication between them. This is of very great importance since the modernization of one district may be carried out in stages as local conditions permit, without disturbance of the traffic.

The transito exchanges are provided with *registers* which receive the digits dialled by the subscribers and repeat them to other exchanges. Hereby the number of direction numbers required depends only on the number of exchanges or local systems between which automatic traffic is to be performed. In decade systems one digit is required for each stage of connection.

Any number of transito exchanges may be connected in series. All transito exchanges being equal it is unnessary to block junctions to the main exchange of the district if these junctions are not to be included in the connection.

The junctions connected to a transito exchange may operate with DC or AC impulses.

Local Exchanges.

Ericsson have evolved several systems for the automatization of exchange groups, these systems varying in design according to the number of subscribers in the particular area.

For small exchange groups consisting of one junction exchange and a number of terminals, there are two types of switchboards. In both types of switchboards 25-line step-by-step operated rotary selectors are used. At the *terminals* they are operated by the subscribers' dials; at the *junction exchanges,* on the other hand, they are operated by registers which are also designed for repeating the received digit impulses to the terminals.

Both types of switchboards are provided with fault-signal transmitters, by means of which all faults of importance are signalled to the nearest supervised exchange. The terminals are made so that a short-circuited line is disconnected from the cord circuit after a certain interval.

Automatic systems with 500-lines' selectors are used for exchanges of more than 300 subscribers.

Automatic Exchange for LB Systems.

The aforementioned exchanges operate on the CB system which requires better insulation of the subscribers' lines than exchanges on the magneto system. On automatization for the CB-system the subscribers' lines will often need alteration, which involves considerable expense.

To avoid this Ericsson have designed an automatic magneto system that can operate over lines of inferior quality.

The exchanges built on this system operate according to entirely new principles, and a brief description might therefore be of interest (for further information we refer to the article »Automatic Telephone Exchanges for LB-Systems» in the Ericsson Review No 4, 1933).

When the setting up of connections is carried out without the aid of the operator the existing magneto telephones must be provided with dials, and these can be added to the instruments without any other alterations being necessary.

The subscriber calls the exchange in the ordinary way by turning the magneto; 50 cycles' AC is then emitted from the exchange over the subscriber's line. The AC is heard by the subscriber as a dialling tone.

Impulsing is carried out by the subscriber interrupting the AC by means of his dial, and DC is never connected to the subscribers' lines. Consequently, transforming and phantoming is possible on the subscribers' lines. Both single and double lines may be connected to the switchboard.

The calling is by means of intermittent ringing current. When the called person answers, the ringing is interrupted and automatic metering is carried out in the usual manner.

When a call has been finished the subscribers give clearing signals by turning their magnetos; the circuit is then immediately disconnected.

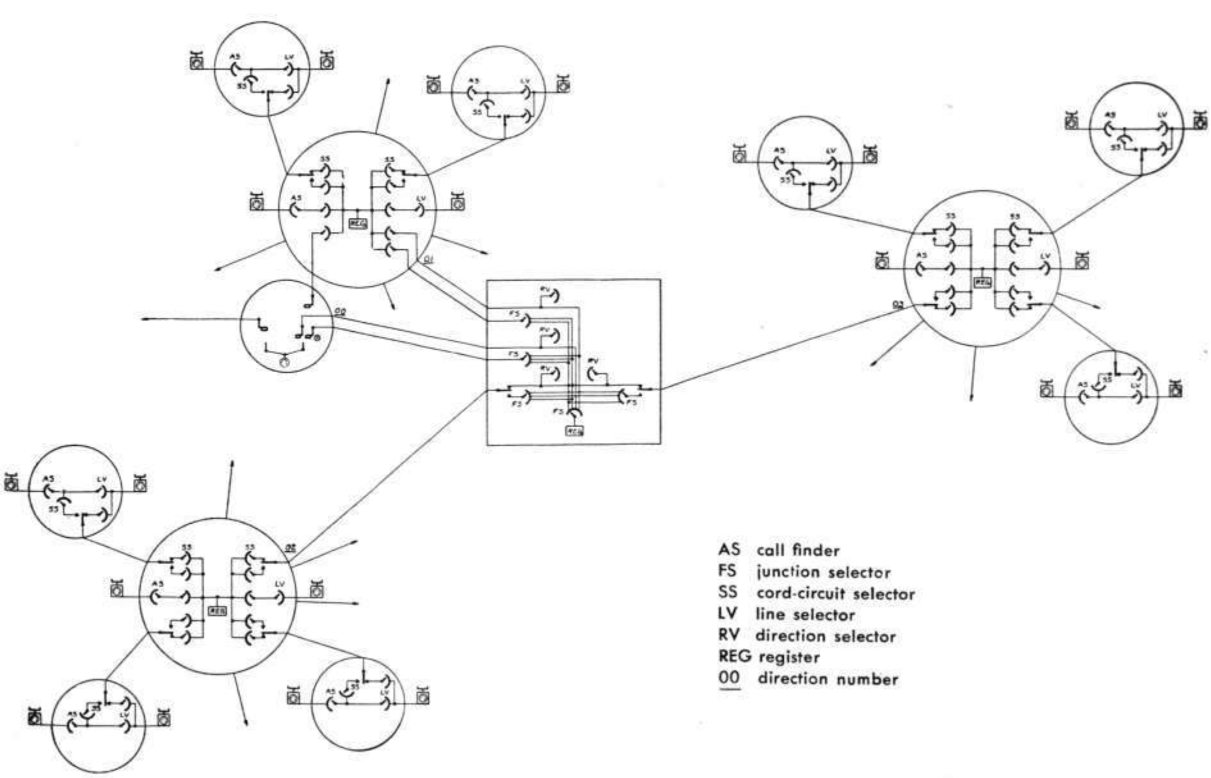
In order to prevent a cord circuit being blocked when the subscribers on replacing their microtelephones have omitted to give clearing signals, a special device has been introduced which at intervals of about one minute checks whether a conversation is going on or not. Thanks to this arrangement a cord circuit cannot remain blocked for a longer time than one minute after the microtelephone of the calling party has been replaced even though no clearing signal has been given.

Party-Line Systems.

In order to make party-line traffic possible in automatic systems Ericsson have evolved several party-line systems; secret and non-secret twin lines, party-line switchboards for 8 lines, and selective-calling lines.

In all these systems ordinary CB-telephones are used. Calls to and from the party-line subscribers are made as usual by means of directory numbers. Automatic intercommunication between the different subscribers of one party line may be arranged in all these systems.

O. Siewert & C. Berglund.



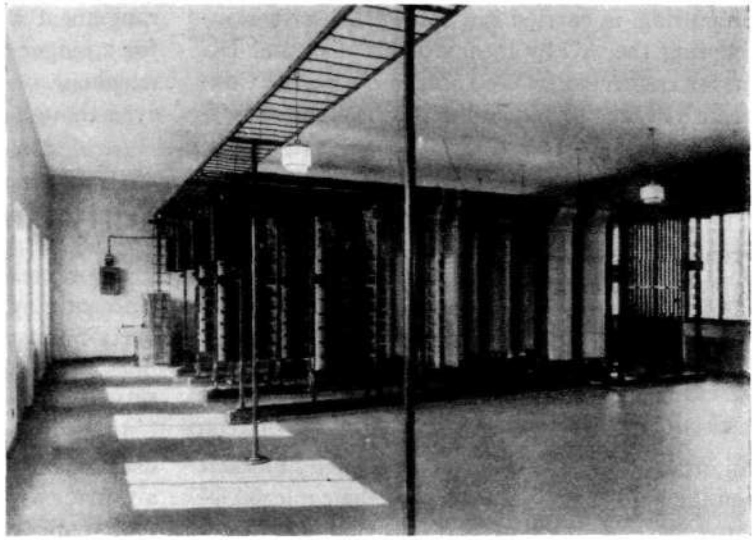
X 7049

Diagram of three exchange groups and one transito exchange for switching over the traffic between the groups.

New Ericsson Exchanges in Norway

Fredrikstad Telefon Co., which celebrated its fiftieth anniversary last autumn, put its new automatic telephone exchange in to service on November 5th 1933, and a few days later, in the night of November 18th to 19th, the new automatic exchange at Moss was switched on.

These two exchanges have been built on the Ericsson system by A/S Elektrisk Bureau, which has given the following description of the new exchanges.



X 5107 **The selector room in the Fredrikstad exchange.**

The Fredrikstad Automatic Exchange.

On November 1st 1883 Fredrikstad Telefon Co. started with 66 subscribers. The original small switchboard served until 1897 when an exchange for 600 subscribers was supplied by A/S Elektrisk Bureau. From this time on the system expanded rapidly and 6 years later the same furnishers supplied a new exchange for 1 100 subscribers with the possibility of taking nearly 2 500 subscribers.

Through a long series of years Fredrikstad Telefon Co. have been looking forward to the thorough modernization that has now been carried out. The line system of the town has been rebuilt as an underground cable system and in adjoining districts the line systems have also been modernized. The large new building, into which the company has moved, is situated in one of the principal business streets of the town, the position having been chosen by the company so as to obtain the greatest possible economic advantage of the premises. The ground floor is arranged as modern shops, the first and second floors are let as offices and apartments, and the company occupies the whole of the third floor and the basement; the new automatic exchange, equipped for 2 500 lines, has been installed on the third floor in a light and airy room of about 165 m². An excellent noise-killing insulation has been evolved so as to prevent the noise from the automatic equipment disturbing the other occupants of the building.

An automatic exchange for the Selbakk rural district was put into service at the same time as the main exchange. This exchange which has also been manufactured by A/S Elektrisk Bureau, has equipment for 200 subscribers and may be extended to 1 000 lines; it has been supplied with supervisory devices in connection with the main exchange to such an extent that it may operate permanently without supervision.

The Moss Automatic Exchange.

Moss Telefonanlegg have erected a new and practical building for the new automatic telephone exchange, situated near the new market of the town. The ground floor is let as offices. The selector room which is very light and spacious and the office of the company are housed on the first floor. The watchman of the exchange lives on the second floor, which stands further back than the ground and first floors. Garage, workshop and a room for the reserve power plant are to be found in an outbuilding in the large yard of the house.

In the selector room there are main distribution frames for 1 800 lines with carbon lightning arresters and fuses, bays with line and cut-off relays, line finders, group and final selectors and registers. There is room for extension to about 4 000 lines. A combined switchboard for traffic supervision and testing has also been installed.

The power plant consists of two storage batteries of 24 V with a capacity of 288 Ah and two motor generators, producing 100 A at 24—36 V. For use on breakdowns in the electricity works a four cylinder Penta motor has been installed coupled direct to a three phase generator for 15 kVA at 220 V.

The exchange is in connection with Oslo at night when the long-distance office at Moss is closed, as AC impulsing over the long-distance lines to Oslo has been arranged. The subscribers at Moss may thus set up direct connections to the Oslo long-distance office by means of their dials.

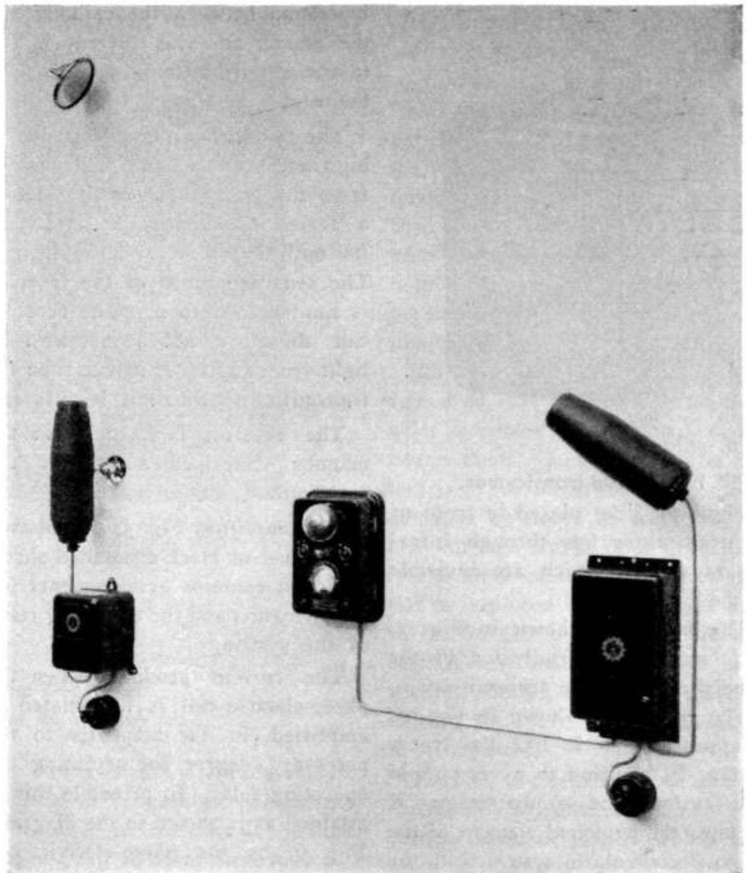
Moss Telefonanlegg has substations at Råde, Rygge, Svinndal, Våler and Larkollen, and these exchanges are also to be automatized.

T. Lunde.

Photo-Electric Burglar-Alarm System

Photo-electric cells, which are commonly used for talking pictures and television, are used also in other ranges of modern technics as fundamental elements for accurate measuring, supervisory and remote-control arrangements.

The new Ericsson burglar-alarm system with photo-electric cells is described below. At the present stage of technical development it constitutes the best automatic protection against burglary for apartments or whole buildings. Banks, offices where money or other valuables are kept, museums, libraries, shops — especially jeweller's — factories, private houses in extensive grounds, etc. are by the Ericsson photo-electric system provided with a means of protection against burglary that even the most scientific burglar is incapable of avoiding or rendering harmless.



X 5103 **Photo-electric burglar-alarm plant.**

Left the transmitter, which is connected to the mains over a transformer; right the receiver with the amplifier; center the alarm apparatus; top left the mirror.

Main Principles.

A small projector, the transmitter, sends out a cone of rays towards a cell sensitive to light, the receiver, which is inserted in an electric circuit. The cell conducts electricity only when exposed to light. If the ray of light is interrupted, be it only for a moment, by a person or a thing coming in its path, the circuit in which the cell is inserted is broken, and an alarm or supervisory arrangement is put in operation. The ray of light between the transmitter and receiver may be directed to and fro by a number of mirrors, and in addition it can be made invisible to the human eye by the provision of a filter on the transmitter.

Design.

The Ericsson photo-electric burglar-alarm system is made up of the following parts: transmitter, mirror, receiver, amplifier and alarm apparatus.

The *transmitter*, Fig. 1, consists of a black-enamelled tube in which the adjustable projector lamp, the diaphragm, the lens and the filter are mounted. The transmitter rests on a universal joint with adjustment screw. The bottom plate of the universal joint may be fixed to a horizontal base or to a wall by means of three screws. In this way the transmitter can be fixed in any desired direction and locked by means of the adjustment screw. On account of its small dimensions — the lens opening of the transmitter is only 6 cm — the apparatus is very suitable for mounting inside the door of a cupboard or in a wall.

The transmitter is connected direct to AC mains over a small transformer, Fig. 2. If there is only DC available, the transformer is connected to a rotary converter.

X 3168 **Fig. 1. The transmitter.**

x 3166 **Fig. 2. The transformer.**

The light filter placed in front of the transmitter lets through infra-red rays only, which are invisible to the human eye.

The *mirror* is shown in Fig. 3. It is mounted and adjusted in the same manner as the transmitter.

The *receiver* is shown in Fig. 4; in appearance it is like the transmitter. In addition to a very rapid lens system and a diaphragm it contains the principal element of the photo-electric alarm system, *i. e.*, the photo-electric cell.

The cell consists of a glass bulb filled with a rare gas and containing two electrodes. The cathode consists of a layer of alkali metals on the glass wall and the anode of a nickel wire. The cell is always under tension from the mains through the amplifier. When the cell is not illuminated no current can pass through it, the cathode and anode being insulated from each other by means of a space filled with a rare gas. On the other hand when the cell is illuminated electrons are emitted from the surface of the cathode and absorbed by the anode. On illumination an electron current is set up between the cathode and the anode, and this current is fed to the amplifier to be amplified to the necessary degre.

x 3169 **Fig. 3. Mirror.**

The receiver can be adjusted with high accuracy to the bunch of rays from the transmitter or the last of a series of mirrors by means of its optical system and diaphragm. The sensitive range of the receiver is limited to 1 to 2°. The receiver can therefore not be actuated by light from any other source than the transmitter to which it is adjusted.

The receiver is mounted in the manner described above for the transmitter and the mirrors.

The *amplifier*, Fig. 5, is protected by a cover of black enamelled sheet-iron and contains arrangements for amplification and the operating relay of the system.

The current produced when the photo-electric cell is illuminated is amplified in the amplifier to the necessary degree for actuating the operating relay. In principle this is attained as is shown in the diagram, Fig. 6, by the photo-electric cell being connected in series with a resistance of about the same value; when the cell is illuminated the potential is altered at the point where the resistance is connected to the cell. The variation of tension produced in this manner is fed to the grid of the amplifier valve and influences the anode current of the valve so that the armature of the operating relay inserted in the anode circuit is kept attracted when the cell is illuminated. When on the other hand the cell is not illuminated the armature of the operating relay is released.

The accurate adjustment of the amplifier is made once for all by means of the adjustment screw belonging to the potentiometer placed on the side of the apparatus. In order to facilitate this adjustment the terminal strip on the bottom side of the amplifier is supplied with a test jack, to which a measuring instrument for accurate measurement of the anode current may be connected.

The operating relay of the apparatus contains the necessary contacts for various applications of the photo-electric system. Further, various additional devices may be connected to the terminal strip of the apparatus and consequently the system has a wide range of use.

x 3167 **Fig. 4. The receiver.**

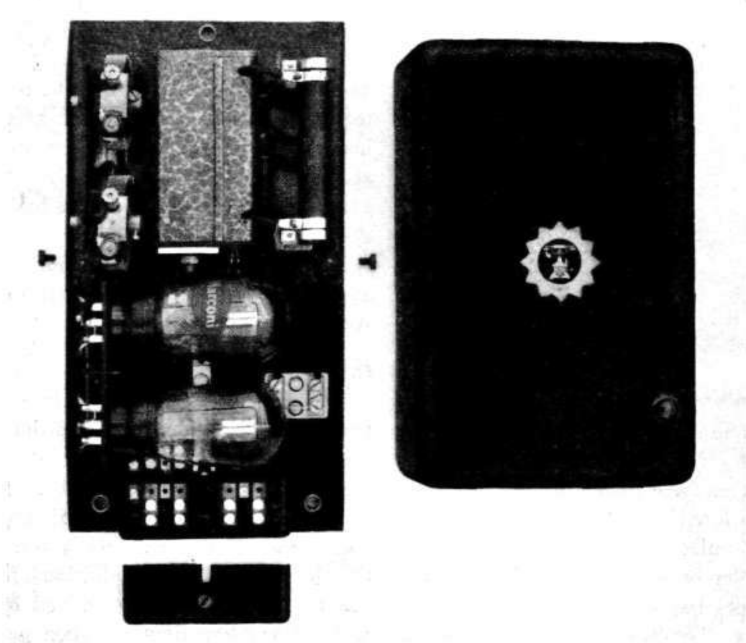
Like the transmitter the amplifier is fed from the mains. It is built as a universal amplifier, *i. e.* it may be connected to AC or DC mains.

The *alarm apparatus*, Fig. 7, contains, in addition to the main and battery switches, a neon lamp which indicates whether the apparatus is in circuit, a milliammeter for the supervision of the closed circuit battery, test button for detecting leakage, alarm key and alarm bell. All the parts are built into the apparatus along with terminals for one extra alarm circuit. The apparatus is of the same dimensions as a wall telephone of ordinarry type.

From the terminal strip on the bottom side of the alarm apparatus circuits are drawn to amplifier, closed-circuit battery and mains and further to alarm apparatus, which may be placed in other rooms, outside the house of in the nearest police station. In addition, there may be connected a loop including door and window contacts, installed according to older burglar-alarm systems, or else a loop including thermo-contacts, placed in different parts of the building in order to provide automatic fire alarm.

Operation.

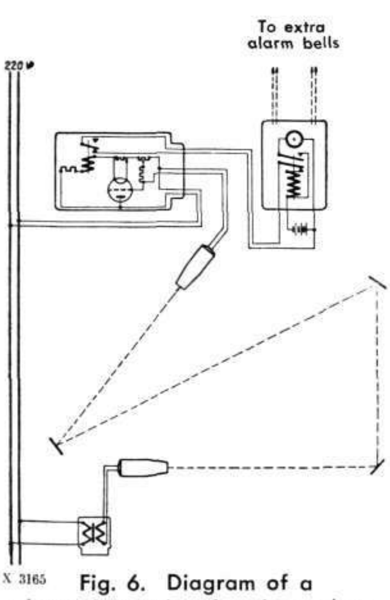
The system is in service during hours when the rooms or buildings are left without guard. It is put in operation in a very simple manner by connecting the transformer or



X 5104 Fig. 5. The amplifier.
Top left, over the amplifier valves, the operating relay.

rotary converter to the mains and switching on the main switch of the alarm apparatus. The system functions in the following manner (see Fig. 6).

From the transmitter is sent out an invisible bunch of rays which is reflected towards the receiver by mirrors placed at different heights and positions. The current produced in the receiver is fed to the amplifier and from the operating relay to the alarm apparatus, which may be installed for instance at the doorkeeper's. In addition there may be a circuit from the alarm apparatus, to an alarm bell outside the building or direct to the nearest police station.



X 3165 Fig. 6. Diagram of a photo-electric burglar-alarm plant.

When a person enters a room protected by this invisible bunch of rays, he is bound to interrupt the rays at some point; this will actuate the alarm apparatus at the doorkeeper's and the alarm bell outside the building. If in addition there is a circuit to the police station alarm is also given there, and on an illuminated board it may be seen where the alarm cames from. The doorkeeper and the police station are thus informed the moment a burglar enters the protected room or house.

Advantages.

The advantages of the system are briefly as follows:

Reliability.

The system operates according to the principles of closed circuit current, *i. e.*, that any intentional or unintentional influence such as interruption of the lighting current, alteration of an apparatus or mirror, cutting of wires, short-circuit, etc. will immediately raise an alarm.

As mentioned above the alarm apparatus has its own batteries and is therefore unaffected by a breakdown in the mains. This is also the case with the alarm apparatus at the police station. The alarm system can only be switched off by the proper persons, otherwise alarm signals will immediately be given.

The bunches of rays may be directed so that a person will not be able to creep below, above or between them. Consequently, the system is a protection not only against entrance by doors or windows, but also through walls, floor or ceiling.

The light of the transmitter cannot be replaced by other light such as the burglar's flash-lamp. As has already been said the receiver is of such a design that it is sensitive only to the source of light to which it is adjusted.

Further the sensitivity of the receiver is adjusted so that small objects such as insects which may come in the way of the rays will not raise an alarm.

Simplicity.

No barring arrangements, door or window contacts, etc. are necessary for the new system. The bunch of rays proper bars the room.

The whole system is designed for mains supply. The switching on and off is made by means of three switches.

X 3184. Fig. 7. The alarm apparatus.

When switched on the system operates without interruption and needs no supervision.

Adaptability.

The position of transmitters, mirrors and receivers can be altered any time.

Ordinary decorative mirrors or polished metal surfaces may be used as mirrors.

The system can easily be installed out of doors, for instance in the grounds of a villa. The functioning of the system is not disturbed by fog or falling snow.

Door and window contacts of existing burglar-alarm systems may be connected direct to the alarm apparatus. Thermo-contacts in various rooms may also be connected to the alarm apparatus which can thus serve both as burglar alarm and as automatic fire alarm.

Invisibility.

The infra-red rays are invisible to the human eye. All the apparatus may be hidden.

Quality.

The pictures show the practical construction and the high quality of all parts of apparatus. The optical apparata are manufactured by Visomat A/G in Leipzig which is one of the leading companies in this line.

Small Maintenance Cost.

The system is designed so that the transmitter lamp, the photo-electric cell and the amplifier valve operate at a low tension. This ensures a long and uniform life time for these parts. Under ordinary conditions these elements require changing only once a year. The power consumption of the whole system is not more than that of an ordinary bulb lamp. The cost of operation and maintenance are thereby kept within a very reasonable figure.

Taking into account the great distance and areas that may be protected by means of a burglar-alarm installation on the system described above, the cost of this system compares very favourably with older systems.

Neither for supervision nor for operation does it require skilled staff.

Flexibility.

The Ericsson photo-electric system may be provided with additional equipment to enable it to be used for many other purposes than burglar and fire alarm. Examples of such uses are automatic counters, automatic door openers, installations for the automatic switching on and off of shop window lighting when persons pass, apparatus for the automatic supervision of machine tools, etc. *F. von Meissner.*

Party Line Telephones in Hungary

In the article »Party line telephones in Hungary»[1] in the Ericsson Review No 3, 1933, it was stated *inter alia,* that the problem of connecting two instruments to one line had been solved in a uniform way for all existing systems of operation in Hungary. After this article was written the Royal Hungarian Post Office decided to introduce party line subscriptions, and in connection with this they ordered 160 relay boxes from the Ericsson Magyar Villamossàgi R. T., Budapest; these relay boxes were delivered in April 1933. On account of the increasing public demand for party line subscription additional orders for 810 relay boxes have been placed up to the present, the greater part of which have already been delivered.

Twin lines have now been connected to the automatic system of Budapest and to CB and magneto exchanges in several towns in Hungary. The Post Office have supplied the additional equipment for the exchanges.

In the above-mentioned article was also described an experimental installation in the Kaposvár CB exchange, built as a selective-calling system so arranged that outgoing and internal communications over the main line were established by operators using dials. It was pointed out that great advantages might be gained if the selective calling system were made so that the party line subscribers could be served in the same manner as ordinary subscribers. Such an alteration of the Kaposvár installation was carried out in April 1933, and in January this year the Royal Hungarian Post Office reported in a letter to Ericsson that since its installation the system has operated in a perfect manner and that it fulfils the requirements.

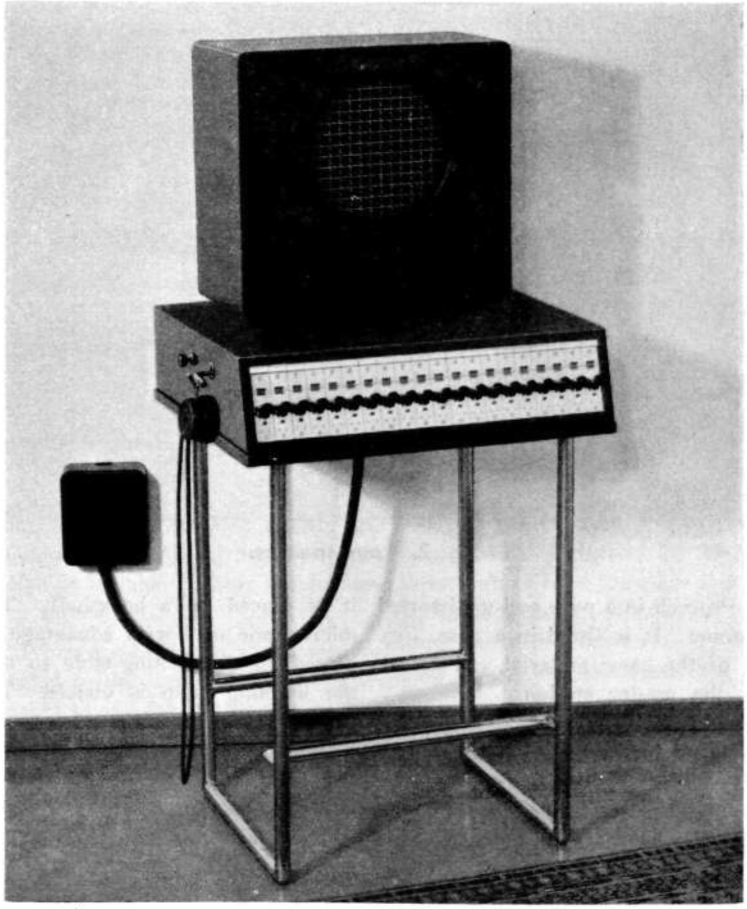
The fundamental idea of the Post Master-General, Mr. Alexander Lédeczy, that party line subscribers should have the same answering and multiple equipment and be served in the same manner as ordinary subscribers, has thus been realized for both twin lines and selective calling lines by the installations now carried out in Hungary.

[1]) Due to a printer's error, the second paragraph of this article stated that the first selective-calling systems were in service in Switzerland since 1932 instead of *1922.*

Loud-Speaking Intercom. Telephones

A description was given in the Ericsson Review No 3, 1933 of a system of loud-speaking intercom. telephones evolved by Ericsson Telephones Ltd., London-Beeston.

Extensive experiments and investigation for the design of material of this kind have also been carried on in the Ericsson laboratories in Stockholm. This investigation has resulted in a series of apparatus on the development of which great care has been taken not only in respect of the electric properties of the system but also in respect of the exterior of the apparatus.



X 5106 **Fig. 1. Master station with loud-speaker.**

The following main points have been kept in view in regard to the construction of the Ericsson loud-speaking intercom. telephone system:

1. the system must be of such a design that the instruments of the system are simple and convenient to operate, or, in other words, the necessary operations must be as few and take up as little time as possible;

2. amplifiers or other complicated apparatus should not be used. All electric and mechanical details must be of such a construction that points where faults are liable to occur be limited to a minimum;

3. the current consumption must be small. In this way the requisite batteries will have a long life, and consequently the system will be cheap in operation and require little supervision;

4. transmission must be good, *i. e.*, the received speech must be perfectly clear and distinct both in loud-speakers and extensions, even if loud-speaker and microphone are placed in a fairly large room;

5. conferences must be possible; the manager must be able to talk to several subordinates at a time, and the latter must also be able to talk to each other;

6. the calls must be secret so that they cannot be heard at other extensions than those engaged in the conversation;

7. all apparatus should be designed with a view to an attractive appearance, so that they might form not only a practical but also a decorative part of office equipment.

The following description of the design and functioning of the Ericsson loud-speaking intercom. telephone system shows that all these requirements have been well fulfilled. The apparatus thus constitutes a valuable contribution to the auxiliaries for the simplification and rationalization of office work.

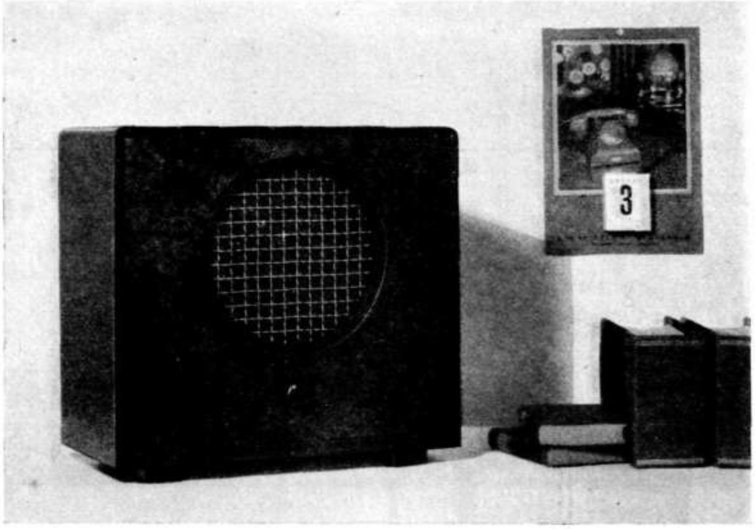
Design.

The Ericsson system consists of a master station with loud-speaker and microphone and side stations of various kinds.

The *master station,* Fig. 1, has a very attractive up-to-date appearance. It consists of a case of reddishbrown polished birch mounted on a nickel-plated frame of welded steel tubes. A key with a corresponding indicator for each side station is fitted at the front of the apparatus. Up to 20 side stations may be connected to a master station.

Other parts such as transformers, DC bell, relay, etc., are fitted inside the case. All parts are easily accessible. The case is fixed to the frame by means of four screws.

The moving-coil *loud-speaker* has a permanent magnet and reproduces



X 5105 **Fig. 2. Loud-speaker.**

the speech in a pure and undistorted manner. It is fitted in a case, Fig. 2, of the same material and colour as the master station.

A special *microphone* has been designed for this system; it can pick up and reproduce correctly even comparatively feeble speech, no matter what part of the manager's room the speech comes from. The microphone is fitted in an attractive cover of wood, Fig. 3, similar to the loud-speaker case. Immediately below the microphone, which is protected by a neat grid, there is a warning lamp which lights up as soon as one of the keys of the master station has been thrown.

Another design of microphone, which in this case is fitted in a cover of soapstone, with a frame of dull nickel-plated brass is shown in Fig. 4. The warning lamp is placed at the top right-hand corner.

The loud-speaker and the microphone are connected with the master station, and this set with the wall fitting, by flexible cables covered with black artificial silk. The wall fitting has a cover of black-enamelled sheet-iron and contains all terminals of the master station.

The master station with the keys must of course be placed within arm's reach, but the loud-speaker may be placed anywhere in the room. Fig. 1 shows loud-speaker placed on top of the master station; in Fig. 2 it is placed on a bookshelf. The microphone may with advantage be placed on the writing-table so that the warning lamp is visible. The master station is suitable for use as a telephone table, where for instance the local and exchange telephones may be placed.

There are two kinds of *side stations:*

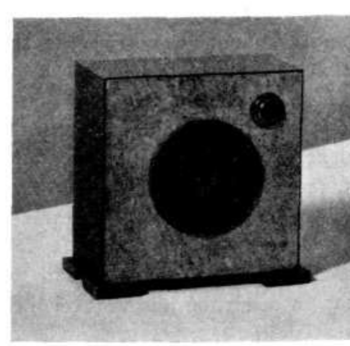
The simple side instrument, Fig. 5, which can only be connected to the intercom. system, is fitted in a bakelite case of the small standard type, described in the Ericsson Review No 4, 1933. The instrument contains a switch with an operating arm, which is actuated by the microtelephone, DC bell for signals from the master station and a press button with automatic release. The bakelite wall fitting is of the Ericsson standard type.

As there is usually one more telephone instrument, for instance that connected to a private exchange, it has been considered advisable to design a side station for connection both to the intercom. telephone system and to the private exchange. The space that would otherwise be occupied by the loud-speaking intercom. instrument is thus saved, and, in addition, the cost of installation is considerably reduced.

The combined side instrument, Fig. 6, is also of bakelite, and the exterior is similar to the Ericsson standard telephone of the large type (se Ericsson Review No 1, 1933). This side instrument consequently does not occupy more space than an ordinary automatic telephone instrument. The equipment consist of a polarized AC bell for signals from the CB central and a DC bell for signals from the master station. The latter bell is placed inside the instrument and the former in a wall fitting of black-enamelled sheet-iron, which in addition contains the necessary terminals. The instrument is provided with two press buttons, one red and one white, and complete equipment for connection with the master station and the CB exchange.

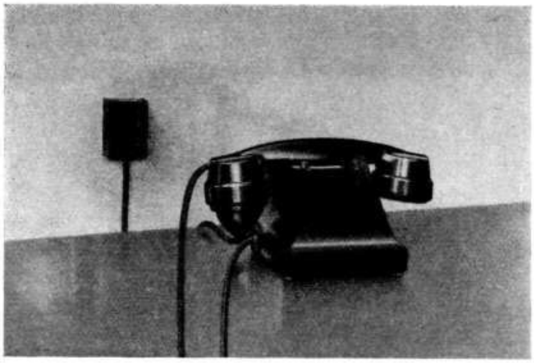
Operation.

A side station is called by throwing the corresponding key in bottom, or ringing position. As long as the key is kept in this position the bell of the side station will ring. When the key is released it returns to medium, or talking position, and communication is obtained when the



X 3170 **Fig. 3 and 4. Microphones,** X 3171

left in wood cover, right in soapstone cover.



X 1264 Fig. 5 and 6. Side stations, X 1263

left simple side instrument for connection to the intercom. system only, right combined instrument for connection to the public exchange as well.

microtelephone of the side instrument is lifted if the instrument is of the single type, or when the white button is also pressed if the instrument is of the combination type.

The speech from the side station is reproduced distinctly and perfectly naturally by the loud-speaker, and the sensitive microphone transmits the speech from the manager's room to the earphone of the side instrument. Several persons in the room can thus converse with the side station independent of microtelephones.

The system may be used for conferences if the desired number of keys are thrown on the master station. Communication between the master station and all connected side stations as well as between the latter may be arranged in this manner.

The conversation is secret, *i. e.*, it cannot be overheard at any of the other side stations unless additional keys are thrown.

When the conversation is finished the key is returned to top, or home position.

The warning lamp beside the microphone lights up as soon as a key is thrown. If after the conversation has been finished a key should not have been returned to home position, the lamp remains lit, indicating that the conversation in the manager's room may be overheard.

To the left of the master station there is an extra earphone, which is connected when lifted, the loud-speaker being disconnected simultaneously. In this manner a conversation may be carried on with a side station, without the other persons in the room being able to hear the incoming speech.

When a side station which is connected to the intercom. system only wishes to call the master station this is carried out by lifting the microtelephone; the corresponding indicator in the master station then shows from which side station the call is made. If the press button of the side station is then pressed the bell of the master station will ring. When the key that corresponds to the indicator is thrown the current through the indicator is broken; the indicator returns to home position and the side station can converse with the master station.

If the call is made from a side station that is also connected to a CB-exchange the white button is pressed after the microtelephone has been lifted; the indicator will then announce the call as in the previous case. When the button is pressed to its bottom position a signal is sent out. When the microtelephone is replaced after the conversation has been finished, the white button automatically returns to home position.

On calls to or from the CB-exchange the microtelephone is lifted and the red button pressed, after which the instrument will be in communication with the CB system. When the microtelephone is replaced the red button returns to home position.

If a side station is engaged in conversation with one of the two lines, signals from the other line will arrive independent of this fact. The lines cannot be joined up.

If on certain occasions the manager does not want to be disturbed by the bell of the master station the latter may be disconnected by a press button on the left side of the apparatus. The indicators will, however, announce the calls as usual, and calls from the master station are carried out as has been described above.

Wiring and Current Consumption.

Each side station is connected to the master station by 4 wires; there is an additional wire which is common for the whole system.

The combination side instrument must of course also be connected to the CB exchange.

The necessary electric power for the system is supplied by three batteries: one battery of 1.5 V and two batteries of 4.5 V each.

All electric parts are designed so that the current consumption will be small; dry cell batteries can therefore be used with advantage. If batteries with a capacity of 100 Ah are used they will last for at least three years at a call frequency of 30 three-minute calls a day.

A. Petersén.

Differential Thermo-Contacts for Automatic Fire-Alarm Systems

The many fires that have occurred recently in various countries are evidence that even the most efficient means for extinguishing fires are often of no value if these are not detected at an early stage; protection against fire must therefore be concentrated on preventing the spread of the fire.

The best protection is obtained by the use of automatic fire alarm systems with thermo-contacts sensitive to heat. Systems of this kind have for a long time been manufactured by Ericsson, and after a series of accurate tests in practice in several of the company's works some new designs of thermo-contacts have been evolved, which answer the most severe requirements respecting sensitiveness and reliability.

These new differential thermo-contacts are manufactured on two different systems, one evolved by Telefonaktiebolaget L. M. Ericsson, Stockholm, and the other by Société des Téléphones Ericsson, Colombes.

A modern installation for automatic fire alarm should fulfil the following requirements in respect of reliability:

rapid and reliable signalling,

instant signalling of line faults, even of faults which do not prevent alarm,

safety against false alarm, *i. e.*, against alarm signals given instead of fault signals when complicated line faults occur; this is of special importance in systems provided with arrangements for automatically calling a fire brigade.

Main Principles.

Selective signalling for fire alarm and for faults may be obtained in two different ways. In the system developed by Ericsson, Stockholm, two-wire loops are used for the thermo-contacts, and, in addition, the thermo-contacts are provided with two normally closed contacts inserted one in each conductor. When fire occurs the two contacts are opened, and an alarm signal is then obtained on the alarm board; when faults occur — rupture, short-circuit or leakage — the alterations of the circuit are of another kind and a fault signal, differing from the alarm signal, is then indicated.

In the system developed by Ericsson, Colombes, in compliance with French official requirements single-wire loops are used, and the thermo-contacts contain a contact which under normal conditions short-circuits a resistance built into the thermo-contact. When fire occurs this resistance is inserted in the circuit, and fire-alarm is given, while for interruptions etc., the current is totally broken which is indicated in a special manner on the alarm board.

The loops are under permanent electric supervision, and all kinds of faults, such as rupture or leakage in a loop and short-circuit between the wires of one or different loops, will be indicated automatically on the alarm board.

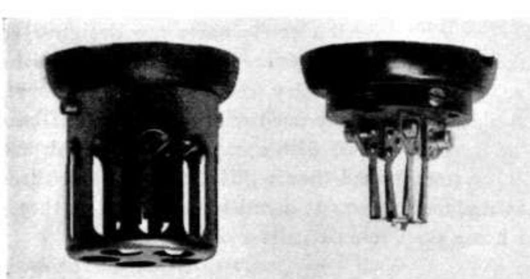
The lines composing the alarm loops depart from the alarm board as lead cables of two or more conductors. Outside the insulation each conductor is provided with a tin-foil band connected to the earth terminal of the alarm board. Short-circuits between two conductors cannot occur without at the same time two tin-foil bands getting in contact, and, consequently, fault signals for leakage will be indicated when short-circuits occur.

The thermo-contacts usually employed in fire-alarm systems are melting contacts or bimetallic contacts.

The *melting contacts* are usually made for causing signals at about 65° C. For special cases (boiler rooms, foundries, etc.) these contacts may be made for higher signalling temperatures, *viz.* for 80° to 120° C. They are made with open contacts, Fig. 1, or watertight for moist or dusty places, Fig. 2.

The *bimetallic contacts* are provided with screws for adjusting the signalling temperature. The regulating range of the standard type is 40—100° C. These contacts also are made in two designs, one open, Fig. 3, and one closed, Fig. 4.

In special cases, where still greater sensitiveness is required, *differential thermo-contacts* are used. Ericsson manufacture these contacts in two types. The one, designed by Ericsson, Stockholm, for insertion in two-wire loops is based on the expansion of a metal tube, while the

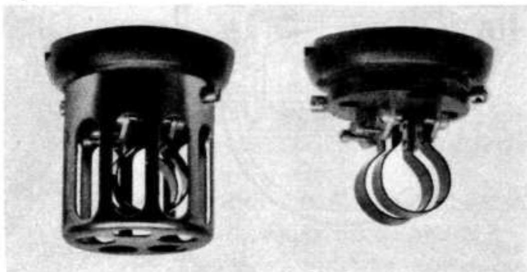


X 5101

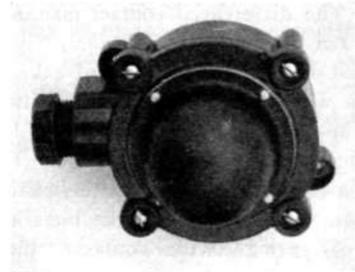
X 3163

Fig. 1 and 2.
Melting contact,
left open, right watertight design.

Fig. 3 and 4.
Bimetallic contact,
left open, right watertight design.



X 5100



X 3164

other designed by Ericsson, Colombes, for connection to single-wire loops is of an aerodynamic type, *i. e.*, its operation depends on the expansion of an air volume.

Differential Thermo-Contacts.

The Ericsson differential thermo-contacts function in two different manners with variations of temperature: as *differential contacts* since the contacts are opened rapidly when temperature rises at a certain speed but not when temperature rises more slowly and as *maximum contacts, i. e.*, the contacts are opened when the temperature reaches a certain maximum even if the increase has been very slow.

In the differential contact of *Ericsson, Stockholm*, Fig. 5 and 6, the element sensitive to temperature is composed of two concentric brass tubes with thin walls. One end of these tubes is fixed to the cover of a connection box, and at the other end they are provided with hard bottoms. In the inner tube there is a contact arm which touches the bottom of the outer tube in the centre and the bottom of the inner tube at two points situated on a line perpendicular to the axis of the tubes and at a distance of 5 mm from the axis. A spring touches this arm between these points and presses it against the bottoms of the tubes, so that the arm will have a determined position in relation to the tubes. The contact arm is parallel to the axis of the tubes and passes a hole in the connection box cover; at this end the arm has a pertinax fitting, by means of which the contact springs are actuated.

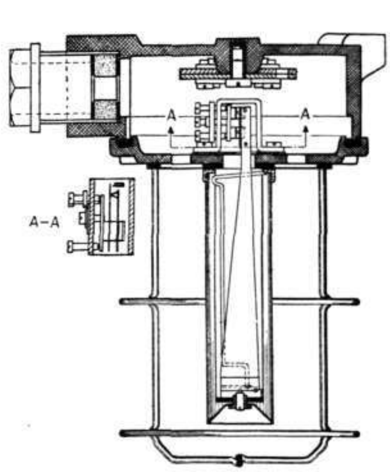
Two pairs of contact springs are fitted to the inside of the cover and connected with a terminal block by means of flexible wires, this terminal block being screwed to the bottom of the connection box. A brass bow protects the contact springs from being touched inadvertently.

The coarse adjustment of the contact arm's position is carried out by means of a screw in the bottom of the outer tube. This screw is fitted in a bushing which is soldered into the bottom of the tube by means of an alloy with a low melting-point.

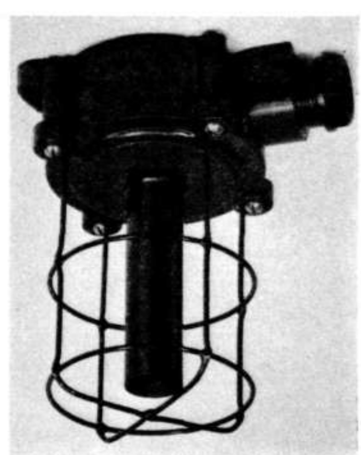
There are three screws at the contact springs for adjusting the springs in relation to the contact arm and for regulating the sensitiveness of the contact device.

The differential acting of the thermo-contact when the temperature of the surrounding air rises rapidly is based on a slower rise of the air temperature in the inner than in the outer tube on account of inferior heat transmission to the inner tube. For this reason the outer tube expands more than the inner one and the contact arm turns around the bearings in the bottoms of the tubes so that the contacts open when sufficiently rapid increases of temperature occur. With slow increases of temperature the difference of temperature in the tubes is small and the contacts do not open.

The maximum temperature action of the thermo-contact is produced by the soldering alloy which fixes the bushing with the supporting screw to the outer tube; this alloy melts at a certain determined maximum temperature so that the bushing becomes detached. Under the pressure of the spring the contact arm turns around the bearings on the bottom of the inner tube and opens the contacts.



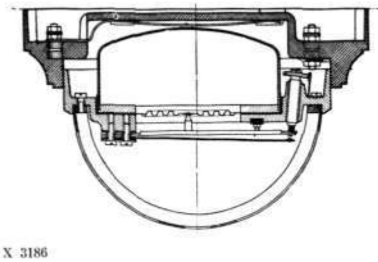
X 3185



X 3161

Fig. 5 and 6. Differential thermo-contact, Ericsson, Stockholm, system.

The differential contact manufactured by *Ericsson, Colombes,* Fig. 7 and 8, consists of a plate of bakelite on which the contact case is fitted. This case is made of metal and has the shape of a hemisphere. The plate which is fixed to the ceiling has two terminals for the lines and two springs with contacts, these being connected to the sensitive contact device fitted in the case.



X 3186

X 3160

Fig. 7 and 8. Differential thermo-contact, Ericsson, Colombes, system.

The case is removable and is fixed to the plate by means of a bayonet fitting. It is composed of two air filled chambers: an inner one turned towards the base and enclosed in a thick metal cover, and another which is separated from the surrounding air by means of a thin copper sheet of large surface and with good heat conductivity. This thin wall is protected against injury by a perforated cover which allows the access of air to the copper sheet.

Between the two chambers there is a thin silver diaphragm specially shaped to ensure high sensitiveness and stability to the device. The diaphragm presses against an adjustable gold-silver-platinum contact which short-circuits a resistance fitted in the base.

In addition the apparatus contains a maximum thermo-contact with a bimetallic spring placed in the outer chamber. This thermo-contact gives alarm when the temperature exceeds a certain figure for which it has been set by means of a regulating screw.

When fire breaks out in a room the hot air rapidly rises towards the ceiling or the upper parts of the room where the contacts are situated. The air in the outer chamber is immediately heated and expands, thus pressing against the elastic diaphragm between the chambers, which gives way thus breaking the alarm contact. The resistance previously short-circuited by this resistance is then inserted in the loop connected to the alarm board and alarm is given.

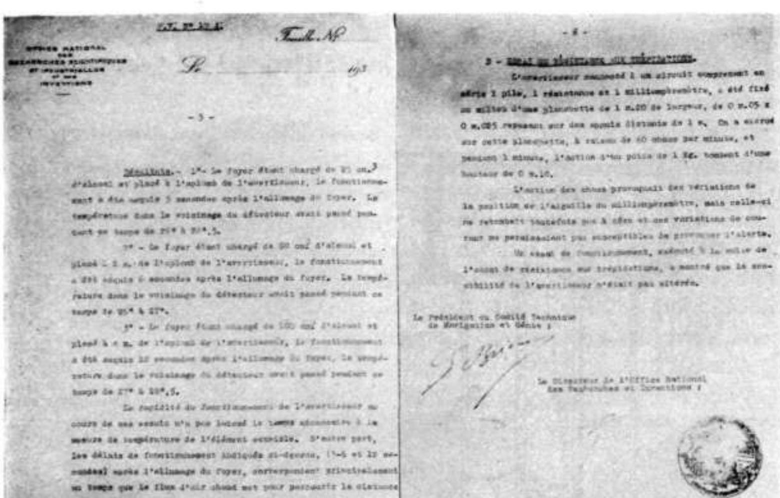
Thanks to the high sensitiveness of the contact, alarm is given within a few seconds of fire breaking out. The sensitiveness of the contact is adjustable so that alarm is not caused by normal variation of temperature, such as occurs, for instance, when the rooms are heated. In such cases the elastic diaphragm is subjected to but small variations of pressure and the alarm contact is not broken.

When a fire is smouldering and temperature rises slowly the differential system described above is not actuated, but in this case the maximum contact operates when the temperature exceeds the figure for which it is adjusted, the alarm being given in the same way as by the diaphragm contact.

The French fire insurance companies requested the Office National de Recherches et Inventions to test automatic fire alarm contacts, and in order to increase the use of these contacts they have decided to allow a certain discount on the rates for insurers using automatic thermo-contacts of approved types.

The thermo-contact of Ericsson, Colombes, has been submitted to the severe tests for operation and reliability prescribed by this institution. All requirements have been fulfilled, which is proved by the excerpt from the minutes of the Office National de Recherches et Inventions, Fig. 9, certifying the efficiency of the apparatus, as attained by a careful manufacture and superior construction.

A. Parschin & V. Kostomaroff.



X 5099 Fig. 9. Excerpt from the minutes over tests carried out with the Ericsson, Colombes, differential thermo-contact.

Alarm Board for Fire-Alarm Systems with Single-Wire Loops

Société des Téléphones Ericsson, Colombes, have in addition to the differential thermo-contacts described in the preceeding article designed a new alarm board for use in fire-alarm systems with single-wire loops.

The alarm board is fitted in a metal case, the size of which varies with the number of loops. Fig. 1 shows the exterior view and Fig. 2 the internal equipment of an alarm board for 6 loops, designed for the supervision of a system comprising up to 120 thermo-contacts.

The following signalling apparatus is fitted on the front:

a red lamp: *fire,*
a white lamp: *battery fault,*
a white lamp: *interruption,*
a green lamp: *leakage,*
six strips, one for each loop, containing two lamps and one three-position key each,
one strip with two special keys for the daily testing of the system.

The loops with the thermo-contacts carry permanently a closed circuit current which ensures immediate signalling on the alarm board in case of fire alarm or faults in the system.

When a thermo-contact gives alarm the red lamp »fire» and the two white lamps light up; the latter indicate from which loop the alarm has been given. In addition signalling devices such as bells, syrens, etc. mounted at suitable points are connected to the alarm board.

After alarm has been given the thermo-contact is ready to give alarm again and may consequently give alarm immediately should a fire break out anew.

Faults in the system are indicated in the following manner:

When an interruption in a loop occurs the two small lamps corresponding to the loop in question light up as well as the white lamp »interruption».

Leakage in a loop is indicated by the green lamp »leakage» lighting up.

Faults of this kind may be located rapidly by means of the keys of the alarm board. On account of the construction of the lines a short-circuit cannot occur without leakage occurring at the same time.

Should the current supply fail the milliammeter will indicate zero, and the white lamp »battery fault» connected to a reserve source will light up.

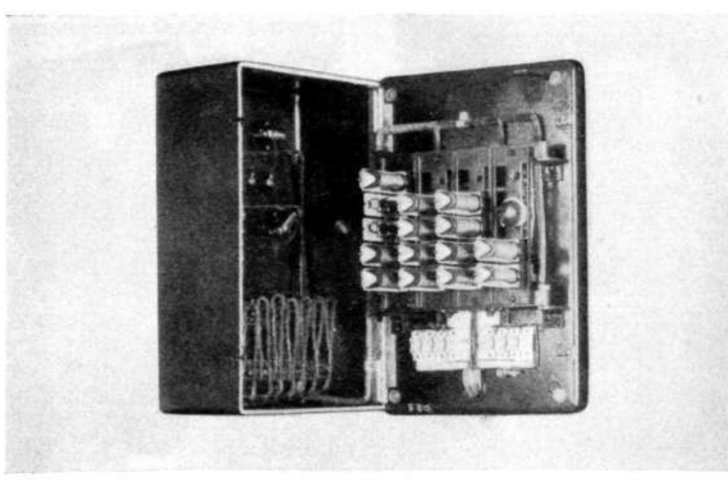
In addition all these faults are signalled by means of a bell.

After alarm or faults have occurred it is advisable to test the alarm board before the system is put into service again. For this purpose the key of each loop has a test position. When the key is thrown in this position the relays of the alarm board are actuated in the same way as by alarm signals, but the alarm arrangements outside the alarm board are disconnected.

The alarm board is very reliable and easy to operate; this has been attained by using parts such as keys and relays which have for many years been tested in telephony and by avoiding delicate parts.

There are two lamps for each loop, which operate independently of each other; in addition the alarm lamps are connected in parallel with bells.

V. Kostomaroff.



X 3159 Fig. 1 and 2. Alarm board for fire-alarm systems with single-wire loops. X 5098

Top: the signalling lamps and the milliammeter; below: the key and lamp strips for each loop and the test-key strip.

Alarm Board for Small Automatic Fire and Burglar-Alarm Systems

This alarm board, Type TH 980/01, is designed for fire-alarm systems with single-wire loops as well as burglar-alarm systems with two-wire loops. It provides at low cost a very efficient protection against fire and burglary in small installations, as villas, hotels, banks etc.

The alarm board has a frame of black enamelled sheet-iron and contains a relay and a milliammeter which are connected in series with the alarm loops and carry a weak supervisory closed circuit current. When alarm is given this current is interrupted, and the relay releases its armature; the relay contacts then connect current to a bell fitted in the alarm board and to extra alarm bells that may be connected to the apparatus.

Two batteries, say of 8 dry cells each, are used for the operation of the alarm board, one connected to the apparatus and one in reserve. The batteries are changed every day by means of a switch on the apparatus so as to obtain a better utilization of the dry cells. The loop current may be read on the milliammeter, and the condition of the batteries is thus tested.

After line faults or alarm have occurred the apparatus is disconnected by means of a switch, the fault switch. A fault lamp will then be switched on and will remain lit as long as the system is out of service; a neon lamp connected to the mains is used for this purpose so as to save the batteries. When the apparatus has again been put in service the closed circuit current is switched on by pressing a restoring button.

For the supervision of the line insulation a special earth-fault button is provided. When this button has been pressed and the apparatus has been disconnected by means of the fault switch, one pole of the battery is connected to earth; if the insulation is imperfect the milliammeter will be deflected. Leakage on the line does not interfere with alarm signals.

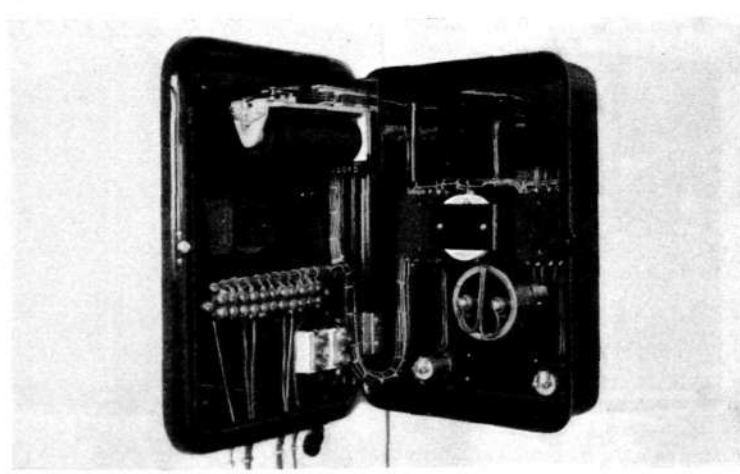
When the apparatus is used for *fire alarm* only, the thermo-contacts and alarm press buttons are inserted in series in a single-wire loop both ends of which are connected to the alarm board. Under normal conditions the closed circuit current runs through the loop and the contacts, and alarm is caused by interruption of the closed circuit.

Two-wire loops are used for *burglar-alarm* installations. The alarm contacts are provided with a double contact device which has one closed and one open contact in home position. All closed contacts are inserted in series in one of the loop wires, and are thus run through by the closed circuit current. The open contacts are connected in parallel between the conductor under tension and the other neutral conductor. The neutral wire is connected to the alarm board in such a manner that the relay coil is left without current when the two wires are connected with each other. When alarm is given, *i. e.*, when some of the burglar-alarm contacts has been actuated, signal is given both by the interruption of the closed circuit and by the contact between the two conductors of the loop.

The alarm board may also be used for combined *fire and burglar alarm* installations; the thermo-contacts and burglar alarm contacts are then inserted in a common closed circuit.

The burglar-alarm contacts that can be disconnected for certain hours should be provided with *disconnecting arrangements,* one for each group. For this purpose a disconnecting switch, Type TL 550, is used; this apparatus has a supervisory lamp consisting of a neon lamp for mains supply, which remains lit as long as the burglar-alarm contacts are disconnected.

A. Parschin.



X 3184 X 5102

Fig. 1 and 2. Alarm board for small fire- and burglar-alarm systems.

Top: the alarm bell; below: the battery switch, the neon lamp and the fault switch; below the milliammeter the restoring and earth-fault buttons.

The New Ericsson Loading-Coil Works

X 5109 Interior of the Ericsson loading-coil works at Älvsjö.

The manufacture of the Ericsson loading-coils, which was previously divided between Svenska Radioaktiebolaget, Älvsjö Kabelverk and A.-B. Alpha has during last year been combined in a separate new factory at Älvsjö. The operations were transferred progressively during the spring and summer of the year but, on account of strikes, the building has not yet been completed. However, the work has proceeded so far that we are able to show a few pictures of the new factory.

On account of intense activity on the cable network of the State and on railway electrification, the capacity of the factory is at present well utilized. Among the large deliveries which have been completed or are in hand at the new factory the following items might be mentioned: to the Royal Board of Telegraphs 199 cases with about 20 000 coils for the Gävle—Sundsvall cable, 90 cases with about 11 000 coils for the Norrköping—Nässjö cable and 78 cases with about 7 500 coils for the Malmö—Älmhult cable; and to the Swedish State Railways 305 cases with about 11 500 coils for the cables of the North Main Line and 147 cases with about 3 000 coils for the cable of the Malmö—Gothenburg line. Part of the delivery, completed last year, of 73 cases with about 9 000 coils for the Gothenburg—Trollhättan—Mellerud cable of the Royal Board of Telegraphs was also made from the new factory.

A. Westling.

X 3174 Measuring hut.

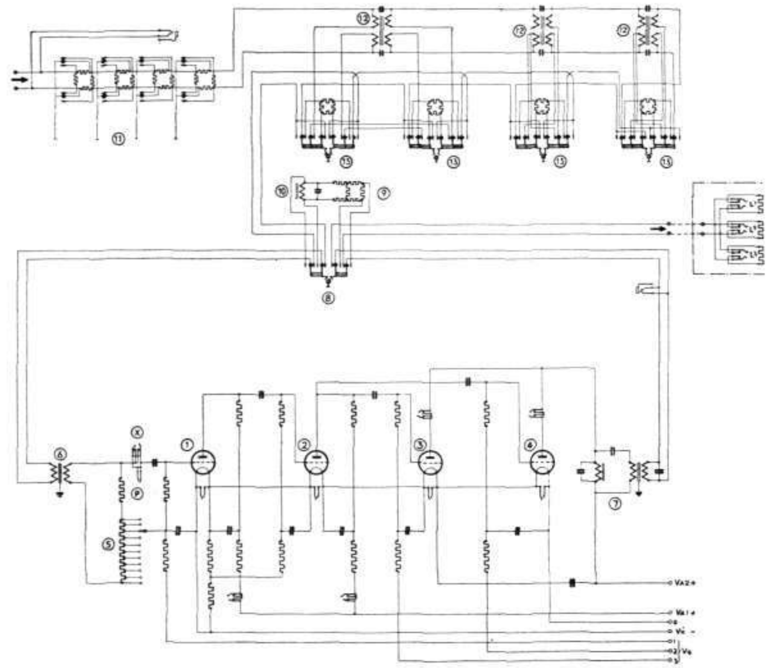
X 3177 A delivery of loading coils.

X 1265 The winding department.

X 1266 The assembly department.

Repeater for Broadcasting Transmission

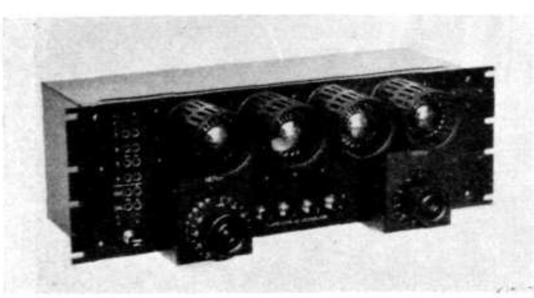
Ericsson, Stockholm have designed a special repeater, Type PFP 133, for the transmission of broadcasting programs over long overhead lines where intermediate repeaters are required. At the same time a special current-distribution panel, Type SF 133, has been designed for serving up to four repeaters.

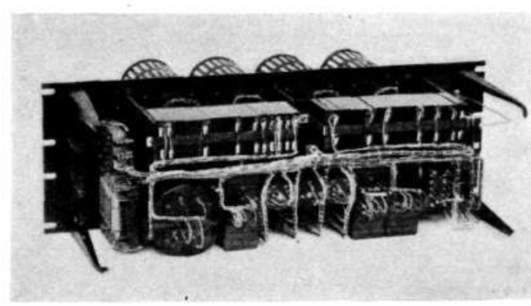


X 5110 **Fig. 1. Diagram of a broadcasting repeater.**

1, 2 amplifier valves
3, 4 power valves
5 grid potentiometer
6 input transformer
7 output band-pass filter
8 gain-adjustment switch
9 gain-adjustment attenuation network
10 tuned circuit for gain adjustment
11 variable attenuation network for gain adjustment
12 attenuation equalizer
13 equalizer regulation key
X, P jacks for connecting several repeaters in parallel on the same program.

The broadcasting repeater, of which a diagram is shown in Fig. 1, is provided with arrangements for gain adjustment, gain regulation and an attenuation equalizer. It consists of two stages with high amplification valves *1* and *2* in resistance-condenser connection (Marconi-Osram, Type LS 5B) and one output stage with two power valves *3* and *4* connected in parallel (Marconi-Osram, Type LS 5A). The first stage is fed from a transformer *6*, which is terminated by a potentiometer *5*. The potentiometer serves for the accurate adjustment of gain and is divided into 14 steps of 0.05 neper. The output stage is provided with a filter *7* to obtain the necessary band width 50—10 000 c/s. The repeater is designed to feed three lines. Where fewer than three lines are used the missing ones are replaced by terminating resistances. When one program is to be sent out over more than three lines two repeaters may be connected in parallel. For this purpose there are two jacks *X* and *P* in the grid circuit of the first valve. The jack *P*, of the repeater from which the program is to be fed to another repeater, is connected to the jack *X* of the latter by means of a plug cord. The input transformer and potentiometer of the second repeater are then disconnected. In this way two input valves, one for each repeater, are connected to the transformer and potentiometer of one repeater. The two repeaters will thus have common regulating devices. Moreover it should be observed that all outgoing lines will have the same input level. Measuring jacks for filament and anode current are provided for each



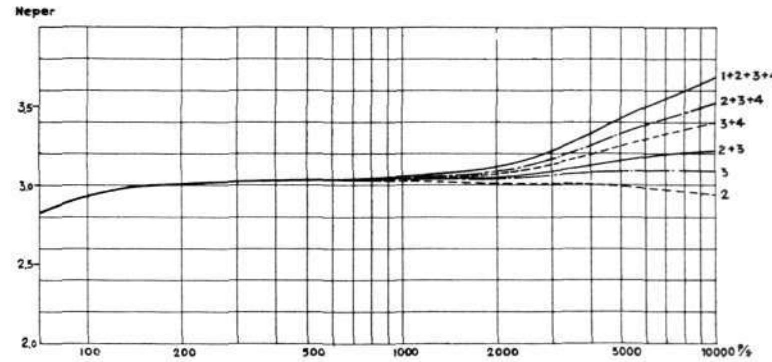


X 1259 **Fig. 2 and 3. Broadcasting repeater.** X 1260

On the left figure is seen; extreme left: the double measuring and listening-jack strip, below: the gain-adjustment switch; center: under the amplifier valves, the grid potentiometer, the four equalizer keys and the variable attenuation network for gain regulation.

valve. A gain adjusting device may be connected between the output filter and the input transformer by means of the self-restoring press button *8*, which at the same time disconnects the incoming and outgoing lines. This device is made up of an artificial line consisting of an attenuation network *9* and a circuit *10* tuned to 1 000 c/s. This artificial line has the same attenuation as the gain wanted in the repeater. If the press button is kept pressed and the gain is increased by turning the grid potentiometer at the input transformer, the repeater will start to sing with a frequency of 1 000 c/s at a gain of 4.5 neper; this occurs on account of reaction over the tuned artificial line which has an attenuation of 4.5 neper.

In front of the input transformer of the repeater there is the variable attenuation network *11* for gain adjustment and the attenuation equalizer *12*. The latter consists of three cascade-connected networks on the Ericsson system, calculated so that they create a constant gradient of the gain curve between 1 000 and 10 000 c/s. By means of the cascade connection a three-fold gradient is obtained. The attenuation networks may be connected and disconnected while the press button *13* is held down. The disconnected attenuation networks are inserted direct in the line by means of the keys. This arrangement ensures that the attenuation of the equalizer at 1 000 c/s will remain constant. This attenuation is 1.5 neper, and, consequently, the effective gain of a repeater panel may



X 5111

Fig. 4. Gain curves of broadcasting repeater at various correction degrees.

The figures to the right indicate which correcting switches are operated.

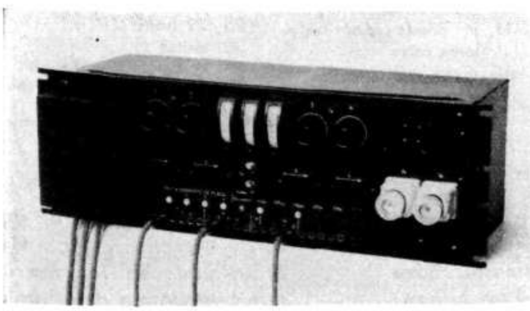
mount to 3.0 neper as a maximum when adjusted to the singing point by means of the gain-adjustment device. In one of the three equalizers the attenuation network has been divided into two sections to produce half the gradient produced by one network. By means of four press buttons belonging to the equalizer, seven different combinations may be obtained corresponding to seven different lengths of the line, the longest of about 350 to 400 km. Attenuation equalizing at frequencies below 200 c/s is arranged by utilization of the increasing attenuation of the input transformer at low frequencies.

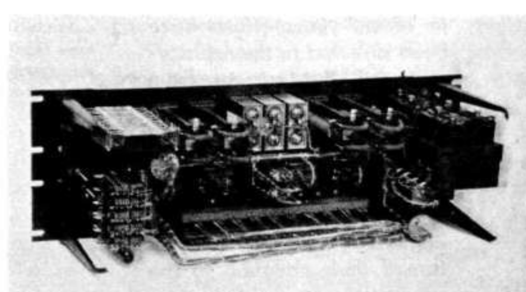
By means of the variable attenuation network the gain may be regulated from 0 to 3 neper in steps of 0.3 neper.

The mechanical design of the repeater is shown in Fig. 2 and 3. The repeater with its attenuation equalizer and gain-regulating device is fitted on an iron panel of 550×180×3 mm. On this panel are fixed the two voltage-amplifier valves and the two output valves, a double jack strip for measuring jacks, listening jacks for the input and output sides of the repeater and the jacks *X* and *P* mentioned above. Below the jack strip there is the press button for gain adjustment.

On the front of the panel there are in addition the grid potentiometer, the variable attenuation network for gain regulation and the four equalizer keys. These keys are locked in their positions and may be moved in or out only if turned about 45° to the right.

The grid potentiometer has a movable dial, which is turned in relation to the potentiometer arm so that, when this arm is resting on the contact representing the singing point when the gain-adjustment press button is pressed, the zero gradation of the scale is in front of the mark. The effective gain, *i. e.*, the gain to be utilized, is 3.0 neper at the singing point of the repeater.





X 1261

Fig. 5 and 6. Distribution panel for broadcasting repeaters.

X 1262

On the left figure is seen: extreme left: the fuse box, below: the measuring cords; center top: the filament current rheostats and measuring instruments, below: the filament and anode-current switches as well as the voltmeter and alarm keys, quite down: the alarm-lamp and measuring-jack strip; extreme right: the main fuses for filament and anode current.

The variable attenuation network covering the range from 3.0 to 0 neper, the gain may be read direct on the dials of the regulating devices with an error of less than 0.05 neper. The two dials are therefore graduated direct in nepers.

The attenuation equalizer gives seven different stages of correction. Seven determined combinations of pressed, or, acting, keys correspond to these stages. The curves, Fig. 4, present the gain at different stages of correction.

Current distribution.

The current distribution for the broadcasting repeaters is carried out in the same manner as in the case of the Ericsson two-wire repeaters, Type FBP 332. The positive wire of the filament circuit comprises a regulating resistance and a measuring jack and the negative wire a switch and a fuse. The anode voltage reaches the valve over a switch, a fuse and a measuring jack. In this case the two output valves only are fed through the anode alarm relay while the two voltage-amplifier valves are fed from a shunt in front of the relay. The grid biases are fed through protective resistances of 100 000 ohm. The grid biases are as follows:

$V_{g1} \simeq 1.5 V; V_{g2} \simeq 6.0 V; V_{g3} \simeq 10.5 V.$

Alarm relays and lamps are fed from a 24 V battery over a special fuse. Should the main fuse melt the current will be supplied from another suitable source in the station.

The current-distribution arrangements are fixed on an iron panel 550×180×3 mm. The construction may be seen from Fig. 5 and 6. The cover of the fuses is seen to the left and below the three measuring cords for filament voltage, filament current and anode current. To the right of these there is a horizontal row of two filament-current resistances, three measuring instruments and two more filament-current resistances. The measuring instruments are of the small curved type with vertical scale and an accuracy of about 3 %. In the next row there are four switches each of which breaks the anode and filament current of one repeater. In the centre there are two press buttons. The top one switches over the voltmeter to another measuring range and at the same time connects the anode voltage for direct measurement. The bottom one disconnects the alarm bell and lights a green alarm lamp. In the bottom row there is the lamp and jack strip with alarm lamps and measuring jacks. Finally there are two main fuses for anode and filament current placed to the right. The measuring instruments and the plug cords may be used also for measurements in ordinary two-wire repeater bays.

As has been mentioned this repeater is designed for use in overhead circuits. With slight alterations it may also be made for cable circuits. The repeater has been in actual operation in the Mexican overhead line system for some time and has given very satisfactory results.

C. Anjou.

Battery Eliminator for Carrier Systems

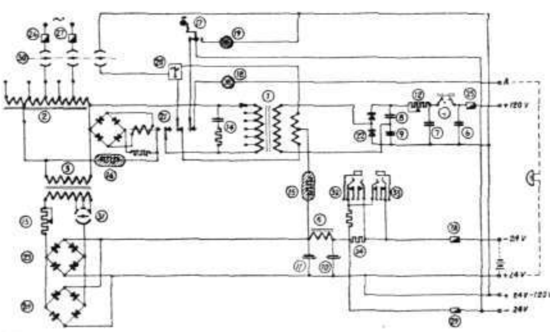


Fig. 1. Diagram of battery eliminator for single-channel systems.

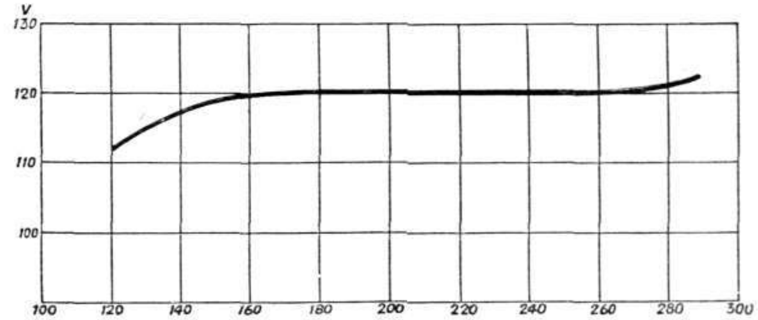
X 1270

1 transformer for anode-current supply
2 auto-transformer for voltage regulation
3 transformer for filament-current supply
4, 5 chokes
6–11 filter condensers
12 anode-current rheostat
13 charging-current rheostat
14 phase compensating circuit
15, 16 anode-current regulator valve
17 alarm switch
18 alarm lamp
19 signalling lamp
20 pendulum converter
21 under-voltage relay
22 anode-current rectifier
23, 24 filament-current rectifiers
25–29 fuses
30 switch
31 charging-current switch
32 jack for measuring the charging current
33 jack for measuring the discharge current
34 measuring shunt.

In recent years efforts have been directed to the replacement of the current from batteries, previously the only type of current supply used in telephony, by cheaper current taken direct from the mains.

In this connection Telefonaktiebolaget L. M. Ericsson turned their attention to the production of suitable battery eliminators not only for manual and automatic exchanges but also for those parts of the interurban equipment where such a replacement is possible. The following types of battery eliminators have been constructed up to now: Type ZL 180, designed for the single channel telephone systems, Type ZL 100 and ZL 200 (see the Ericsson Review No 2, 1933) and a grid voltage rectifier, Type GSP 1133, designed for the interurban station as a whole; in cooperation with a small Nife battery of 80 cells this will supply grid bias of up to 100 V.

Power plant for single-channel systems.



X 5112 **Fig. 2. Regulating curve of battery eliminator,** showing the anode voltage as function of the mains voltage.

The power plant for single channel systems, Type ZL 180, is manufactured for connection to AC mains only of 40—60 c/s and for tensions between 110 and 440 V. The apparatus comprises an auto-transformer for step-wise voltage regulation, two transformers for changing the voltage to a suitable figure cuproxide rectifiers, and filter circuits for eliminating the superimposed noise frequencies in the DC. In addition there is a 24 V battery outside the panel, which serves for noise killing and voltage regulation and acts as a reserve in case of breakdown in the mains. In such cases a pendulum converter placed on the panel supplies the power for the anode current rectifier. Finally there are manual and automatic regulating devices for the voltages and supervisory and alarm equipment.

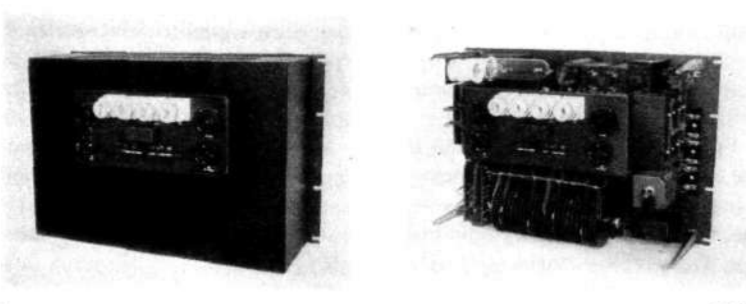
A diagram of the apparatus is shown in Fig. 1. The mains are connected over the fuses *26, 27* and the switch *30* to the auto-transformer *2*. This transformer feeds the anode-current rectifier *1*, and the transformer of the filament-current rectifier *3*. On the secondary side this latter is provided with a switching device *31*, which gives three different voltages. The transformer feeds the filament-current rectifiers *23, 24* over the rheostat *13*. The pulsating output DC is filtered by means of the choke coil 5 and the condensers *10* and *11*, and is then led over the fuse *29* to the output terminals. The above mentioned floating and reserve battery is connected over the fuse *28* and the measuring shunt *34* to the circuit mentioned above.

The floating battery is conveniently made up of four 6 V »Ford» batteries of 80 Ah, which are easy of replacement and maintenance in any conditions. The apparatus may, however, quite well be connected to an existing 24 V station battery already in service. The noise-killing circuit *5, 10, 11* is of such a kind that no disturbance of the station battery need be feared. When in service the battery should be kept charged at a tension of 25.2 V. For this purpose the charging current, which is measured in the jack *32*, may be regulated by means of the switch *31* and the resistance *13*.

The above-mentioned anode-current transformer *1* is fed from the auto-transformer *2*, over the regulating valve *16* and the relay contacts *21*. The relay winding is inserted between the transformer *2* and the regulating valve *16* and is energized when the current is switched on to the transformer *2*. The secondary side of the transformer *1* is connected to the rectifier *22*. The DC passes the choke coils *4, 5, 7, 8, 9* and the rheostat *12* to the fuse *25* and from there to the output terminal, where an anode current of 30 mA is supplied at a tension of 120 V.

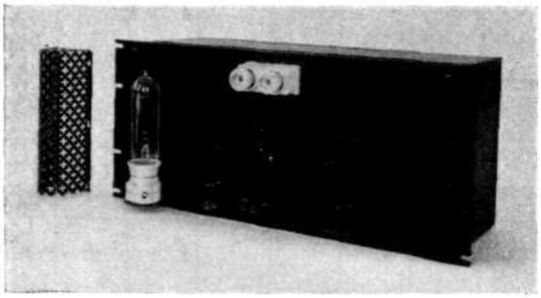
Should the mains voltage fail while the apparatus is in service the relay *21* is immediately released. The following circuit is then closed: + 24 V, switch *30*, pendulum converter *20*, relay contacts *21*, transformer *1*, regulator valve *15*, —24 V. The pendulum converter *20* is fed over this circuit and supplies the transformer *1* with the necessary anode power as AC, which is rectified in the same manner as before. The floating battery supplying 24 V filament current, the carrier system may operate undisturbed by a breakdown in the mains. The current consumption of the single-channel system is 2.55 A, and the pendulum converter consumes 0.85 A. This makes a total of 3.4 A, which must be supplied by the 24 V battery. A Ford battery can supply this amount for at least 24 hours, provided it is well charged at the outset. This constitutes an appreciable reserve.

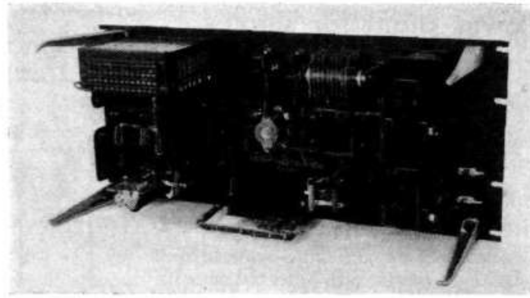
When the relay *21* is released the following circuit is also closed: —24 V, press button *17*, relay *21*, lamp *18*, *A*. If this point is connected with the alarm bell of the carrier rack or another suitable bell, a signal will be given informing the staff that the mains supply has failed. The alarm bell may then be disconnected by means of the press button *17;* when the lamp *19* will light up and remain lit until the press button has been restored.



X 3172 **Fig. 3. Battery eliminator for single-channel systems.** X 3173

On the left figure is seen: left: regulating dial and switch for anode current; center top: fuses, below: measuring-jack and alarm-lamp strip; right: regulating dial and switch for filament current.

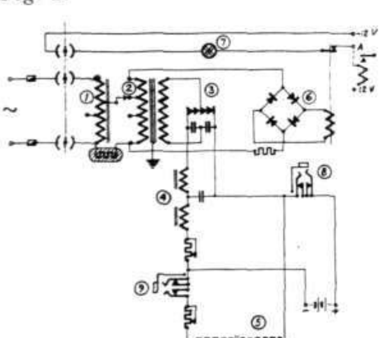




X 1268 **Fig. 4. Grid-voltage rectifier for interurban exchanges.** X 1269

On the left figure is seen: extreme left: the regulating valve (cover removed); center top, fuses, below: regulating dials and switches, quite down; measuring-jack and alarm-lamp strip.

The most difficult problem to solve in regard to a battery eliminator is that of voltage regulation. The mains voltage may vary within a fairly wide range, depending on the load. Variations of ± *10* and up to ± 15 % are not so very infrequent. On the other hand, the anode voltage of a single channel system should not vary by more than ±20 % and the filament voltage not by more than ± 4 %. These figures refer to the Ericsson single-channel system without automatic level regulation. With such a regulation considerable variation of both anode and filament voltage may be permitted. The necessary regulation is obtained by means of the floating battery on the 24 V side and by means of the regulating valve *15* and *16* respectively on the 120 V side. The accuracy of the regulation is shown in the regulation curve, Fig. 2.



X 3175 **Fig. 5. Diagram of grid-voltage rectifier.**

1 regulating transformer.
2 input transformer.
3 grid-voltage rectifier.
4 filter circuit.
5 potentiometer.
6 under-voltage relay.
7 alarm lamp.
8, 9 measuring jacks.

Fig. 3 shows the apparatus with the cover removed. In the middle the fuses and regulating knobs may be seen, and at the bottom the rectifier elements are to be found. Behind the latter on a felt covered bracket the pendulum converter is placed, the operation of which is so silent that only with difficulty is it possible to make out its vibration.

As has been stated in the description, all the attention the apparatus requires is adjustment of the charging current by means of the resistance *13* and the switch *31* so that, with the actual voltage variation, it supplies the battery with a charge to make up for its leakage, and to the maintenance of the battery by filling with water and acid etc. This battery eliminator will therefore increase the flexibility and adaptability of the single-channel system considerably, and it will probably make possible the use of these systems at places where they would otherwise not have been feasible.

Grid-voltage rectifier.

The grid-voltage rectifier, Type GSP 1133, Fig. 4, is designed for supplying grid bias to all apparatus of an interurban station, as repeaters, audio-frequency signalling and carrier equipment etc.

From Fig. 5 it may be seen that the arrangements for producing a constant voltage are the same as in the case of the battery eliminator for the single-channel system. A Nife storage battery serves as a reserve. Unlike ordinary lead storage batteries this type of battery has a very small leakage and may consequently be used with advantage in a case like this when practically no current is taken from the battery except on breakdown in the mains. In addition such a battery, which produces no corrosive vapours, may be placed in the repeater room proper, which is often desirable.

A potentiometer *5* is connected between the battery terminals and over this all voltages from 2 to 100 V may be tapped in steps of 2 V. The potentiometer is composed of 50 resistances of 200 ohm with an accuracy of ± 1 %. The apparatus is connected and adjusted so that about 1 mA charging current flows through the battery permanently, while the potentiometer receives 10.0 mA. The Nife batteries have a capacity of 2 Ah which, with the above-mentioned current consumption, gives a time of discharge of nearly 200 hours. Since the current through the potentiometer may easily be kept constant within ± 1 % the apparatus will supply grid biases which are correct within ± 2 % of the given value, provided no current is tapped from the potentiometer. If the grid battery must be charged, which is the case with *e. g.*, audio frequency signal receivers etc., the tappings for charging may of course be connected to the terminals 100 V.

As with the battery eliminator, Type ZL 180, a relay *6* is provided in this case, which closes an alarm contact should the mains voltage fail.

The apparatus is manufactured for AC only and may be adapted for the usual voltages.

T. Bohlin & R. Stålemark.

Ericsson Technics

Ericsson Technics 1933, No 5.

R. Stålemark: The Ericsson Single Channel Carrier Telephone System.

The first Ericsson single-channel system was built in 1929 and since then the system has been improved by stages as experience was gained in operation and also by utilizing the new constructive elements which have been developed, especially in the range of dry rectifiers.

An exhaustive technical and theoretical description of the main principles of the construction of the Ericsson single-channel system is given in this paper. The principles of the special design of modulator and demodulator are explained. It is also shown how the matching of the filther quadripole in the anode circuits of the modulator and demodulator should be arranged in order to obtain an even over-all attenuation curve.

An expression decuced for the coefficient of non-linear distortion corresponds well with the results of apprehension tests made in practice chiefly in conformity with a method recommended by the CCIF. The results of these tests are presented and show that the apprehensibility over a single-channel communication is on a level with that of an ordinary voice-frequency communication.

Finally, a brief description of the main principles of automatic level regulation is given; this subject will, however, be treated more closely in a future issue. The results obtained with the automatic level regulation have proved of great value not only in regard to eliminating the variation of line attenuation at different temperatures and moisture but also in regard to the considerably reduced influence on the system of the variations in anode and filament voltages.

Ericsson Technics 1933, No 6.

H. Sterky: The Ericsson System for Simultaneous Telegraphy and Telephony on Telephone Cable Circuits — with Special Reference to a Four-Wire Carrier Telegraph System.

The need for new facilities for arranging simultaneous telephone and telegraph communication on two and four-wire circuits will become more pressing as teletypewriters are introduced by government and private telephone and telegraph companies. In the introduction the main principles of the three different methods for simultaneous telegraphy and telephony are treated, *i. e.*, sub audio, audio frequency and super-audio telegraph systems. The author then gives a brief description of the connection and construction of the Ericsson sub-audio and super-audio telegraph systems. Towards the end of the paper experience gained during operation of the super-audio telegraph system by the Royal Board of Telegraphs is presented, and finally the main principles of the new Ericsson echo suppressor are described.

New Orders

Telefonaktiebolaget L. M. Ericsson have recently received orders for the automatization of several manual exchanges in Poland, and the following installations on the Ericsson system with 500-line selectors are to be carried out:

at *Lublin*, an automatic exchange for 2 000 lines with a final capacity of 9 000 lines;

at *Boryslaw*, an automatic exchange for 1 000 lines with a final capacity of 6 000 lines;

at *Drohobycz*, an automatic exchange for 1 000 lines with a final capacity of 3 000 lines;

at *Lwów*, an automatic exchange for 12 000 lines with a final capacity of 50 000 lines.

The authorities of *Armenia* in Colombia have ordered from Ericsson an automatic exchange and the corresponding network for an initial capacity of 500 lines. They have also ordered a fire-alarm installation for the city and a police telephone system. Exchanges similar to the above have been supplied by Ericsson to the cities of *Ibagué* and *Honda*.

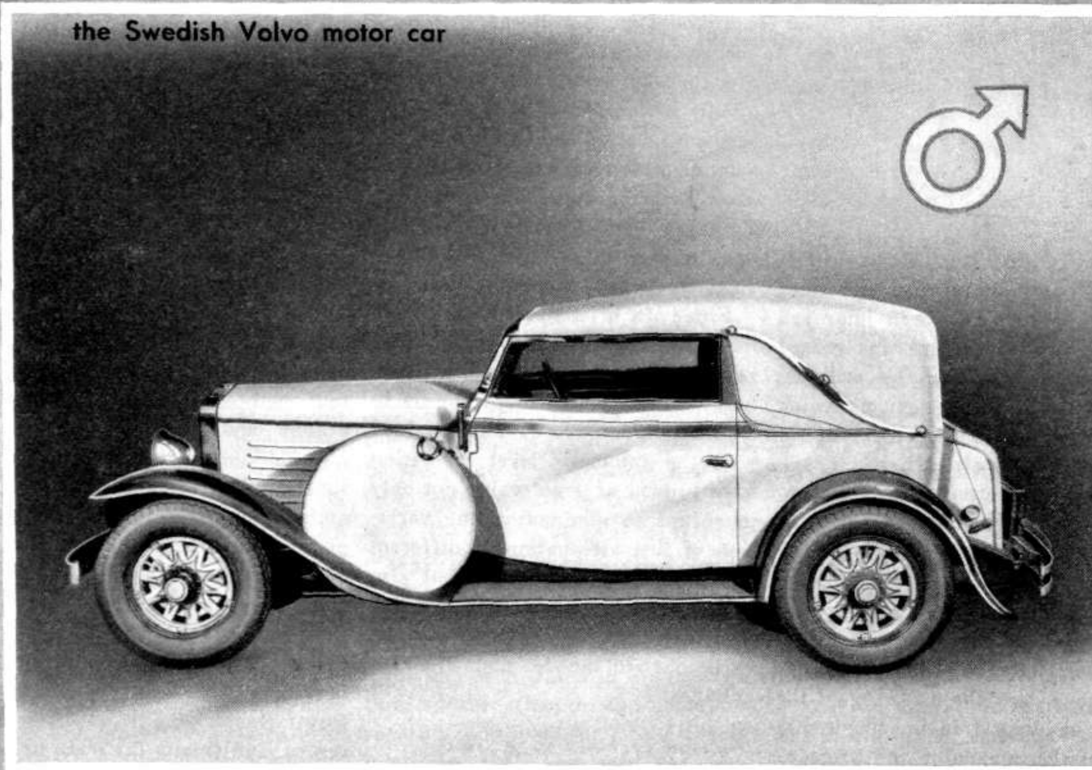
In the near future Ericsson will supply to the concession company at *Tanger* an automatic exchange and a telephone network with an initial capacity of 1 500 lines.

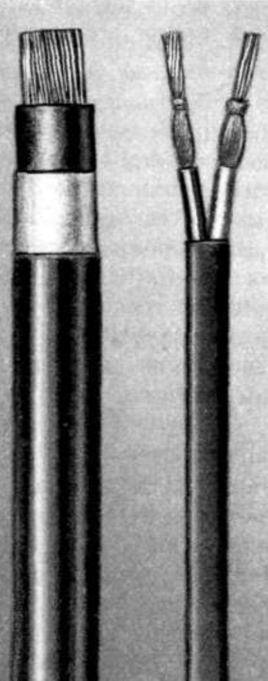
Victorian Railways in the *South of Australia* have ordered a private automatic exchange on the Ericsson system with 500-line selectors with a capacity of 700 automatic lines and 180 additional magneto lines, the traffic to be carried on by a manual switchboard. The traffic to the public exchange, which is of the Strowger system, is carried on automatically, while the traffic from this exchange is directed over a manual junction switchboard. The new exchange permits information to be communicated over the private system during conversations with the public system, communications to be switched over automatically to other instruments, etc.

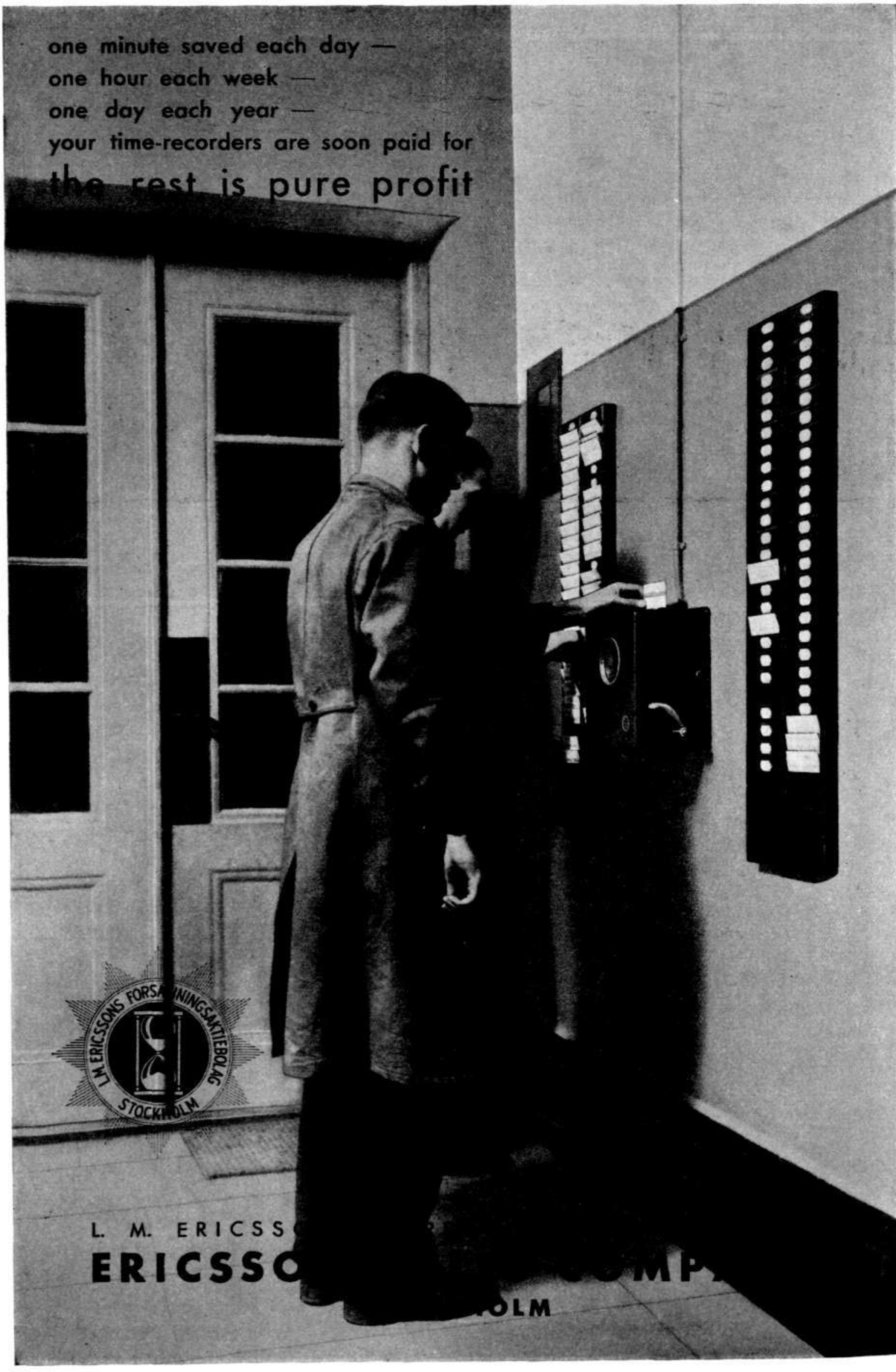
The *Indian Radio & Cable Communication Co., Ltd*, which carries on traffic between British India and the rest of the world, has ordered from Ericsson a carrier system of several telegraph and telephone channels. This installation will be described in a future issue of the Ericsson Review.

L. M. Ericssons Signalaktiebolag have received several orders which include equipment for the signalling and interlocking systems of *Arlöv, Eslöv, Norrholm, Gävle* and *Tofta* stations in Sweden and also an order for an automatic block installation for the double line, partly underground, between *Copenhagen* and *Hellerup* of the Danish State Railways.

In addition the company have received orders from Sweden and Poland for luminous and acoustic signals at railway level crossings.


the Swedish Volvo motor car




one minute saved each day —
one hour each week —
one day each year —
your time-recorders are soon paid for
the rest is pure profit
L.M. ERICSSONS
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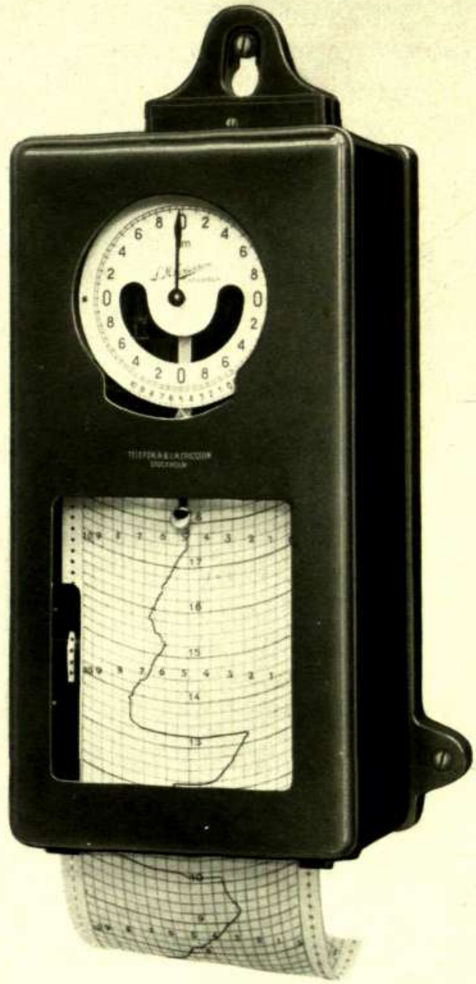

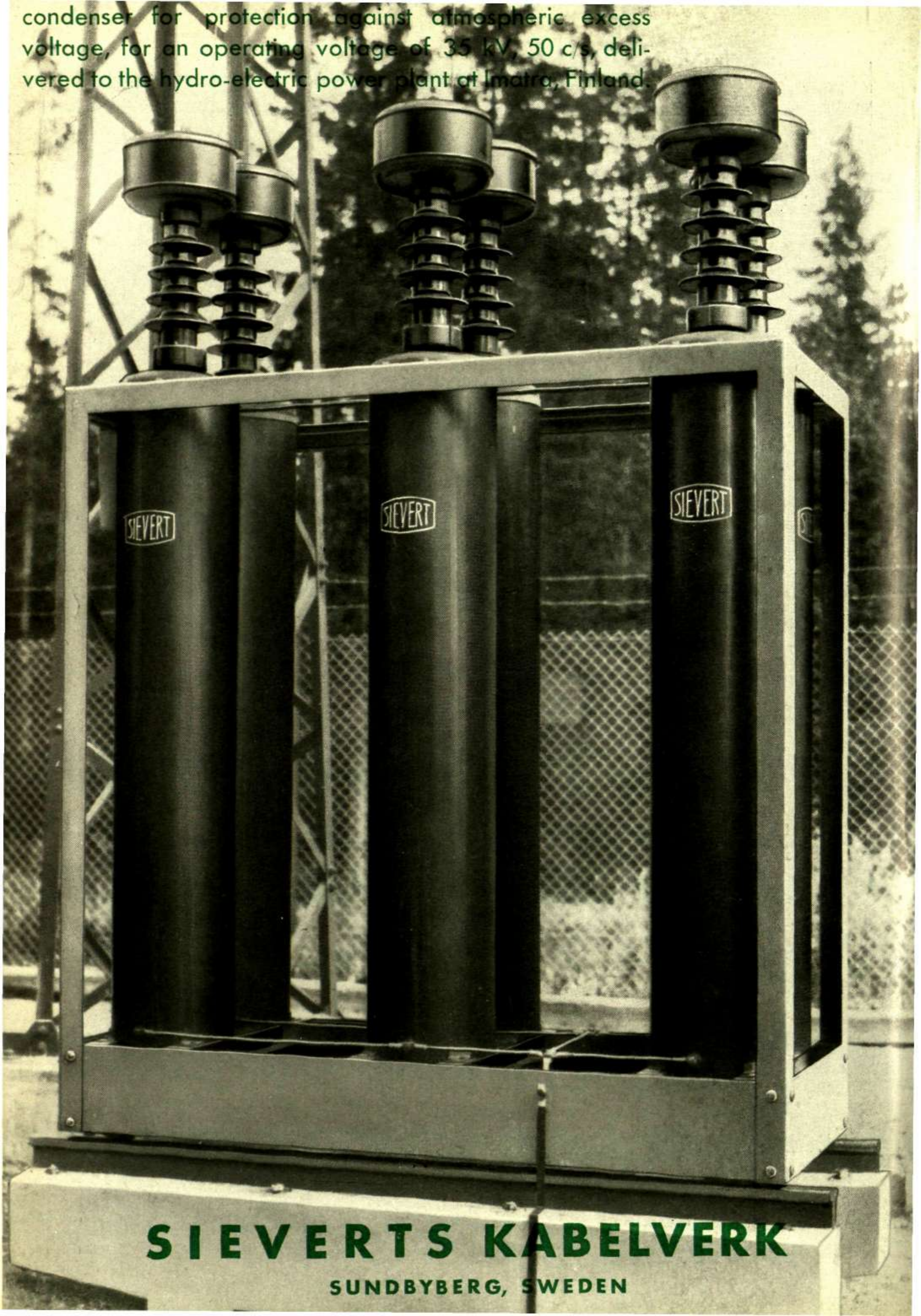

condenser for protection against atmospheric excess voltage, for an operating voltage of 35 kV, 50 c/s, delivered to the hydro-electric power plant at Imatra, Finland.

The L.M. Ericsson Review

No 2 1934


Ericsson's private automatic exchange, Type OL 12, for 10 lines, secret calls; inexpensive to buy, install and operate
operated with dry batteries; no multi-wire cables: the new small bakelite telephone instruments are connected over two wires only
TELEFONAKTIEBOLAGET L M ERICSSON
Telefonaktiebolaget L. M. Ericsson

The L. M. ERICSSON REVIEW

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

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Printed in Sweden
Centraltryckeriet, Stockholm 1934

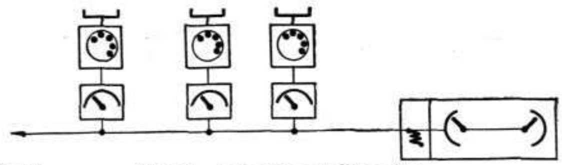
PARTY LINES

By H. V. ALEXANDERSSON,

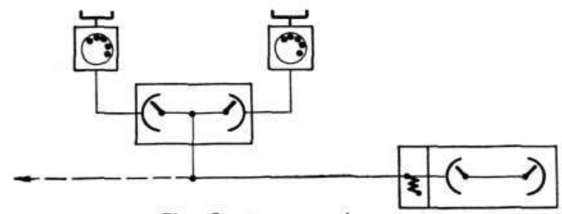
Technical Department,
Telefonaktiebolaget L. M. Ericsson,
Stockholm.

The problem of connecting several telephone instruments to one line has always roused much interest and a great deal of construction has been carried out in this connection. In these days when the automatization of rural districts is extending, the problem has come still more to the fore, since on the automatization of a rural exchange it will often be almost a necessity to use a party line system that may be connected to the automatic exchange.

As the designs of party-line systems made for connection to automatic exchanges will only need some modification to be suitable for connection to manual exchanges, an extensive description of the principles and type of construction used by Ericsson in this range is given below and also a brief summary of the different alternatives that might be used under different conditions.



X 1321 Fig. 1. Selective-calling line.
The subscribers are scattered along the line.



X 1322 Fig. 2. Party exchange.
The subscribers are concentrated to one or several points.

The characteristic of a perfect party line may be said to be that the subscriber should have no other inconvenience of being connected to a party line than that the line may sometimes be busy. In other respects everything should be the same as for subscribers with individual lines to the exchange.

The following may be required of a perfect party-line system:

the conversations should be secret;

it must be possible to converse between two instruments connected to the same party line;

this should preferably be carried out by the same operations as used when calling other instruments, *i.e.* the directory numbers should be used for internal traffic as well;

individual metering must be possible;

long-distance disconnection must be possible;

ordinary telephone instruments should be used, and, consequently, no local batteries should be required.

The working of the Ericsson party-line system and how it meets the above requirements are described below.

In order to make possible its adaptation to existing conditions Ericsson have designed two varieties of their party-line system. The first one is a *selective calling system,* in which each instrument is provided with an additional set containing the necessary equipment. In this case the instruments may be connected at arbitrary points of the line — see Fig. 1.

In some cases, where the instruments connected to party lines are situated comparatively near each other, it may be suitable to join all selector devices to one point, and the equipment may then be simplified to what we will call a *party exchange* — see Fig. 2.

Selective-Calling Instruments.

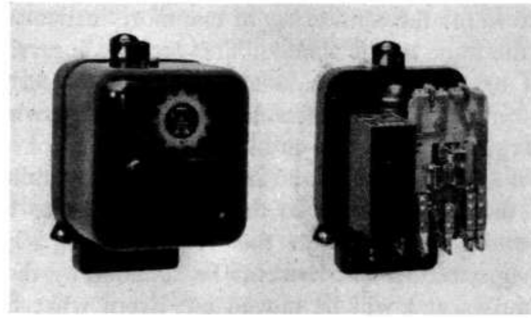
The most important problem of a selective-calling system is the principle of impulsing. In the Ericsson party-line system the same method of impulsing is used as in the selective-calling system for railways, such as has been described in the Ericsson Review No 1, 1933. This method of impulsing, which has given very good results, is based on the application of small cuproxide rectifiers which separate the impulses from the ordinary line current.

When it is required to design a *secret* selective calling system there are in the main two alternatives to be considered. A separate connecting relay may be used for bringing the instrument into speech connection with the line and in this case the selector need not remain in any particular position during the conversation. It is also possible to let the selector carry out the connecting of the instrument, and in this case the selector must obviously remain in connecting position during the conversation. The latter of these principles has been chosen although there are greater difficulties involved in its application. This choice has been made partly because the equipment may be made less expensive if the connecting relay can be dispensed with, and partly because it is necessary to take the whole current supply from the central, as local batteries at the instruments are not desirable. Where there is, say, 60 V available this will not be difficult, but since these party lines are in most cases to be connected to small rural exchanges operating with considerably lower voltage, say, 24 V, it will be rather difficult to get sufficient current over the line for operating the two connecting relays of an internal conversation.

The manner in which these problems have been solved may be seen from study of Fig. 3, which shows the diagram of a selector unit with an instrument connected; the instrument is of the Ericsson standard type, table set, Type DE 702, or the wall set, Type DE 200.

The selector unit contains a selector *S*, a relay *R*, a condenser *C*, and three rectifiers *Re1*, *Re2* and *Re3*. These last are connected in such a manner that they may be made as one rectifier with tappings. The selector and the relay are joined to a mechanical unit on a two-relay bracket. The whole equipment is enclosed in a dust-tight case with terminal block of bakelite. The case may be sealed so that only the proper person will be able to open it for adjustment and supervision. This is necessary in order to ensure perfect secrecy of conversation, since it is very easy for a person aquainted with the construction to cut in on conversations.

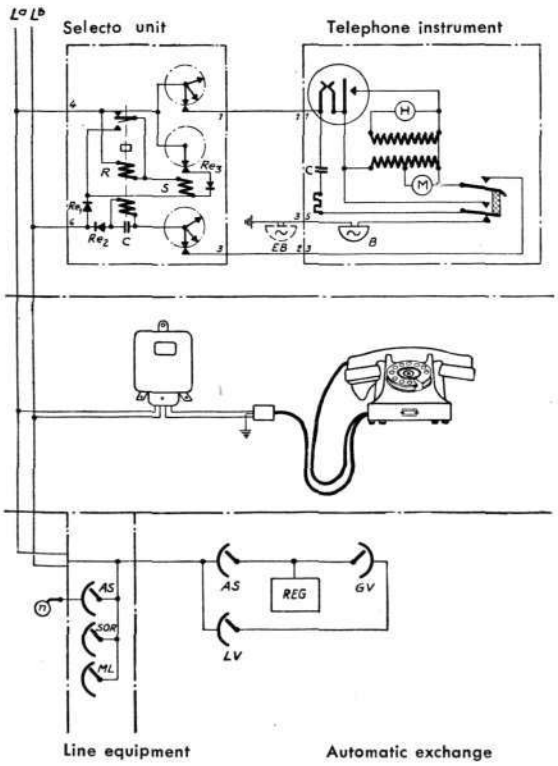
The unit is shown in Fig. 4, which presents it with and without cover. The dimensions



X 1299 **Fig. 4. Selector unit.**
In the right figure is seen: left, condenser; right, selector with relay; in the background, rectifier.

of the unit are 110 × 100 × 110 mm, exclusive of the terminal block.

The connecting is very simple. The unit is inserted between the instrument and the main line. From the selector unit there are consequently only two wires to the line and two to the telephone instrument. From this it may be seen that the selector unit may be placed anywhere between the line and the instrument. It is however convenient to place it comparatively near the instrument where it may be fitted so that it will cause no inconvenience. In addition it should be mentioned that the selector operates with extreme silence, especially as the cover forms an efficient silencer.



X 1309 **Fig. 3. Diagram of selective-calling line.**
The diagram shows two connected subscribers: in the upper part the electric diagram is shown, in the middle the mechanical mounting, in the lower part the arrangements in the exchange.

There is a small departure from the standard diagram of the instrument. The terminal for the extension bell is connected to earth, the ring signal being sent over the a-wire to earth. This, however, causes no alteration in the construction of the instrument. As may be seen from Fig. 3 this will on no occasion bring the line in the metallic connection with earth, the bell being connected in series with a condenser in the instrument. Troublesome earth currents are thus avoided. When the microtelephone is lifted the earth-connection will evidently be broken, so that during conversation the line will be perfectly balanced at the terminals of the instrument.

As may be seen from Fig. 3 the instrument is connected over two contacts, which is necessary if perfect secrecy of the conversations is to be obtained. The connection over only the one contact involves the risk of such high cross-talk that a conversation may be overheard.

On account of the two-contact connection, which is obtained in the selector proper, no separate connecting relay is required. According to what has been stated above it is necessary that the selector be locked in connecting position while it must be possible to actuate the other selectors for the connecting of one more instrument to the same line if wanted. This locking is carried out by means of a slow-acting relay *R* inserted in series with the instrument; this relay when energized will short-circuit the winding of its own selector magnet and insert a locking winding on the relay instead, so that the impulses to the selectors pass through this relay winding. The other selectors will however be actuated by these impulses and will be moved on. From what has been stated it is evident that the selectors may normally be in different positions. When the line is idle it is however necessary that all selectors be in the same home position. It is consequently necessary that after the end of each conversation all selectors be returned to the same position, although they may not have the same number of steps to go to reach it. This is done in such a manner that after the end of the conversation a series of impulses are transmitted over the line in order to actuate the selectors. The number of impulses in this series is sufficiently great to move a selector at least one whole revolution. The selectors are however of such a design that when in home position they close a contact, which connects a small rectifier *Re3* in parallel with the magnet winding of the selector. This rectifier causes the selector to be slow-acting, so that its operation will cease on account of the armature remaining attracted. Not until the series of impulses is finished is the armature released, and the selector will then be in the same position as the other ones. Such a »synchronization» is also necessary since a selector from one cause or the other may take a step too much or too little. Such faults cannot be allowed to remain and will evidently be removed after each conversation by the synchronization.

Line Equipment.

In addition to the selector units at the subscribers' instruments, a line equipment is required for the connection to the exchange — see the lower part of Fig. 3.

On account of various requirements and the necessity to adapt the line equipment to the automatic exchange the types will vary rather much. A complete equipment that fulfils all the requirements stated above contains in the main three small selectors, one line finder *AS*, one sequence switch *SOR*, and one control selector *ML*. In addition a number of ordinary relays are required for the operation of the selectors of the line and for the impulse transmission.

The line finder is used chiefly for connecting the meter corresponding to the calling party, while the sequence switch and the control selector are used for indicating whether the traffic from one instrument on the line shall be directed backwards to another instrument on the same line or not.

The selective-calling line is connected to one position in the line finder multiple of the exchange and to one position of the final selector multiple for each instrument connected to the line. The a-wires from the final selector are connected in parallel while the b-wires are connected separately. The seletive-calling line will then operate in the following manner.

When the line is clear all selectors will be in home position; all instruments are then connected so that a call can be made when a microtelephone is lifted. A high-resistance relay is connected as a calling relay in the line equipment for the reason that it is not desirable that the series relay *R* in the selector unit should attract on calls, and that it is suitable that, when disturbances are introduced on the line, *e.g.*, from power lines, as much as possible of the disturbing voltage be absorbed by the relay, so that the bells of the instruments, which are connected to earth, should not be actuated by such disturbances. In home position the bells of all instruments are connected in parallel to earth.

When a call is made from an instrument this high-resistance relay will attract and start a selecting motion over the selectors in such a manner that a series of impulses — changes of polarity — are transmitted over the line. These impulses operate the selectors which are moved step by step synchonously from home position. The connection to the line over the calling instrument is broken after the first step. At the same time as the selectors operate they are followed synchronously by two selectors *AS* and *ML* in the exchange. After the first impulse the high-resistance relay is replaced by a low-resistance relay, which between the impulses is connected to the line with the same polarity as the calling relay. When on their movement the selectors have reached the position that corresponds to the calling instrument, the line is closed anew over the contact arms of the selector and the calling instrument. In the same moment the low-resistance calling relay will attract and stop the movement of the selector *AS*. The relay *R* in the selector unit will also attract in series with the line. The impulse transmission over the line will however continue until the selector *ML* has again reached its home position. These impulses will, however, not actuate the selector of the calling instrument since the series relay will short-circuit the magnet winding as has been described above.

After the line finding the selectors will consequently be in two different positions. The selector of the calling apparatus has stopped in a position that corresponds to this instrument, while the others have proceeded a certain number of steps, after which they have stopped in a second home position. In this home position however the instruments are *not* connected to the line, contrary to the original home position.

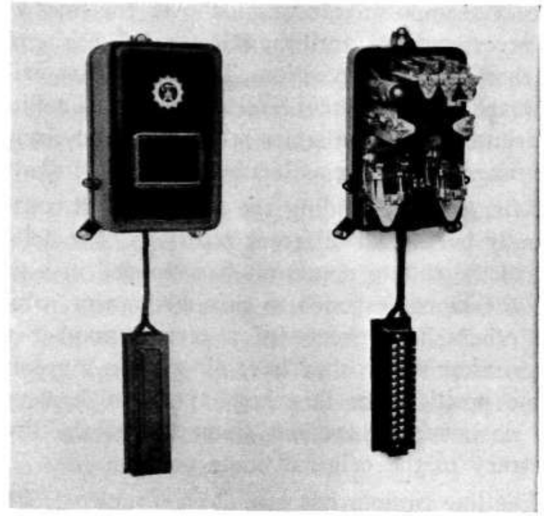
The line finding has now been completed. The calling instrument has been connected to the line and the number has been registered in the exchange. At the same time normal line finding has been carried out in the exchange, so that the line is connected to an ordinary cord circuit in the exchange. A dialling tone is sent out from the register, and the impulsing can take place. The impulses are received by the register and also by the control selector that belongs to the selective-calling line, consisting of the selectors *ML* and *SOR*. By means of the control selector it is ascertained whether connection is wanted with a subscriber on the same line. If the first digits of the number indicate that the called party is connected to the same line as the calling party, a switch-over will take place in the line equipment, which means that the impulses from the dial for the following last digit of the number are transformed into polarity changing impulses to the selectors of the home line according to the method of impulsing used by Ericsson. These impulses will however not actuate the selector of the calling instrument, the series relay *R* remaining attracted and short-circuiting the selector. All the other selectors will on the other hand be moved forwards the same number of steps as the dial gives impulses for the last digit. By means of the third contact arm of the selector the instrument corresponding to this number will be connected to the line. After the last digit a ring signal is sent out from the exchange over the a-wire to earth through the bell of the called instrument, which will consequently give a signal. The calling instrument is also connected to the line, but the b-wire being interrupted in the exchange during signalling, the signal will be heard as a buzz in the receiver, which indicates that a ring signal has really been sent out. One ring signal only is given. It is rather difficult at intermittent signalling to indicate when the called party has answered, and because of this single ring signals have been preferred. After the conversation has finished and when both parties have replaced their microtelephone the selectors are returned to home position by means of a long series of impulses according to the method described above.

In this manner internal conversations are exchanged. A call from the selective-calling line to another line is set up in the same manner, with the exception that the above-mentioned switch-over for impulse transmission is reversed. During such calls the selectors remain in the above-mentioned second home position except the selector of the calling instrument, which remains in the first working position.

Incoming calls are set up in such a manner that when a ring signal is sent out to the ring relay of the selective-calling line the intermittent ring signal from the exchange will cease — without indicating answer from the B-subcriber — and the line finder of the line equipment will start a selecting motion over all b-wires from the exchange connected to the final selector multiple. This motion will cease when the b-wire is reached, that leads to the final selector in position for the desired subscriber's number. During the selecting motion a series of impulses are transmitted over the selective-calling line to the selectors, and when the selecting, and consequently also the impulse transmission, ceases a ring signal is sent out in the above-mentioned manner to the instrument connected over one of the selectors. It is only when the microtelephone of this instrument is lifted that the answer from the B-subscriber is indicated, so that metering can be carried out for the A-subscriber.

When the selective-calling line is used by a subscriber the other subscribers will of course be busied. Long-distance disconnection may however be carried out in such a manner that after the long-distance operator has cut in on the line in the usual manner she simply sends out a ring signal. This ring signal will first cause a disconnection of the conversation going on and the movement of the selectors to home position; the selectors are then started again, and this time they will stop on the number wanted by the operator. A ring signal is then sent out in the usual way to the instrument connected.

Party Exchange.



X 1300 **Fig. 5. Party exchange.**
In the right figure is seen: below, the two selectors; top, the relays and the rectifier.

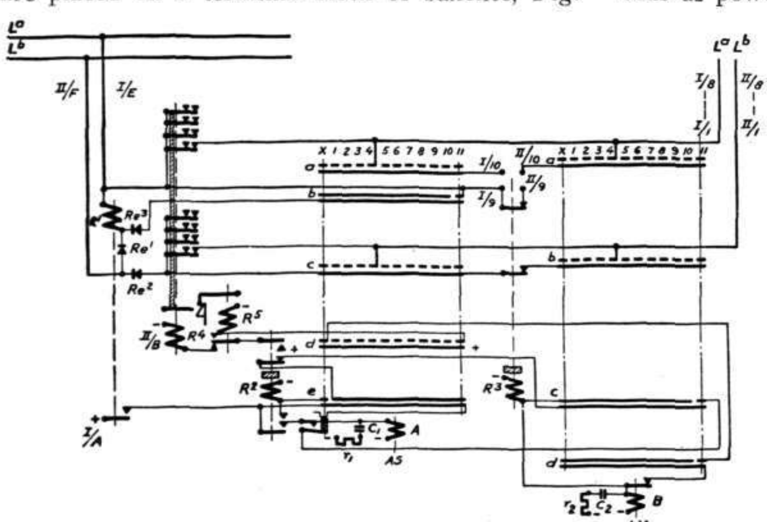
As said in the introduction, Ericsson have also designed party exchanges on the same principles as the selective-calling system. The difference lies chiefly in the wiring. On selective-calling lines the instruments may be connected anywhere on the main line. In the case of party exchanges all instruments are connected to one point, see Fig. 2.

The instruments are ordinary automatic telephone instruments, which are connected to the party exchange over two-wire circuits as in the selective-calling system; the bells of the instruments are also in this case connected to earth. In this system the individual selector units are replaced by an equipment which is common for all instruments, *viz.*, the party exchange, which is to be located at a place which permits the shortest possible total length of lines. The position of the exchange will often be indicated when the party exchange replaces an old manual exchange of a small type. In this case the line system to be used will already be installed.

The party exchange also consists of two main parts, *viz.*, the equipment in the main station and the units required on the line, the party exchange proper. The equipment in the main station is nearly identical with the corresponding equipment for selective-calling lines, and consequently it needs no further description.

The party exchange proper consists of two small selectors and five relays. In addition there are a number of resistances, condensers and rectifiers. The whole device is fitted in a small dust-tight cover of sheet-iron, and all terminals are placed on a terminal block of bakelite, Fig. 5. This party exchange is designed so as to consume no power during conversations. The consumption, being concentrated to the times of setting up and disconnecting circuits, is so small that a dry-cell battery may serve as current supply. The tension has been chosen at 12 V, which can be supplied by, say, 8 dry cells of 1,5 V. A battery with a capacity of, *e.g.*, 150 Ah will under these circumstances last for at least one year. Such party exchanges being installed at places where there is not always electric power distribution, it is of great importance that the power can be provided in the manner described above.

It is of course possible to arrange charging over the junction line, but as this involves certain disadvantages the more simple solution with dry cells as power supply has been preferred.



X 1528

Fig. 6. Diagram of party exchange.
The exchange line comes in top left to: (from left to right) operating relays, line finders and line selectors; on the right, outgoing subscribers' lines.

A diagram is shown in Fig. 6. When idle all lines are connected in parallel to the main line. When a call is made a transmission of polarity changing impulses from the main station is started. These impulses will actuate the relay *R1*, which in its turn connects current to the relay *R2*, the operating magnet of the line finder *A*, and the relay *R4*. This last relay disconnects all the lines and is made with mechanical locking so that it will require no current during the conversation. When by means of the impulses from the main station the selector has reached the position where the called instrument is connected, the line is again closed over this instrument. This is indicated in the main station and the impulse transmission for the selecting motion will cease. The relay *R2* is then released and the impulses received after this by the relay *R1* will be transferred to the selector *B* instead of *A*. According to what has been said concerning selective-calling lines such impulses will arrive only when the first digits of the dialled number indicate that the called subscriber is connected to the same line as the calling party. During the dialling of the last digit, impulses will be transmitted over the line, which move the selector *B*. This selector will then connect the called instrument over its contacts and a ring signal is then sent out from the exchange over the a-wire to earth.

The selectors are returned to home position by means of impulses from the exchange as is the case with selective-calling lines. The impulses will first move the selector *B* to its last position and then the selector *A* to its last position. In this position the relay *R1* will be shunted by the rectifier *Re3*, from which it follows that the relay will become delayed acting and will keep its armature attracted until the series of impulses has ceased. Current will then flow through the selector *A* also. The selector being driven indirectly it will consequently move to home position when the series of impulses ceases, after which the selector *B* is also moved one step to home position. The party exchange is then prepared to receive the next call since with the arrival in its last position of the selector *A* the relay *R5* was energized and so released the mechanically locked relay *R4*.

The purpose of the relay *R3* is to ensure that on the setting up of an internal conversation a lifted microtelephone shall not interfere with the impulsing from the instrument connected over the selector *A*.

Eight different subscribers may be connected to the party exchange. If a higher number of subscribers is required a somewhat different construction will be necessary, as the relay *R4*, when only a single relay, cannot be fitted with contacts for more than 8 subscribers.

In addition it is possible to connect more than one party exchange to one line. The total number of subscribers must nevertheless not exceed 10.

Different Types of Party Lines.

The main principles on which the Ericsson party-line system has been designed have been treated in detail above, but it is evident that in many cases it will not be necessary to fulfil all the requirements mentioned. In addition there will often be the need of a party line with the above properties but designed for connection to manual exchanges.

A number of different types that answer various requirements are described below. All these types have one thing in common, *viz.*, the equipment *outside* the exchange to which the party line is connected is identically equal, whether the exchange is automatic or manual, and from this it follows that the automatization of the exchange to which the party line is connected, *will not call for any alteration of the subscribers' equipment*, which is very favourable from both the technical and economical points of view. There is, however, one small exception: Type H described below makes it necessary for the CB-instruments used to be fitted with dials.

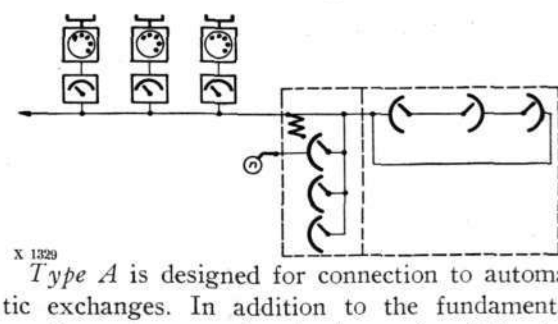
The following requirements are fulfilled by all types:

the conversations are secret with two-wire disconnection of the instruments not wanted;

internal conversations may be exchanged;

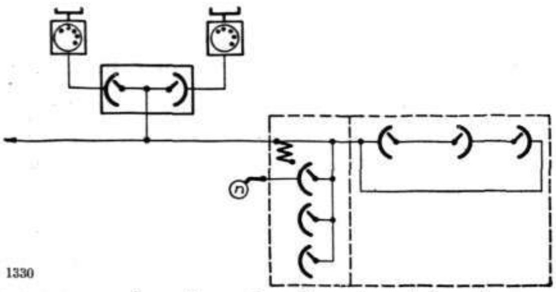
standard telephone instruments may be used;

no local batteries are required.



Type A is designed for connection to automatic exchanges. In addition to the fundamental requirements mentioned above the following requirements are also answered;

long-distance disconnection may be carried out



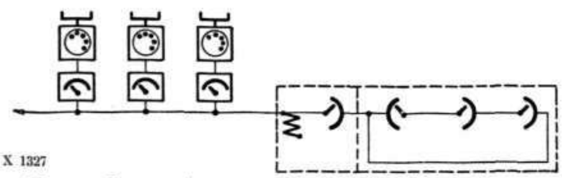
X 1330

by means of a ring signal sent out by the operator;

individual metering is provided;

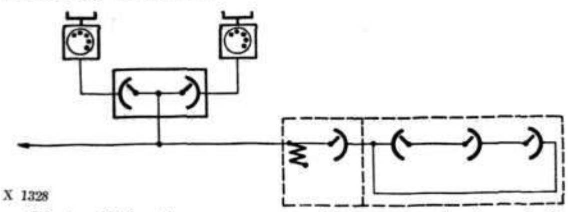
the system operates with hidden direction digits, *i.e.*, internal calls are also set up by means of the directory number.

Type B has the same properties as type A, but is designed for the connection of one or more party exchanges instead of selective telephone instruments.



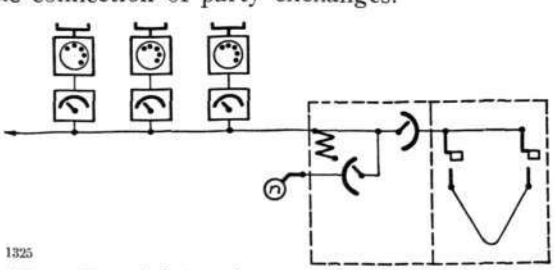
X 1327

Type C constitutes a simplification of type A inasmuch as open direction digits are used and individual metering is not possible. An internal conversation is set up by dialling one digit only, which consequently will be the last digit of the directory number.



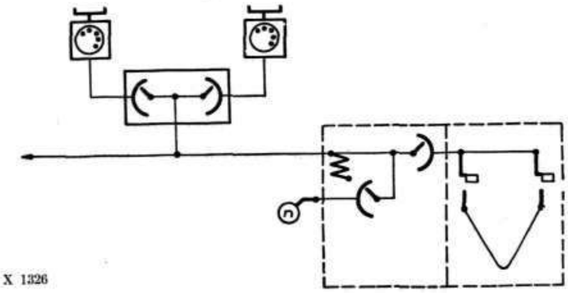
X 1328

Type D is the corresponding type designed for the connection of party exchanges.



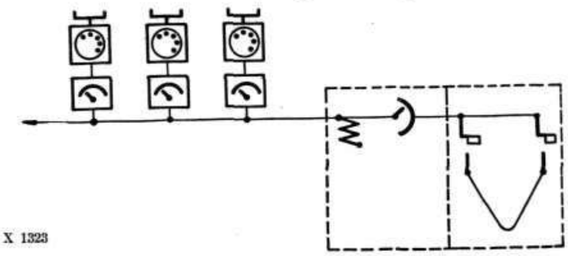
1325

Type E and following are designed for connection to manual exchanges. Type E is made as complete as possible. Individual metering has consequently been arranged, and long-distance disconnection may also be carried out. The operator is called by dialling a special number, *o*. Outgoing calls from the operator are set up without using the dial; the operator plugs into the jack of the wanted subscriber and sends out a ring signal in the usual manner, which will start the selecting of the wanted instrument.



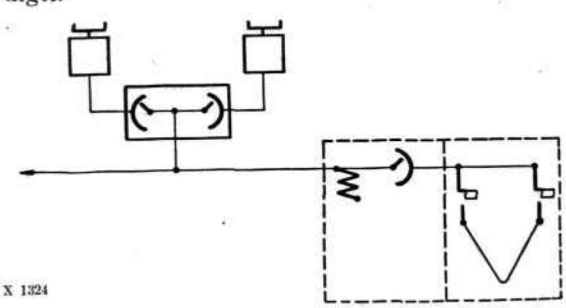
X 1326

Type F corresponds to type E but is designed for the connection of party exchanges.



X 1323

Type G is the simplest selective-calling line. In this case individual metering has not been arranged, and the operator operates the selective-calling line by means of a dial. Internal calls are set up automatically by the subscribers, and calls to the operator are set up by dialling a special digit.



X 1324

Type H is the simplest type for the connection of party exchanges. Consequently it corresponds to type G for the connection of selective-calling instruments but is still simpler since internal calls as well are set up by the operator. The subscribers' instruments are consequently *not* provided with dials but are ordinary CB-instruments.

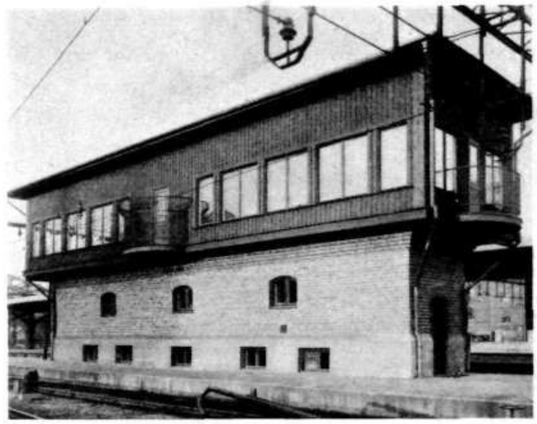
The types described above do not cover all possible variations. They have been presented in order to show that the Ericsson party-line systems both from technical and economical points of view provide new and excellent facilities of widening the scope of telephone service.

THE INTERLOCKING SYSTEM AT THE STOCKHOLM CENTRAL STATION

(CONTD.)

By T. HÅRD

First Administrative Engineer of the Swedish State Railways, Stockholm.



X 1272 The signal cabin at Stockholm C.

The Signal Cabin at Stockholm C.

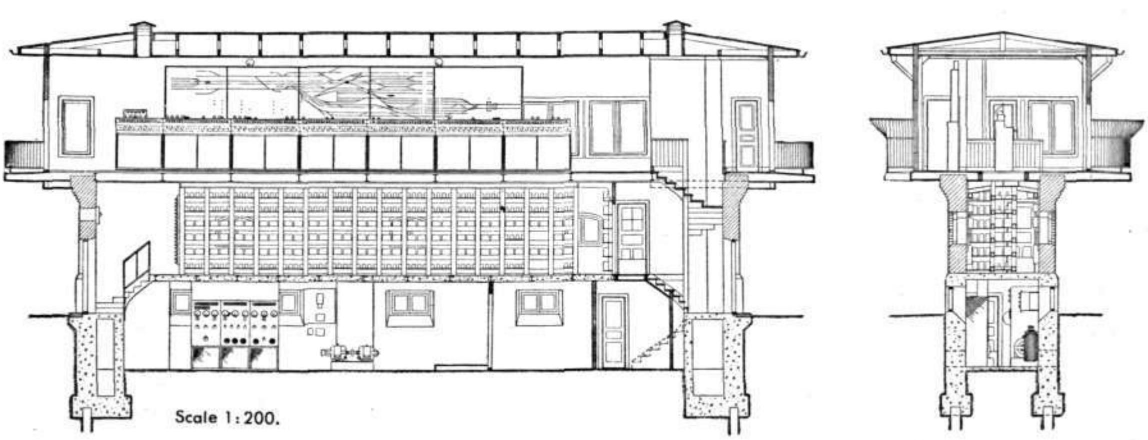
The signal cabin at Stockholm C, Fig. 7, is a three story building. According to the usual practice of the Swedish State Railways the top floor is built of wood and the two others of brick and concrete. The height of the cabin was determined by the requirement that, according to investigation made, the floor level of the top section should be about 4 m above the ground in order that the best possible view under the street bridge immediately north of the signal cabin might be obtained. With a view to making the rooms of the two bottom floors sufficiently high, the floor of the ground floor has been sunk 1.5 m below ground level.

The ground at the site consisted of old filling on sea bottom. In view of the risk of injury to the apparatus in the signal cabin by vibrations from trains passing, special care had to be taken with the foundations and these were made by friction piling.

The width at the bottom was determined by the position of the building on a platform between two train tracks, as free passage for platform trucks is required on either side of the building. The bottom floors are therefore only 2 m wide. The top floor is overhanging and the rooms are, therefore, wider. Lookout balconies have been arranged on all four sides of the signal cabin. The railings of the side balconies have been provided with guards to prevent the staff when on the balconies from touching the high tension trolley wires which run close by.

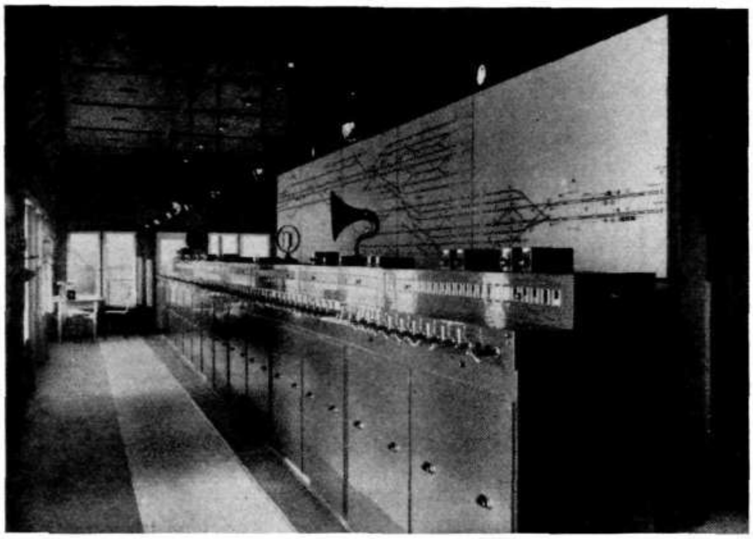
The building is warmed by hot water from the steam central of the station. In addition electric heating elements have been installed in the top floor for use during the periods of the year when the steam central is not in service. In the middle floor there is as a rule a certain surplus of heat from the electric apparatus installed there, and ventilation has been arranged by means of an electric fan placed in the wall.

The top floor, Fig. 8, is built as an operators' room with interlocking machine, illuminated



X 7050 Fig. 7. Section of the signal cabin at Stockholm C.

On the top floor: the operators' room; on the middle floor: the apparatus room; on the bottom floor: the power plant.



X 5114

Fig. 8. The operators' room, with interlocking machine and illuminated track diagram.

track diagram and the necessary telephone equipment. Loudspeakers and microphones for the yard telephone system may be seen on top of the interlocking machine.

Walls and ceilings are made of plywood painted brown. The light is supplied by projector lamps which throw light on the track diagram and on the upper part of the interlocking machine where the switches, indicators and supervisory windows are situated.

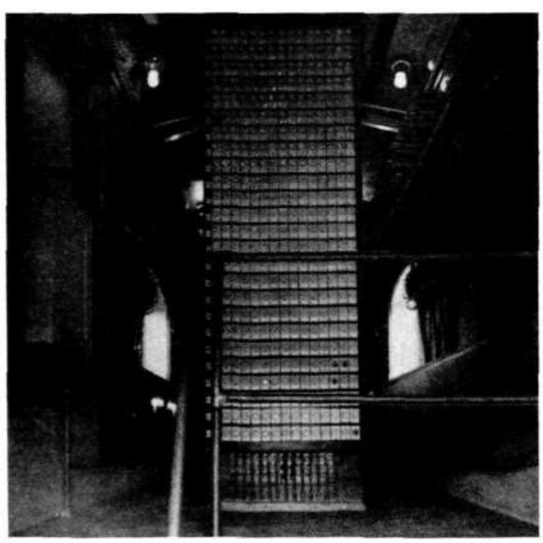
On *the middle floor*, Fig. 9, there are the relays mounted on a separate wooden frame along the middle of the room, also the terminal boxes of the incoming underground cables, and finally all transformers etc. connected direct to the outgoing cable circuits. In the relay room there are more than 1 000 relays, 160 transformers and 110 terminal blocks for the cables. On the middle floor there are also the fuses with the exception of those of the AC motors, which are placed below the corresponding switches in the interlocking machine.

On the *bottom floor*, Fig. 10, all equipment for the power supply has been installed. In the northern end there is a small room with a working place for a repairer and shelves and cupboards for various stores. Part of the bottom floor is occupied by a distribution central for the outdoor lighting of the yard and by the heating installation.

Illuminated Track Diagram.

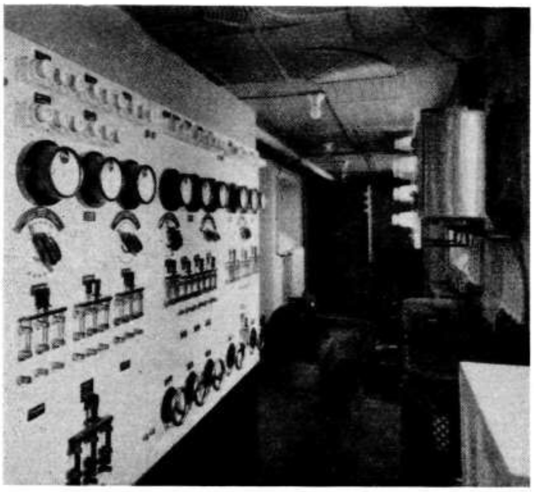
The track diagram is 13 m long and has been made in five parts which are held together by a frame of iron bars. The front is of sheet-iron, with the tracks represented by two narrow parallel black lines on a blueish-grey background, this having proved less tiring to the eye than the white background previously used, and with yellow filling between the lines for the tracks controlled by track circuits.

In this plate there are small windows behind which are lamps for track supervision, supervision of signals, signalling of train arrivals etc., so that by regarding the track diagram the staff may easily follow the movements. The total number of lamps is 748, all of which are easily accessible as behind the track diagram there are easily removable doors of wood.



X 1273

Fig. 9. The relay room, with relays, cable terminal boxes, transformers and fuses.



X 1274 Fig. 10. The power plant.
Left, instrument panel; right, main transformers for the track circuits; in the background, converters.

The oblong light windows to be seen in Fig. 11 cooperate with the track circuits. The lamps light when the corresponding track circuits are occupied by vehicles.

The dwarf signals are indicated in the diagram by circular light openings which show white light for »clear» and yellow light for »caution». For »stop» the openings are unlighted.

The main signals are indicated by red and green lamps, which are connected direct in series with the lamps of the signals.

At the bottom of the track diagram, Fig. 11, there are the train-indicator lamps which indicate whether the block sections of the double track to Tomteboda are occupied by trains of the State Railways or those of the private railway company. Before a train leaves, the kind of the train must be indicated on the diagram, which is done by pressing a button, whereby a lamp (departure lamp) in the diagram lights up. When the train enters the first block section of the line the departure lamp goes out, and the corresponding lamp for the first block section of the line lights up. This lamp goes out and the corresponding lamp for the second block section of the line lights up when the train has left the first block section, and so on until, when the train has left the last block section, the last indication disappears.

The space below the track diagram between the supporting pillars has been utilized as a cupboard for housing such electric resistances, transformers, light relays, etc. as have direct connection with the lamps of the track diagram.

The Interlocking Machine.

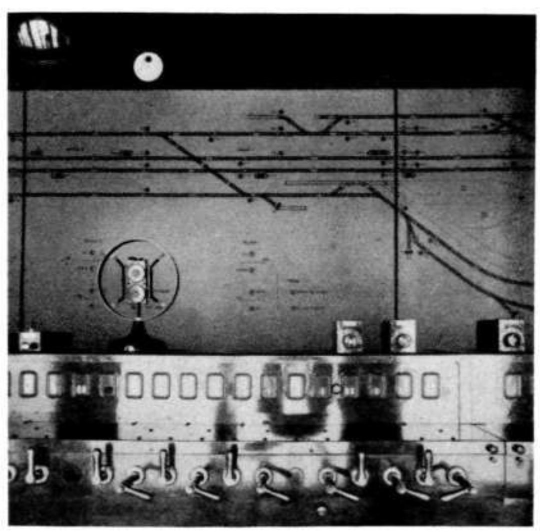
The interlocking machine is placed in front of the track diagram. It has a total length of 13.5 m and contains 70 point switches and 61 signal switches, by means of which more than 100 points and 150 signals with about 380 track combinations are operated. The interlocking machine has place for 30 additional switches to provide for future completions and extensions.

The interlocking machine is built into a cubicle of green enamelled sheet iron. The switch handles are of polished brass.

On the top of the interlocking machine are fitted various apparatus for the management of the traffic, such as switches for changing the traffic direction on the automatic block sections, time contacts for emergency release of track locking, press-buttons for the operation of certain shunting signals and train-indicator lamps.

The switches of the interlocking machine are placed in front of the corresponding points and signals in the track diagram. The handles of the signal switches point upwards and those of the point switches obliquely downwards, Fig. 11. Boards with symbols and information regarding the sequence of operation are placed in horizontal position above the switches (when the picture, Fig. 11, was taken the boards were not yet in position).

Figure symbols are used for both points and signals and these symbols are always the same as the corresponding number on the interlocking machine.



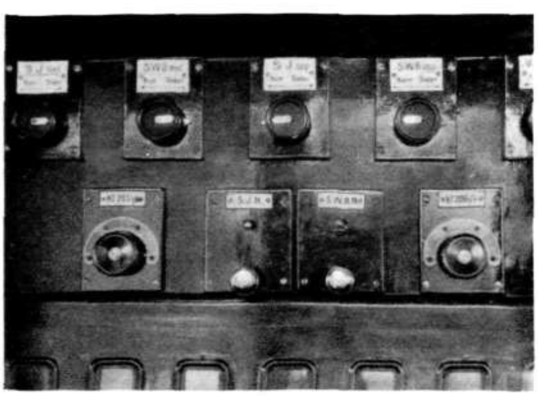
X 1275 Fig. 11. Detail of the track diagram and the operating switches.

Above the boards the supervisory windows may be seen, in which indicators of different colours are shown, Fig. 11. The supervisory windows at the signal switches are used for indicating when the switch for the road that corresponds to the switch in question may be thrown. The rule to be followed when throwing over the switches is that the switch should be moved in the same direction as the movement. When the switch has been thrown over the colour in the window will indicate whether the switch may be thrown back or not.

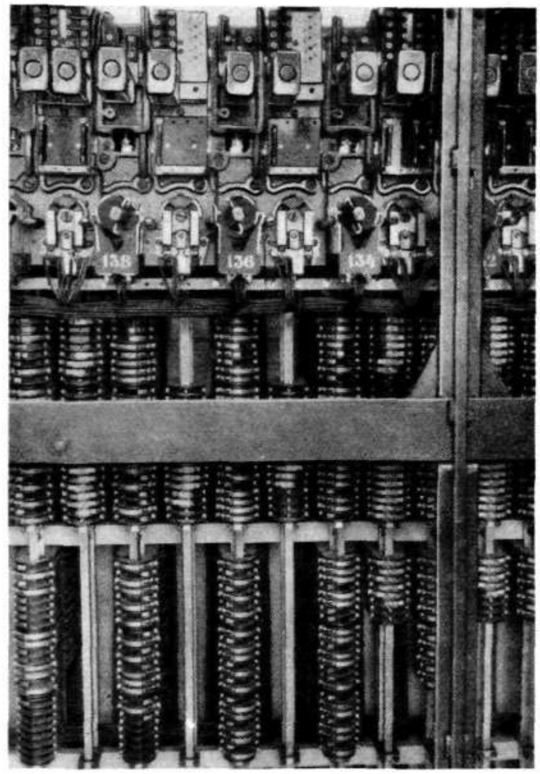
White appears in the supervisory window of the point switches when the position of the switch in question corresponds to the position of the points that are operated by means of the switch. When a switch is thrown over the white indication will consequently disappear, but it will return when the points have also gone over to the other position.

In order to indicate whether a point switch may be operated or not there is a special indicator device consisting of a pointer which appears in the supervisory window when the point switch is locked. The staff need therefore never try a switch but will always know beforehand whether the switch in question may be thrown over or not.

Fig. 12 shows the part of the interlocking machine that cooperates with the block sections of the line. In the top row there are the switches which are used for changing the traffic direction on the automatic line sections between Tomteboda and Huvudsta and Solna respectively. When the traffic direction is to be changed the handle is given half a turn, and a clockwork is then started. This clockwork actuates a contact device, which first sets the signals in stop position. After about 1 minute, during which the signals have indicated »stop» for both traffic directions, the



X 1276 **Fig. 12. Detail of the switches for operating the line sections.**



X 1277 **Fig. 13. The register of the interlocking machine, seen from the rear.**

signals will change over to indicate »clear» for the other traffic direction.

At the ends of the bottom row, Fig. 12, there are two time contacts for emergency release of track locking and in the centre two press-buttons for indicating the kind of train (State railways or the private railway company) arriving from the north on the double track between Tomteboda and Stockholm C. By the use of time contacts for emergency release of track locking the sealing of the corresponding apparatus has been rendered unnecessary.

The interlocking machine at Stockholm C, of which a part is shown in Fig. 13 with the sheet-iron plates removed, is of a comparatively new design, used for the first time in 1927 for an interlocking machine manufactured by Signalbolaget for the Hässleholm station. In all previous electric interlocking machines mechanical locking registers have been used, *i.e.* the different switches of the machine are made mechanically dependent on each other by means of rods along the machine.

In the Hässleholm interlocking machine this principle was departed from for the first time, and the mechanical register was replaced by purely electrical connections between the switches. By application of the experience gained with this interlocking machine, the same design has been used at Lund, Gothenburg and several other stations and has now been installed at Stockholm also.

Each switch with the corresponding contacts and magnets is a separate unit having nothing but electric connections with the other switches. This makes the system extremely flexible for the planning of new installations and for alterations or extensions of existing plants. From a reliability point of view dispensing with the mechanical register has not caused any inconvenience, since it has been replaced by electromagnetic locking devices which are of the same or even of a higher degree of efficiency. A compulsory acting supervision of the functioning of the locking magnets has been arranged, and special steps have been taken so as to render harmless current leakage between different circuits due to faults in the insulation.

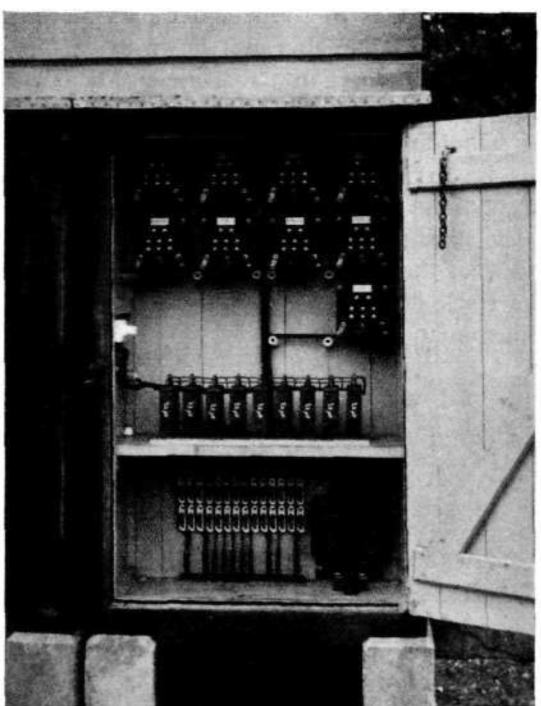
Power Plant and Track Circuits.

The primary power consists of three-phase AC, 50 c/s, which is supplied to the signal cabin at a tension of 220 V between phases. This power is partly used directly, and is partly converted into three-phase AC, 75 c/s, and DC of 220 V and 12 V.

As reserve in the case of breakdown at the mains there is also available in the signal cabin 2 × 220 V from the DC mains of the Stockholm Electricity Works. Equipment has been provided for converting the DC into AC of 50 and 75 c/s.

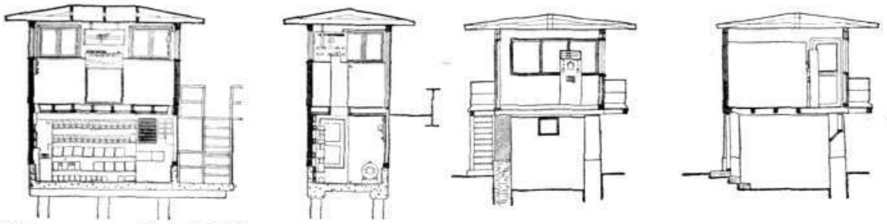
With the exception of a small 12 V storage battery for voltage equalization there are no reserve storage batteries in the plant, operation being based on the assumtion that power should always be available from one of the mains systems. The switch-over from the one system to the other is carried out by hand by means of a switch on the switchboard.

The main transformers, Fig. 10, for the track circuits are of a special design which prevents the voltage differences that might occur in the tracks on account of the electric traction from entering the local phases of the track relays, which might cause dangerous disturbances. The protection against the traction current has previously been arranged by using special frequency selective relays insensitive to the traction current, but in the present system ordinary two-phase track relays for 75 c/s AC have been introduced. The necessary protection has instead



X 1278 **Fig. 14. Transformer cubicle for the current supply of nine track circuits.**
Top, track transformers; middle, on the shelf, condensers; below, terminal strips.

X 1279 **Fig. 15. Relay cubicle at a block station along the track.**
Top and middle, relays and choke coils; below, storage battery with charging equipment.



X 7051 Scale 1:200.

Fig. 16. Section of the signal cabins at Mälarstrand (left) and Jakobsgatan (right).

been arranged by a kind of filter fitted in the feeding transformer which is common for all track circuits and this has rendered possible considerable reduction of both installation cost and power consumption.

Fig. 13 shows a cubicle with equipment for the supply of 9 track circuits. For each track circuit there is a condenser and a track transformer. AC of 75 c/s and 110 V is supplied to the cubicle. The transformers are connected to this supply with the condensers in series with the primary windings. The power for the track circuits is taken from the secondary sides of the transformers. The transformers are of such a design that the voltage supplied at the secondary side varies with the resistance of the track circuit and is adjusted automatically so that the current fed to the track circuit will remain practically constant.

In the case of the arrangement formerly used, with constant voltage over the track transformer and series resistances on the secondary side, an overcurrent will occur on account of the shunting when vehicles enter the section; this overcurrent will render the release of the track relay more difficult and makes necessary a more complete short-circuit over the axles than would otherwise be required. The track feeding with constant current therefore involves an increase in the sensitivity of the track circuit to shunting, which is of great importance from a safety point of view. The arrangement at the same time provides better economy on account of the reduced power consumption.

The power supply to the track circuits of the line north of Tomteboda, which are situated at a comparatively great distance from the signal cabin, is carried out by means of DC from storage batteries which are continuously charged from cuproxide rectifiers, Fig. 15. In order to protect the relays from the traction AC, choke coils with high reactance and low DC resistance have been inserted in series with the relays.

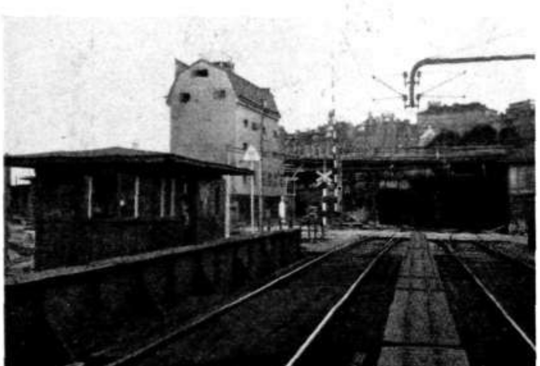
Track circuits of this type have been in use for several years to a great extent on the electrified lines of the Swedish State Railways. The principle of the design, however, in spite of its simpleness is rather unique.

Arrangements at Mälarstrand and Jakobsgatan.

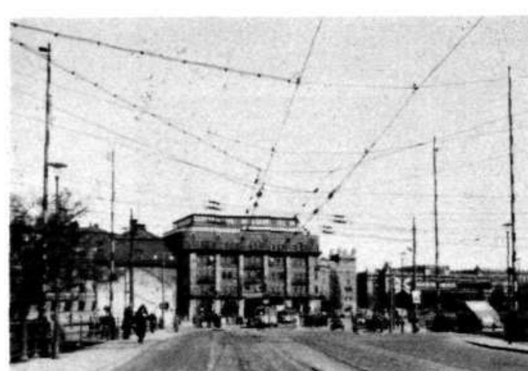
Cross sections of the signal cabins at Mälarstrand and Jakobsgatan are shown in Fig. 16.

The greater part of the work at Mälarstrand consists of the operation of the street barriers and the swing-bridge, since the operation of the signals is carried out automatically for all trains except those to and from the harbour.

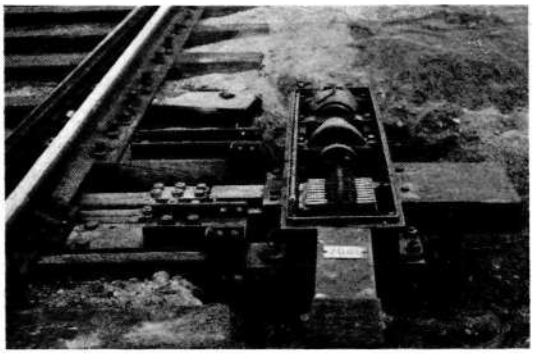
The interlocking machine has 8 switches only and is of the same type as that of Stockholm C. The track diagram is of wood and is provided with miniature lamps.



X 1281 Fig. 17. The signal cabin at Mälarstrand.



X 1280 Fig. 18. The level crossing at Jakobsgatan, between the tram line (600 V) and the railway line (16 000 V).



X 1282 Fig. 19. Electric point drive.

X 1284 Fig. 21. Double crossing points, with double drive.

The primary power for the signal cabin at Mälarstrand is taken direct from the DC mains of the Stockholm Electricity Works, which also supply the power for the operation of the swingbridge. Reserve supply has not been considered necessary as there are practically never any breakdowns in the power supply.

A picture from Mälarstrand is shown in Fig. 17. The left tunnel opening leads to the Stadsgården harbour and the right one, to which the points are thrown on the illustration, forms the entrance of the tunnel under the southern part of Stockholm.

The driving machine for the street barriers, which is common for the two 12 m long barriers, may be seen to the right on the illustration near the base of the old signal cabin, which has now been removed.

The street barriers of the level crossing at Jakobsgatan are operated from the signal cabin situated near this crossing; it carries the heaviest traffic of all the leval crossings of the Swedish State Railways in respect of both railway and street traffic.

The barriers are operated by means of two motors, one for each pair of barriers, and are combined with light signals, which stop the traffic of the street before the barriers begin to close.

The power to the barrier system at Jakobsgatan is supplied from the power plant in the signal cabin at Stockholm C. The operating instruments consist of switches mounted on a switchboard in the upper part of which there is a small track diagram with lamps for the signalling of the arrivals of trains etc.

The barrier watchman has to follow the traffic by means of the track diagram and to decide for himself when the barriers must be closed.

When the barriers are operated a motor-driven contact device is automatically actuated, by means of which the trolley wires above the street will be connected either to the 16 000 V line of the railway or to the 600 V line of the tramway, according as the barriers are open or closed to the street traffic.

Arrangements for the Throwing-over and Locking of Points.

Fig. 19 shows how the driving machine of a point is mounted on a bracket of U-irons which are fixed to the ends of the sleepers and to the irons of the point fundament. The driving ma-

X 1283 Fig. 20. Point rollers.

X 1295 Fig. 22. Mechanical switchman.

X 1285 Fig. 23. North view of the points at Tomteboda.

chine will consequently follow variations in the height of the track. The cable from the signal cabin is terminated in a separate box connected to the driving machine by a flexible tube through which the conductors have been drawn.

Four rods leave the driving machine, *viz.*, two point rods for the operation of the tongues and two supervisory rods which serve for controlling the position of the tongues, independent of the position of the point rods.

The locking of the tongues is carried out by means of a device built into the driving machine. Point locks are therefore not required, which makes the cleaning of the points from snow and ice much easier. The driving machine may be forced open and is provided with an enclosed gear which runs in oil. For all other sliding surfaces and bearings the lubrication is by means of grease forced into the driving machine by means of a syringe through lubricators with ball valves.

The cleaning of the points from snow and ice is facilitated by notches made in the point plates, so that the channel between the tongue and the guard rail will be open at the bottom, Fig. 20. Roller bearings have been provided below the tongues so as to support them during the switch-over. The slide plates have only to support the tongues in their resting positions. It is therefore not necessary to lubricate them, and the switch-over will always be easy.

Fig. 21 shows double crossing points. Two driving machines are required for such points, each machine operating two pairs of tongues.

Fig. 22 shows points provided with a mechanical switchman which returns the points to home position after they have been forced open. This arrangement has been provided at some points at the inner end of the platform tracks of the Eastern Yard. The switches are generally trailed and need then not be thrown over but may be forced open if the points should not be in the right position.

Signals.

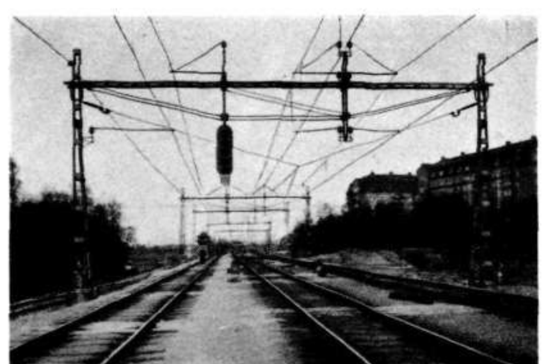
Fig. 23 to 32 show signal arrangements at various places in the yard and on the lines.

Fig. 23 shows the signals for the points at Tomteboda Övre, situated at a distance of 2.5 km from the signal cabin. Main signals have been provided for the two left tracks only. For the other tracks the signalling is carried out by means of the dwarf signals. The main signals are fitted on poles of reinforced concrete and the dwarf signals on low bases of the same material. A signal telephone to the signal cabin is mounted on the pole of one of the main signals.

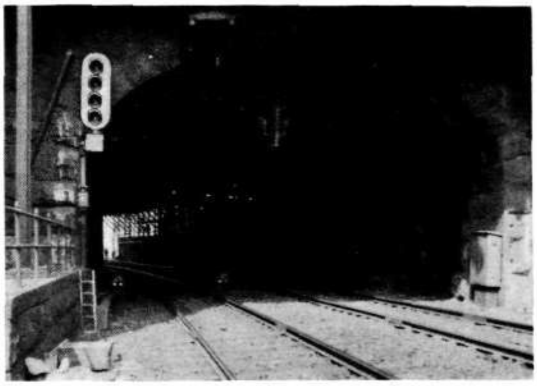
The rectangular shape of the number plates indicates that the signals are operated from the signal cabin. The number plates have a coating of enamel, which reflects the light from the headlights of the engine, so that the number may be seen clearly from the engine even in the dark.

Fig. 24 shows automatic signals at the block station about 800 m north of the Tomteboda points. The signals have been fitted with a round

X 1286 Fig. 24. Block station north of Tomteboda Övre.



X 1287 Fig. 25. South view of Tomteboda Övre.



X 1288 **Fig. 26. Entrance signal at Mälarstrand.**

X 1289 **Fig. 27. Southern entrance of the tunnel.**

plate, which indicates that the signals are operated automatically.

The main signal shown in Fig. 25 belongs to the upward track and indicates »clear» by means of one green light for the trains of the private railway company and two green lights for the trains of the State Railways. The two bottom lights form the distant signal of the next block section and show green light or flashing white light. When passing over the crossing points on to the downward track the signalling is carried out by means of the dwarf signals only.

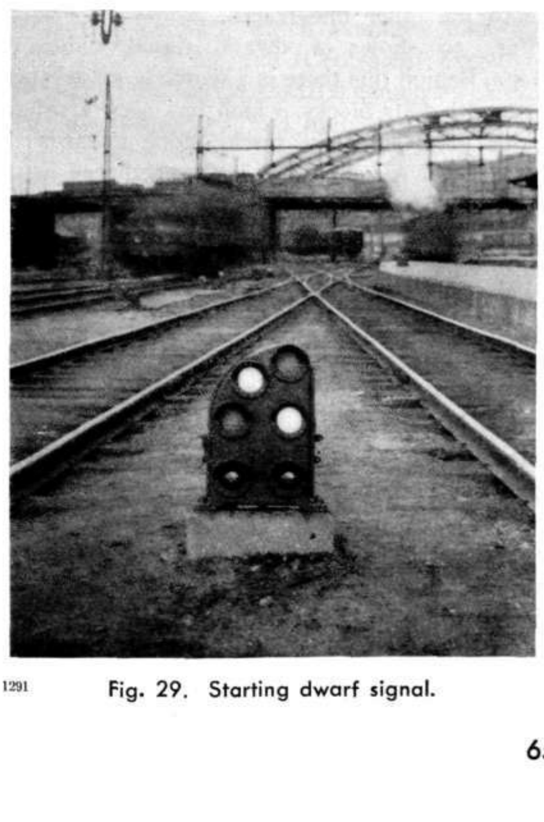
The signal telephone may be seen on the left pole carrying the trolley wire. In this case the main signal has been placed in the catenary bridge and is accessible by means of a ladder raised against a support which is placed on the bottom part of the signal. The old Tomteboda signal cabin may be seen in the background; after the removal of the interlocking machine the building has been used as office for the Tomteboda shunting yard.

Fig. 26 shows the signals south of the points at Mälarstrand, *i.e.,* main and dwarf signals for the upward track and a dwarf signal for the other track.

Fig. 27 shows approach signals at the southern entrance of the tunnel under the southern part of Stockholm. On account of the sharp curve the signals are repeated further along the tunnel. The special painting of the background plates indicates that the signals are distant signals. On main signals these plates are black.

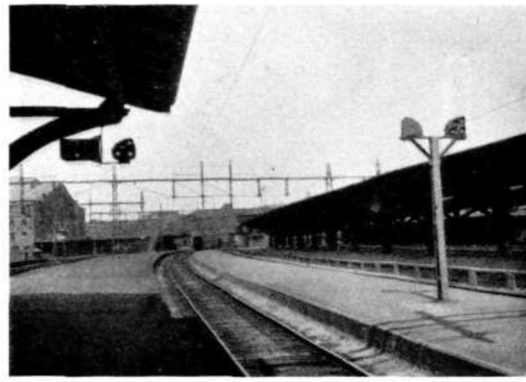
In Fig. 28 »clear» and »stop» is indicated by

X 1290 **Fig. 28. Entrance signal south of Stockholm C.**



X 1291 **Fig. 29. Starting dwarf signal.**

X 1292 Fig. 30. Dwarf signal and scotch-block light.



X 1293 Fig. 31. Platform signal.

the two top lights of the main signals. The same »clear» signal feature is shown for all five train tracks. The lower lights of the signal are used as distant signal for the starting signals at the other end of the yard.

A home dwarf-signal with similar signalling but without main signal has been provided for the downward track also, for use on single-track traffic on this track.

Fig. 29 shows a starting dwarf signal indicating »caution». The bottom lights are used for indicating when the whole starting road is clear, and such signals may consequently replace the main signals of starting roads. Flashing light is shown when the starting signal at the station limit indicates »stop» and fix light when this signal indicates »clear». The light to the right corresponds to the upward double track and the left one to the other line tracks.

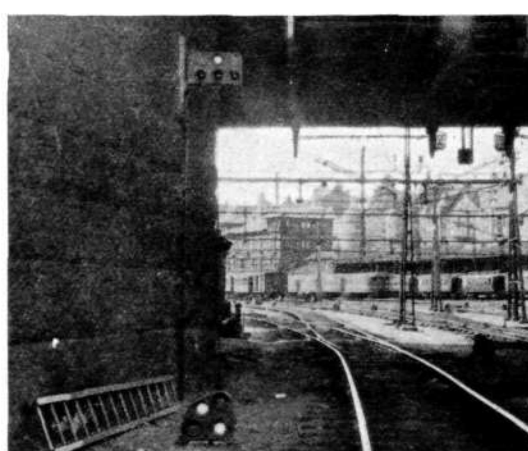
Fig. 30 shows a dwarf signal indicating »stop». Behind this there is a scotch block arrangement with four blocks, which has been arranged in this place since the tracks slope towards the train tracks. A guard rail has been placed in the track so as to prevent the carriages on running off the rails from striking against the adjacent trolley-wire pole.

About 10 m behind the main signal the home dwarf signal may be seen; this signal is provided with a special light at the bottom for green light. Fix green light is shown when the whole entrance road is clear. When only half the train track is clear flashing green light is shown by the dwarf signal while the main signal shows red light. If not even half the track is clear the train will proceed by clear from the dwarf signals only, but the engine driver must then have special permission to do so. This may be obtained from the staff of the signal cabin by means of the signal telephone at the main signal.

The scotch blocks must be turned down before »clear» can be indicated on the dwarf signals of the track circuits where the scotch blocks are placed. In addition the scotch blocks are combined with a separate scotch-block light which shows a black bar on a white background. The slope of the bar indicates that the signal refers only to the track towards which the bar is directed.

Fig. 31 shows a platform signal with indication lights, and some of the dwarf signals which divide the platform tracks of the Western Yard in two parts. With regard to their position on the platforms these dwarf signals have been mounted on poles.

Fig. 32 shows a special signalling device, which shows to which track of the storing groups the points are thrown; this device is necessary as the view is screened by the left abutment of the bridge. The signal shows a white light permanently as well as a yellow light, the position of which in relation to the white light indicates to which track the road leads. Yellow light can be shown only when the dwarf signal further along the track indicates »clear» for shunting.



X 1294 Fig. 32. Shunting signal.

RELIABILITY AND MAINTENANCE COSTS OF THE AUTOMATIC TELEPHONE EXCHANGES IN STOCKHOLM DURING 1933, WITH SUMMARY FOR 1931—1933

By A. **LIGNELL**, Director of Telephones, Stockholm.

In January 1934 the oldest of the Stockholm automatic exchanges, "Norra Vasa" had been in operation for ten years. At the close of 1933 the "Kungsholmen" exchange had been in service for 5 1/2 years, "Centralen" for 5, "Söder" for 2 1/2, "Södra Vasa" for 1 3/4 and "Östermalm" for 3/4 year. As a study of the operation of the exchanges not only for last year but also for longer period of years may be of interest the results of operation are given below both for 1933 and for the period 1931—1933.

The sixth automatic exchange »Östermalm» was put into operation in April last year. It is equipped with bays and multiples for 30 000 lines and with connecting devices for the number of subscribers to be served at the outset, which was 16 600. This switch-over brings more than 100 000 of the 116 000 subscribers' lines of inner Stockholm into connection with the automatic exchanges. The division of these lines among the different exchanges is shown by the table below:

	capacity	number of subscribers December 1933	exchange put into operation
Norra Vasa	10 000	6 589	January 1924
Kungsholmen	27 000	15 731	June 1926
Centralen	20 000	16 000	January 1929
Söder	40 000	25 469	July 1931
Södra Vasa	30 000	20 354	March 1932
Östermalm	30 000	16 813	April 1933
total	157 000	100 956	

The Stockholm area of local traffic comprises 154 000 subscribers with 184 500 instruments.

Reliability.

Table I shows the results of reliability supervision at the above automatic exchanges during 1933.

The supervision is on the calls made by the subscribers —, *i.e.*, on the actual traffic, from the supervisory switchboard of each exchange and comprises all registers of the exchanges. In this way a perfect survey of traffic conditions is obtained. Combined with the cutting in by the supervisory staff when the fault lamps of the registers light up this supervision makes possible effective clearing of the system from faults. Faulty connections in the automatic equipment which would not be apparent otherwise are locked during the supervision and the faults are cleared.

The table shows that of 644 830 calls checked during 1933 there were

97.956 % faultless calls,
1.866 % faulty calls due to subscribers,
0.036 % faulty calls due to operators and,
0.142 % faulty calls due to technical appliances in the automatic or manual exchanges, on subscribers' lines and instruments or due to circumstances unknown.

The average percentage of faultless calls is 97.956 % and ranges at the different exchanges between 98.723 % and 97.097 %. The variation is caused chiefly by the subscribers' part of the percentage. This part, which averages 1.866 %, is least, 1.008 %, for the »Centralen» exchange which carries the heaviest traffic composed chiefly of business telephones, and highest 2.639 %, for »Kungsholmen» which is chiefly concerned with private telephones.

The average of »engaged» for all exchanges was 9.143 %, the variation for the different exchanges being between 9.660 % and 8.691 %.

The average percentage of no reply was 7.502 % ranging from 8.782 % to 6.938 %. This comparatively high percentage is due to the great number of private telephones serving all social classes.

The percentage of lost calls due to technical faults which were traced is 0.065 %, of which 0.050 % were traced to the exchange where the supervision was operating, 0.012 % to other exchanges and 0.003 % to subscribers' lines. Of the 0.077 % of lost calls due to unlocated faults the greatest part occurred outside the automatic equipment in junctions to manual exchanges and departments. Faults in these junctions are as a rule difficult to locate and may in some cases be due to faults by operators in call display positions.

The percentage of lost calls due to technical faults in the automatic equipment, equipment in manual exchanges or faults on subscribers' lines or instruments or due to circumstances unknown was for 1933, at

Söder	0.068 %
Södra Vasa	0.070 %
Norra Vasa	0.101 %
Östermalm	0.126 %
Kungsholmen	0.218 %
Centralen	0.254 %,

or an average of 0.142 % for all exchanges.

The higher percentage of lost calls due to these circumstances at »Centralen» than at the other exchanges — even though it is but small one — is caused by the fact that this exchange has more traffic with manual exchanges and departments than the other exchanges and that the traffic intensity is much higher at this exchange.

From Table II it will be seen that the number of faults decreases as the purely automatic traffic increases.

In view of the fact that in the Ericsson automatic system no calls are lost on account of insufficient number of connecting devices or junctions during busy hours — this only tends to hold up the connections a little — it is evident that the percentage of calls lost on account of technical faults in this automatic system is not as high as for other automatic systems calculating only those due to unsufficient connecting facilities. The reliability of the system is consequently good.

The importance of traffic supervision not only for analyzing the character of the traffic but also for ensuring effective maintenance is demonstrated by the fact that in 1933, with continuous traffic supervision and with the supervisory staff cutting in on calls when fault lamps of registers glow, 2 531 faults were blocked and cleared. This represents 31 % of the 8 175 faults cleared during the year in the automatic equipment of all six exchanges.

Table II gives a summary of the results of traffic supervision at the existing exchanges for the years 1931—1933.

Table I. **Reliability control statistics at the automatic exchanges during 1933.**

exchange		total number of checked calls	faultless						faults by subscriber	faults by operator	faults in the technical equipment located to				faults not located	total
			calls put through	number changed, vacant or cut off	no reply	engaged	total				own exchange	other exchange	lines	total		
Norra Vasa		89 081	72 755	576	6 223	7 742	87 296		1 655	40	33	8	6	47	43	90
	%		81.673	0.646	6.986	8.691	97.996		1.858	0.045	0.037	0.009	0.007	0.053	0.048	0.101
Kungsholmen ..		105 345	82 260	600	9 251	10 176	102 287		2 780	48	102	24	2	128	102	230
	%		78.086	0.569	8.782	9.660	97.097		2.639	0.046	0.097	0.022	0.002	0.121	0.097	0.218
Centralen		123 425	101 396	718	8.700	11 035	121 849		1 244	19	87	9	2	98	215	313
	%		82.152	0.582	7.049	8.940	98.723		1.008	0.015	0.071	0.007	0.002	0.080	0.174	0.254
Söder..........		152 252	123 356	988	10 563	14 434	149 341		2 724	83	51	8	3	62	42	104
	%		81.021	0.649	6.938	9.480	98.088		1.789	0.055	0.034	0.005	0.002	0.041	0.027	0.068
Södra Vasa		76 927	61 745	543	5 969	7 051	75 308		1 546	19	24	4	1	29	25	54
	%		80.264	0.706	7.759	9.166	97.895		2.010	0.025	0.031	0.005	0.002	0.038	0.032	0.070
Östermalm...... (put into operation March 1, 1933)		97 800	78 702	677	7 669	8 519	95 567		2 088	22	25	20	7	52	71	123
	%		80.472	0.692	7.843	8.710	97.717		2.135	0.022	0.026	0.020	0.007	0.053	0.073	0.126
Total..........		644 830	520 214	4 102	48 375	58 957	631 648		12 037	231	322	73	21	416	498	914
	%		80.675	0.636	7.502	9.143	97.956		1.866	0.036	0.050	0.012	0.003	0.065	0.077	0.142

Of 1 320 699 checked calls registered during these three years the average was

97.341 % faultless calls,
2.429 % faulty calls due to subscribers,
0.037 % faulty calls due to operators,
0.193 % faulty calls due to technical arrangements in automatic or manual exchanges, on subscribers' lines and instruments or due to circumstances unknown.

The percentage of faultless calls increased from 96.355 % in 1931 to 97.956 % in 1933, and in the same period the percentage of faults caused by the subscribers decreased from 3.323 % to 1.866 %.

The number of faults caused by the operators remained nearly constant.

The number of lost calls due to technical equipment and unknown circumstances on the other hand decreased from 0.281 to 0.142 %.

The number of subscribers connected to automatic exchanges was

year	number of subscribers	number of exchanges	lost calls %
1931	63 556	4	0.281
1932	84 908	5	0.221
1933	100 956	6	0.142

It is apparent therefore that the very small percentage of lost calls due to faults in the technical equipment and unknown circumstances became still smaller as automatization proceeded.

It might be supposed that the reliability of an exchange that has been in service for several years would show a falling off but that this is not the case with the Ericsson system is proved conclusively by Table III which gives the results of supervision at the oldest automatic exchange of Stockholm, »Norra Vasa», which had been in service for ten years in January 1934.

Of 228 246 checked calls during the years 1931—1933 there were

97.216 % faultless calls,
2.630 % faulty calls due to subscribers,
0.043 % faulty calls due to operators,
0.111 % faulty calls due to technical equipment in automatic or manual exchanges, on subscribers' lines and instruments or due to circumstances unknown.

The percentage of faultless calls increased from 96.373 % in 1931 to 97.996 % in 1933. In the same period the percentage of faults caused by subscribers decreased from 3.444 % to 1.858 %. The number of faults caused by operators showed only small variation while the number of lost

Table II. **Reliability control statistics at the automatic exchanges during 1931—1933.**

year	total number of checked calls	faultless: calls put through	faultless: number changed, vacant or cut off	faultless: no reply	faultless: engaged	faultless: total	faults by subscriber	faults by operator	faults in the technical equipment located to: own exchange	other exchange	lines	total	faults not located	total
1931........... (4 automatic exchanges with 63 556 subscribers)	241 466	190 078	1 113	20 568	20 906	232 665	8 024	99	247	55	14	316	362	678
%		78.718	0.461	8.518	8.658	96.355	3.323	0.041	0.102	0.023	0.006	0.131	0.150	0.281
1932........... (5 automatic exchanges with 84 908 subscribers)	434 403	345 113	2 720	35 231	38 207	421 271	12 019	152	334	90	16	440	521	961
%		79.446	0.626	8.111	8.795	96.977	2.767	0.035	0.077	0.021	0.003	0.101	0.120	0.221
1933........... (6 automatic exchanges with 100 956 subscribers)	644 830	520 214	4 102	48 375	58 957	631 648	12 037	231	322	73	21	416	498	914
%		80.675	0.636	7.502	9.143	97.956	1.866	0.036	0.050	0.012	0.003	0.065	0.077	0.142
1931—1933 Total	1 320 699	1 055 405	7 935	104 174	118 070	1 285 584	32 080	482	903	218	51	1 172	1 381	2 553
%		79.913	0.601	7.888	8.939	97.341	2.429	0.037	0.068	0.017	0.004	0.089	0.104	0.193

calls due to faults in the technical equipment or unknown circumstances decreased from 0.132 % in 1931 to 0.101 % in 1933. The comparatively high percentage of lost calls due to subscribers is mainly because the greater part of the telephones connected to this exchange are private telephones.

After ten years' service the operation of the exchange is excellent and every bit as good as at the other exchanges.

In »Technical Reports from the Royal Board of Telegraphs» No 1—2, 1934, the result of reliability supervision at the Gothenburg telephone exchanges is published for the period 1/8—30/11 1933. The Gothenburg exchanges are also built on the Ericsson system with 500-line selectors having five-digit numbers while for the Stockholm Exchanges the numbers have 6 digits. The local telephone system at Gothenburg has about 34 700 subscribers divided among automatic exchanges. It might be of interest to compare the results of supervision for Stockholm, with 644 830 calls checked in 1933, and Gothenburg, with 182 009 calls checked in 1933, and these are given in the table below:

	Stockholm	Gothenburg
faultless calls with reply	81.311 %	80.703 %
engaged	9.143 %	11.113 %
no reply	7.502 %	6.783 %
fault by subscriber	1.866 %	1.292 %
fault by operator	0.036 %	—
fault in technical equipment or not located	0.142 %	0.109 %

The difference is very small as regards lost calls due to faults in the technical equipment and unknown circumstances and it is chiefly due to the fact that the Gothenburg local system is almost completely automatized while the Stockholm system has still about 16 000 manual subscribers.

The results gained at Gothenburg are a further evidence of the excellent reliability of the Ericsson system.

Fault Frequency.

In Table IV is given the number of cleared faults in 1933 at the exchanges where the traffic from manual subscribers is carried on by means of key positions, and which consequently are equal as regards technical equipment. In the »Norra Vasa» exchange the calls from manual exchanges were worked over manual B-positions, and it was not until June 1933 that key positions were introduced for this traffic; this exchange has therefore not been included in the comparison tables. However, it may be mentioned that the number of cleared faults during the year in the automatic equipment of »Norra Vasa» was 369, representing 0.26 cleared faults per 10 000 outgoing calls or 1.0 faults per day. The number of faults in exchange equipment outside the automatic system was 254 or 0.7 per day.

For the five exchanges in the table fault frequency for the year was an average of 0.365 cleared faults per 10 000 calls with a total of 213 617 461 calls in the year. The corresponding figure for 1932 was 0.363.

Table III. **Reliability control at the oldest automatic exchange of Stockholm, »Norra Vasa» (put into operation in January 1924) during 1931—1933**

year	total number of checked calls	faultless					faults by subscriber	faults by operator	faults in the technical equipment located to				faults not located	total
		calls put through	number changed, vacant or cut off	no reply	engaged	total			own exchange	other exchange	lines	total		
1931	62 834	49 707	303	5 125	5 420	60 555	2 164	32	36	10	3	49	34	83
%		79.109	0.482	8.156	8.626	96.373	3.444	0.051	0.057	0.016	0.005	0.078	0.054	0.132
1932	76 331	61 503	493	5 755	6 289	74 040	2 185	25	20	15	6	41	40	81
%		80.574	0.646	7.540	8.239	96 999	2.862	0.033	0.026	0.020	0.008	0.054	0.052	0.106
1933	89 081	72 755	576	6 223	7 742	87 296	1 655	40	33	8	6	47	43	90
%		81.673	0.646	6.986	8.691	97.996	1.858	0.045	0.037	0.009	0.007	0.053	0.048	0.101
Total	228 246	183 965	1 372	17 103	19 451	221 891	6 004	97	89	33	15	137	117	254
%		80.600	0.601	7.493	8.522	97.216	2.630	0.043	0.039	0.014	0.007	0.060	0.051	0.111

Table IV. **Fault statistics during 1933.**

exchange	average number of subscribers' lines	number of outgoing calls during the year	number of faults repaired during the year: in the automatic equipment: total	per 10 000 outgoing calls	per connected subscriber's line	per day	in exchanges outside the automatic equipment: total	per connected subscriber's line	per day	number of calls: per subscriber per weekday 8 a.m.—9 p.m.: max.	min.	per subscriber per busy hour: max.	min.	the exchange was put in operation in
Centralen ..	16 083	74 284 443	2 906	0.39	0. 8	8.0	687	0.04	1.9	15.5	11.3	2.29	1.82	Jan. 1929
Kungsholmen	15 437	28 363 718	1 052	0.37	0.07	2.9	733	0.05	2.0	5.8	4.2	0.80	0.60	June 1928
Söder	25 594	46 786 226	1 484	0.32	0.06	4.1	764	0.03	2.1	5.7	4.4	0.70	0.58	July 1931
Södra Vasa..	20 072	35 001 584	1 262	0.36	0.06	3.5	488	0.02	1.3	5.4	4.0	0.78	0.52	March 1932
Östermalm .. (1/4—31/12 1933)	16 629	29 181 490	1 102	0.38	0.07	4.0	600	0.04	2.2	7.6	4.9	1.04	0.73	March 1933
Total and average	93 815	213 617 461	7 806	0.365			3 272							

Table V. **Fault statistics during 1931—1933.**

exchange and year	average number of subscribers' lines	number of outgoing calls during the year	number of faults repaired during the year: in the automatic equipment: total	per 10 000 outgoing calls	per connected subscriber's line	per day	in exchanges outside the automatic equipment: total	per connected subscriber's line	per day
Centralen									
1931	14 944	51 872 910	1 579	0.30	0.11	4.3	1 568	0.10	4.3
1932	16 495	68 719 323	1 979	0.29	0.12	5.4	865	0.05	2.4
1933	160 83	74 284 443	2 906	0.39	0.18	8.0	687	0.04	1.9
Kungsholmen									
1931	12 834	23 325 540	947	0.41	0.07	2.6	729	0.06	2.0
1932	14 576	26 830 717	1 156	0.43	0.08	3.2	498	0.03	1.4
1933	15 437	28 363 718	1 052	0.37	0.07	2.9	733	0.05	2.0
Söder									
1932	25 911	47 450 109	1 960	0.41	0.08	5.4	872	0.03	2.4
1933	25 594	46 786 226	1 484	0.32	0.06	4.1	764	0.03	2.1
Södra Vasa									
1/4—31/12 1932	19 719	26 014 350	701	0.27	0.04	2.6	564	0.03	2.1
1933	20 072	35 001 584	1 262	0.36	0.06	3.5	488	0.02	1.3
Östermalm									
1/4—31/12 1933	16 629	29 181 490	1 102	0.38	0.07	4.0	600	0.04	2.2
Total and average		457 830 410	16 128	0.352					

For the four exchanges which were in service all the year the number of cleared faults per 1 000 subscribers' number was

	1933	1932
in the automatic system	86.9	89.4
in exchange equipment outside the automatic system	34.6	39.2

The average percentage of cleared faults per day for 77 186 subscribers connected was:

in the automatic system	18.4,
in exchange equipment outside the automatic system	7.3.

Table V shows the fault frequency at all exchanges for the year 1931—1933. With 457 830 410 outgoing calls the fault frequency for the 3 years per 10 000 calls was 0.352 or 35.2 cleared faults per million calls. The increased number of faults for the »Centralen» exchange which carries the heaviest traffic was due to the great increase in traffic during the 3 years and the increased number of connection devices that was found necessary. The increase in the number of cleared faults in this exchange from 30 to 39 per million calls requires no comment. Nor does the variation in fault frequency at the other exchanges.

The small number of cleared faults during these 3 years and the extremely good reliability are conclusive evidence of the excellence of the automatic system.

Maintenance.

Table VI gives the numbers of the maintenance staff, the number of working hours and the cost for wages and material in 1933 for the exchanges where comparison is possible. The service comprised not only work in the selector rooms but also work at the main distribution frames, fault office and power plants as well as the cleaning of the exchange premises. The maintenance staff consisted of 68 persons for 4 exchanges with 77 186 subscribers or an average of 0.88 persons per 1 000 subscribers per year (0.65 male plus 0.23 female workers) ranging between 1.12 persons at the »Centralen» exchange which carried the heaviest traffic to 0.74 persons for the »Söder» exchange. The average number of working hours per subscriber per year was 2.09 and the maintenance cost per subscriber per year Sw. Kr. 3: 09 of which Sw. Kr. 2: 99 was for wages and Sw. Kr. 0: 10 for material.

The maintenance cost per 100 calls for the 5 exchanges averaged Sw. Kr. 0: 132. The cost of traffic supervision during the year was Sw. Kr. 0: 020 per 100 calls. If supervision be reckoned as part of the maintenance cost, the latter will be increased to Sw. Kr. 0: 152 per 100 outgoing calls, against Sw. Kr. 0: 161 in 1932.

Table VII shows the number of staff and maintenance cost at each of the exchanges during the

Table VI. **Maintenance cost statistics during 1933.**

exchange	average of subscribers' lines	cost of labour including night service, holidays and sick leave				cost of material		total maintenance cost	average per connected subscriber's line and year						
		number of staff		working hours	Sw. Kr.	in the autom. exchange Sw. Kr.	outside the autom. exchange Sw. Kr.		number of staff	working hours	cost of labour Sw. Kr.	cost of material		total maintenance cost Sw. Kr.	maintenance cost per 100 calls
		male	female									in the aut. exch. Sw. Kr.	outside the aut. exch. Sw. Kr.		
Centralen . . .	16 083	13	5	41 750	62 322: —	1 004: —	2 010: —	65 336: —	0.00112	2.60	3: 88	0: 06	0: 13	4: 07	0: 088
Kungsholmen	15 437	11	4	34 297	50 055: —	808: —	678: —	51 541: —	0.00097	2.22	3: 25	0: 05	0: 04	3: 34	0: 182
Söder	25 594	14	5	46 931	65 255: —	861: —	1 238: —	67 354: —	0.00074	1.84	2: 54	0: 03	0: 05	2: 62	0: 144
Södra Vasa . .	20 072	12	4	38 323	53 106: —	233: —	927: —	54 266: —	0.00079	1.91	2: 65	0: 01	0: 04	2: 70	0: 155
Total and average	77 186	50	18	161 301	230 738: —	2 906: —	4 853: —	238 497: —	0.00088	2.09	2: 99	0: 04	0: 06	3: 09	0: 129
Östermalm . . ($^1/_4$—$^{31}/_{12}$ 1933)	16 629	13	4	27 359	42 919: —	436: —	550: —	43 905: —	0.00102	1.65	2: 58	0: 03	0: 03	2: 64	0: 150

period 1931—1933. The number of staff remained unchanged except at the »Kungsholmen» exchange, where an addition of 2 603 subscribers necessitated an increase of staff by 2 male fitters in 1933 and for »Södra Vasa» where the 2 female workers were added making the number 4.

During the 3 year period the average for all exchanges was

number of working hours per subscriber per year	2.16
wages per subscriber per year	Sw. Kr. 3:14
maintenance cost per subscriber per year .... (wages and material)	Sw. Kr. 3:41
maintenance cost per 100 calls	Sw. Kr. 0:141

If the average cost of supervision for 1933, Sw. Kr. 0: 020 per 100 calls, which might be taken as the average, be added the total cost for maintenance will be Sw. Kr. 0: 161 per 100 outgoing calls.

Power Consumption.

The power consumption for driving machines and battery charging was in 1933

exchange	kWh per subscriber			cost per subscriber Sw. Kr.
	driving machines 220 V	battery charging 48 V	total	
Centralen ...	1.52	—[1]	—[1]	—[1]
Kungsholmen	1.17	2.56	3.73	0:222
Söder	0.75	2.24	2.99	0:174
Södra Vasa...	0.73	1.67	2.40	0:143
Östermalm $^1/_4$—$^{31}/_{12}$ 1933	0.89	2.37	3.26	0:190

[1] At the »Centralen» exchange the same battery is also used for the long distance and the rural exchanges housed in the same building.

The results of operation at the Stockholm automatic exchanges during 1933 demonstrate that the Ericsson automatic system possesses

extremely high reliability,
remarkably low number of faults,
very small maintenance cost,
insignificant power consumption,

i.e. the same good properties that it was expected to show when first installed in Stockholm in 1924.

Table VII. **Maintenance cost statistics during 1931—1933.**

exchange and year	average number of subscribers' lines	cost of labour including night service, holidays and sick leave				cost of material		total maintenance cost Sw. Kr.	average per connected subscribers' line and year					
		number of staff		working hours	Sw. Kr.	in the autom. exch. Sw. Kr.	outside the autom. exch. Sw. Kr.		number of staff	working hours	cost of labour Sw. Kr.	cost of material		total maintenance cost Sw. Kr.
		male	female									in the autom. exch. Sw. Kr.	outside the aut. exch. Sw. Kr.	
Centralen														
1931	14 944	13	5	42 122	63 589: —	5 435: —	8 789: —	77 813: —	0,00120	2,82	4: 25	0: 36	0: 59	5: 20
1932	16 495	13	5	41 602	63 630: —	3 285: —	5 096: —	72 011: —	0,00109	2,52	3: 86	0: 20	0: 31	4: 37
1933	16 083	13	5	41 750	62 322: —	1 004: —	2 010: —	65 336: —	0,00112	2,60	3: 88	0: 06	0: 13	4: 07
Kungsholmen														
1931	12 834	9	4	29 828	45 042: —	2 342: —	1 300: —	48 684: —	0,00101	2,32	3: 51	0: 18	0: 10	3: 79
1932	14 576	9	4	30 293	46 961: —	1 663: —	1 756: —	50 380: —	0,00089	2,08	3: 22	0: 11	0: 12	3: 45
1933	15 437	11	4	34 297	50 055: —	808: —	678: —	51 541: —	0,00097	2,22	3: 25	0: 05	0: 04	3: 34
Söder														
1932	25 911	14	5	46 942	66 689: —	1 765: —	5 934: —	74 388: —	0,00073	1,81	2: 57	0: 07	0: 23	2: 87
1933	25 594	14	5	46 931	65 255: —	861: —	1 238: —	67 354: —	0,00074	1,84	2: 54	0: 03	0: 05	2: 62
Södra Vasa $^1/_4$—$^{31}/_{12}$														
1932	19 719	12	2	26 458	39 572: —	1 133: —	1 080: —	41 785: —	0,00071	1,34	2: 00	0: 06	0: 05	2: 12
1933	20 072	12	4	38 323	53 106: —	233: —	927: —	54 266: —	0,00079	1,91	2: 65	0: 01	0: 04	2: 70
Östermalm $^1/_4$—$^{31}/_{12}$														
1933	16 629	13	4	27 359	42 919: —	436: —	550: —	43 905: —	0,00102	1,65	2: 58	0: 03	0: 03	2: 64

INDUSTRY NEEDS TIME CONTROL

By Å. N. BELFRAGE,
Ericsson Sales Company,
Stockholm.

When in the beginning of the 20th century the first mechanical time recorders were introduced for checking the times at which employees began and ended their work the novelty was regarded with a certain amount of scepticism. It was believed that such apparatus — particularly on account of opposition from the workers — would not be commonly adopted. The use of staff control apparatus is, however, spreading steadily, and for many reasons it is now appreciated by both employers and employees. Ericsson recorders have been installed by more than 300 firms, which constitutes sufficient proof of the great value of time control and of the reliability of the Ericsson system. In the present article the operating and economic conditions of the electric time-control system will be presented.

The new system of mechanical time control has come to replace three previously in use for staff control, *viz.:*

booking-in system: the doorkeeper or the foreman had a list of employees and checked them as they passed the gate or arrived at the place of work. Note was taken of how late a person was in arriving or how long before finishing time he left.

the check system: in this system each person had a numbered badge or check which hung in a cupboard near the entrance. Each employee arriving took his check from the cupboard and put it through the slot of a locked box.

When it was time for work to start the doorkeeper noted the numbers of the checks remaining in the cupboard and reported them to the pay-office. When an employee arrived after time he had to show his check to the foreman, who noted the late arrival;

the lock-out system: this system simply consisted in closing the gate at the starting time. The

X 1304

worker who arrived after the gate was closed had to pass through the pay-office where his late arrival was noted.

With this system the foreman had to return each day a list of hands at work.

Disadvantages of Imperfect Time Control.

The above three manual methods of time control, however, had several disadvantages, *i.e.:*

suspicion and disagreement: it is evident that these uncertain control methods gave rise to accusations, perhaps often unfounded, but in any case troublesome, of favouritism against doorkeepers and foreman. They had no way of proving that the timekeeping had been carried out in an impartial and just manner.

office faults in checking: the old systems required large numbers of hand-written reports which often gave rise to faults in checking at the office;

no moral spur of punctuality: such unreliable systems as described above were little spur to the conscentious workers and did not tend to speed up the slow ones.

The Mechanical Time-recording System.

Aquaintance with the above-mentioned facts caused the introduction of individual mechanical time recording, and at present this modern form of check is considered indispensable in all industrial enterprises, great and small. Even employers not engaged in industry have come to understand the advantages of rational staff control, and the market for time-control apparatus is steadily widening. Stores, great offices, schools, state and municipal institutions etc. are beginning to adopt such apparatus.

The points below indicate the value of the mechanical time-control system.

It serves the employer because:

it saves time by creating punctuality,

it reduces the work of the office,

it increases the capacity of each worker,

it leaves the foremen free to devote themselves to other important things,

it eliminates disputes regarding the wages,

it creates discipline by means of punctuality,

it saves money by saving time,

it increases profit by decreasing expenditure.

It serves the worker because:

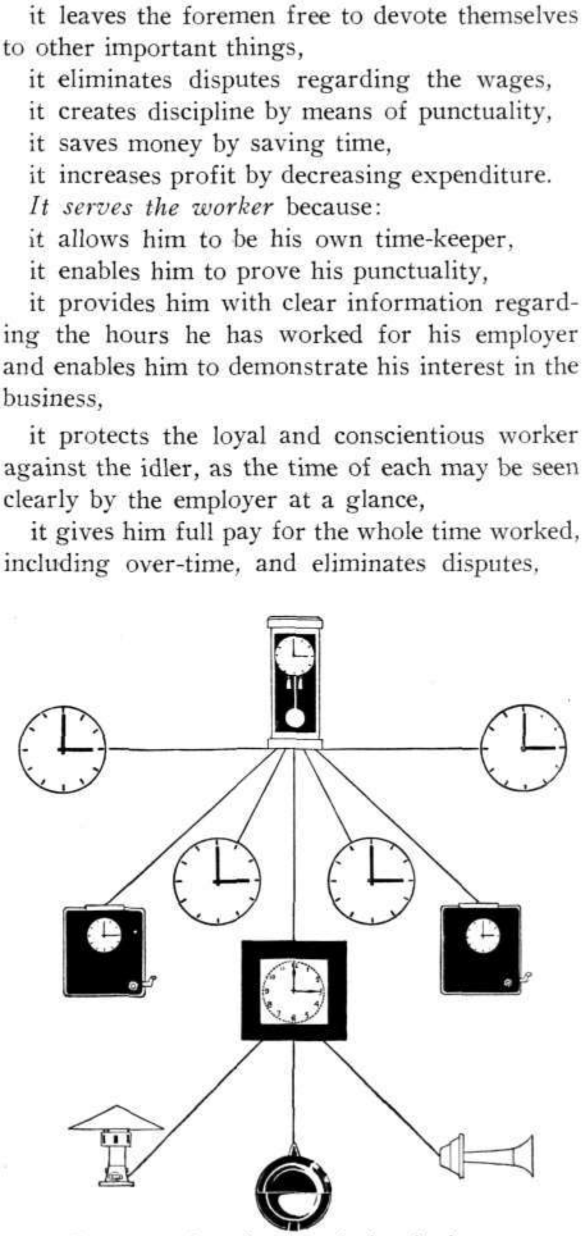
it allows him to be his own time-keeper,

it enables him to prove his punctuality,

it provides him with clear information regarding the hours he has worked for his employer and enables him to demonstrate his interest in the business,

it protects the loyal and conscientious worker against the idler, as the time of each may be seen clearly by the employer at a glance,

it gives him full pay for the whole time worked, including over-time, and eliminates disputes,



X 1302 **Diagram of medium-sized electric time — control plant.**

it reduces the risk of mistakes in calculating wages,

it creates a certain confidence between him and his employer,

it teaches him the value of punctuality,

it is a guarantee of justice for him because his time records are stamped mechanically and impartially.

The first type of time control apparatus was driven by clockwork and pendulum. However, it was found that these old instruments could be cheated without too much difficulty so that careful supervision was necessary. In addition there was considerable expense and trouble in getting several clockwork-driven time recorders in one building to indicate uniform time.

For these reasons Ericsson some years ago put an electric time-control system on the market.

The Electric Time-Control System.

One of the advantages of an electric system is that the most delicate part, *i.e.*, the clock-movement, is not placed in the time recorder itself but may be located at the most convenient spot, independent of the position of the time recorder. The design of this controlling instrument varies with the size of the plant.

In small plants, consisting of, *i.e.*, one or two recorders, the master clock as well as the recorders may be connected direct to the mains.

In large plants a separate battery is used for transferring the impulses from the master clock to the secondary instruments.

The secondary instruments consist of time recorders, secondary clocks, signalling secondary clocks, etc. In the secondary instruments there is no clockwork but only electro-magnetic impulse receivers of sturdy construction, which are operated by the impulses transmitted from the master clock.

The Ericsson electric time-control system has many advantages, of which those mentioned below are the most important:

uniform time is ensured, as the secondary instruments of the system are operated *simultaneously* by each impulse;

correct time will always be assured, as all the secondary instruments follow the accurately adjusted master clock, and no complicated time adjusting device is required;

reliable running, as the mechanism of the secondary instruments is simple and functions regularly, without being affected by dust, moisture, change of temperature etc.;

small maintenance cost, as the secondary instruments require little supervision;

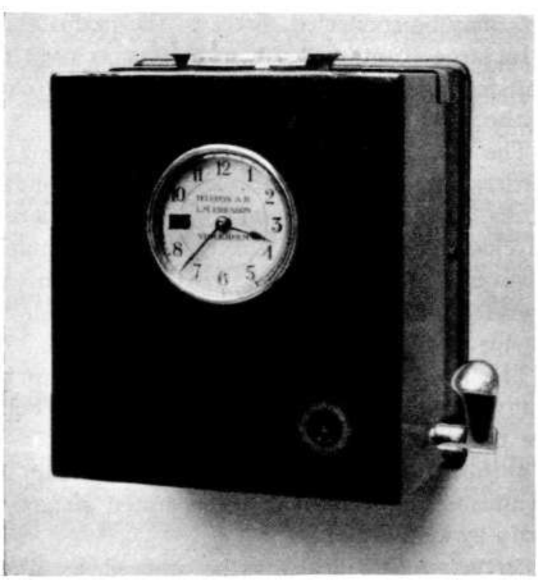
the secondary instruments are practical in construction; the mechanisms require little space as compared with time recorders and clocks driven by clockwork.

Even for an industrial enterprise which at the start may need one time recorder only the advantages are obvious. In addition it should be observed that a plant of this kind may be extended without alterations to the system originally installed. On account of this all instruments of a plant which has been extended by stages will automatically indicate uniform time.

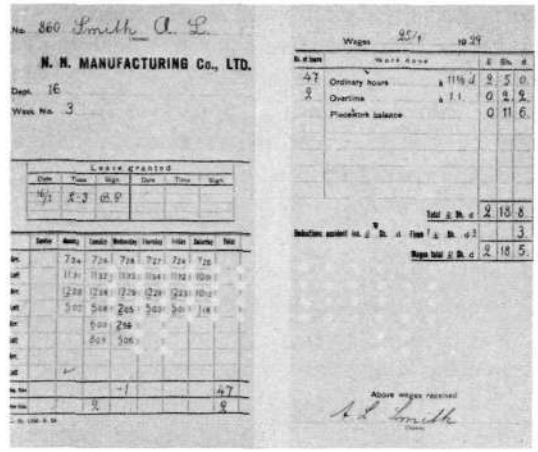
The Automatic Time Recorder.

Ericsson has designed an entirely special type of instrument, which provides the solution of several problems, automatic card adjustment being perhaps the most important. This detail alone is of such great advantage as to render these instruments practically beyond competition.

On tests made under working conditions it has been proved that the greatest number of recordings in one minute can be carried out with the Ericsson time recorders, because



X 1305 **Electric time recorder, Type KC 100.**



No. 860 Smith A. L.

N. N. MANUFACTURING Co., LTD.

Dept. 16

Week No. 3

Leave granted

Wages 25/1 1929

Ordinary hours 47 — 2 5 0.

Overtime 2 — 0 2 2.

Piecework balance — 0 11 6.

Total £ Sh. d. 2 18 8.

3.

Wages total £ Sh. d. 2 18 5.

Above wages received

A L Smith

X 1303 **Time-control card, front and back.**

no manual movement of the card holder is required,

the printing is carried out on the front of the card,

the handle is placed in the most convenient position,

the printing ribbon is shifted automatically without manual aid.

The advantages of the Ericsson time recorders may be summed up as follows:

perfectly automatic card adjustment, by which:

an »out» stamping may be made immediately after an »in» stamping without any special manual operation,

intentional or unintentional faulty stamping is impossible,

no supervision is needed even for departure or over-time stamping;

the recordings of one day appear in a vertical column, which ensures

simple and clear checking of the cards,

easy calculation of wages,

space for a sufficient number of stampings per day;

late arrivals, early departures and over-time are recorded in red;

the shifting of the stamping ribbon for the different working times is carried out automatically for all days of the week, including saturdays when the working hours are ususally different from other days;

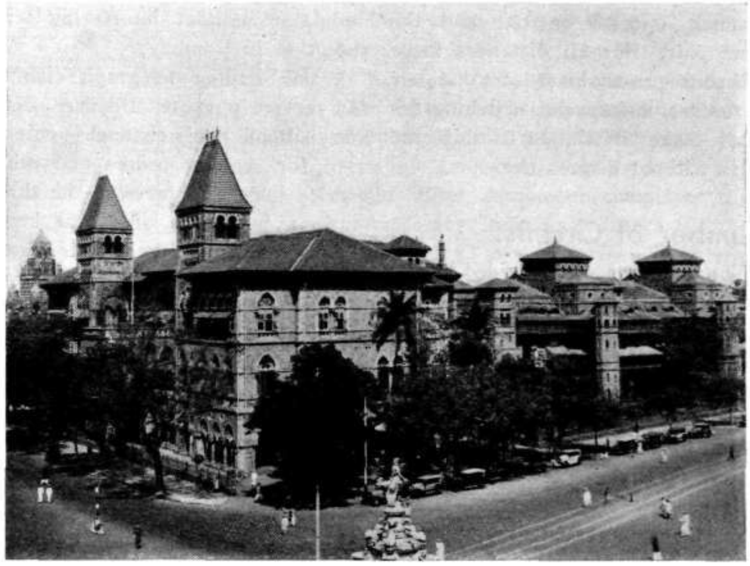
convenient and logical adjustment of the cards; the stamping being made on the front of the cards;

absolutely correct time is stamped on the card.

The Bombay–Kirkee–Dhond Carrier System

A carrier system supplied by Ericsson to The Indian Radio & Cable Communications Co., Ltd. was installed last year in British India. The purpose of the system is to put the Central Telegraph Office in Bombay in direct connection with the radio transmitters at Kirkee and with the radio receivers at Dhond.

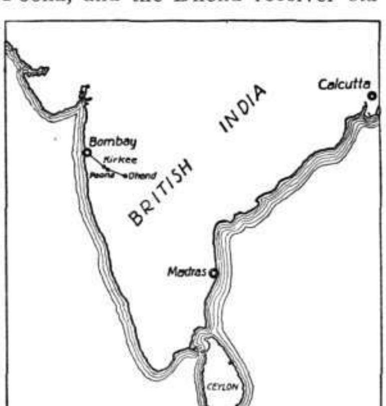
The peculiar operating conditions of this plant bring out particularly the great adaptability of the Ericsson carrier systems.



X 5116 **The Central Telegraph Office in Bombay.**

Telegraph and telephone communication between British India and the rest of the world is chiefly mangaged by The Indian Radio & Cable Communications Co., Ltd. (IRCC), an Indian company with its head office at Bombay. This company, which was established a few years ago, took over both the radio communication previously managed by The Indian Radio Co. and the cable communication previously controlled by The Eastern Cable Co.

Radio traffic is directed over the Kirkee transmitter station, near Poona, and the Dhond receiver station; as may be seen from the map, Fig. 1, these places are situated in the Deccan on the Bombay—Madras railway and are distant from Bombay about 200 and 275 km respectively.



X 3206 **Fig. 1. Map of India.**

As regards the radio traffic Kirkee is the central station, and the connection to the Indian long-distance telephone system is made over the adjacent telephone station at Poona. The central station for the telegraph traffic on the other hand is situated at Bombay, and both the transmission and reception of the telegrams are handled there.

Consequently a comparatively large number of circuits is required between the three stations Bombay, Kirkee and Dhond, not only for the traffic proper but also for internal purposes. The cost of physical circuits is however great both in respect of installation and maintenance, the country between Bombay and Kirkee being mostly covered by jungle. When the first radio telegraph system for the communication with England was built a carrier system was used, operating over telephone lines belonging to The Indian Telegraph Department, *i. e.*, the State. This carrier system, which was the first in India, was supplied by Marconi Wireless Telegraph Company and answered its purpose in an excellent manner.

In recent years new radio communications have however been built and planned, and, consequently, it became necessary to replace the old carrier system by a new one, capable of providing a greater number of simultaneous channels. Ericsson were entrusted with this work.

Lines Available.

The physical circuits available were one quad Kirkee—Dhond and one quad Bombay—Poona belonging to the Indian Telegraph Department. By agreement with the state the IRCC are allowed to utilize the quad Kirkee—Dhond and the frequency range above 3 000 c/s on the Bombay—Poona lines, which for this purpose have been connected to the Kirkee station between Bombay and Poona. Both the physical circuits and the phantom circuit are on the other hand used for ordinary long-distance telephony between the state's telephone stations in Bombay and Poona. The voice frequency channels on the lines between Kirkee and Dhond are also used for other telephone purposes.

It is of course necessary to provide reserve lines for such a great number of important circuits as in this case, as line faults may occur rather frequently. The carrier system has therefore been built so that all necessary telephone and telegraph channels operate on one and the same pair. For all distances there will consequently be at least one pair in reserve, and special switching devices make it simple to shift the pairs without disturbance.

Number of Circuits.

The circuits to be provided by the carrier system are as follows:

1. single-direction telegraph channels for telegraph speeds of more than 200 words per minute, from the machine transmitters in the central station in Bombay to the radio transmitters in Kirkee. The number of such channels is at present 3, but they can be increased to 5;

2. the corresponding telegraph channels for the reverse direction, *i. e.* from the radio receivers at Dhond to the undulators in the Bombay central station. These channels also at present number 3, eventually 5, and operate with the same high speed as the channels for the outgoing traffic.

The technical management of the traffic being located at Kirkee, it is necessary to be able to supervise also the reception at this station. Check receivers have therefore been provided at Kirkee for the carrier channels between Bombay and Dhond, so that, when desired, incoming telegrams may be received at Kirkee as well by means of an undulator without interfering with reception in Bombay;

3. one duplex telegraph channel for service purposes Bombay—Kirkee—Dhond. This channel is chiefly used for sending orders and other service telegrams between the three stations by means of Morse keys;

4. a number of telephone channels that may be used for various purposes. At present one channel between Bombay and Kirkee and one between Kirkee and Dhond have been installed; these channels may be used separately or they may be connected for conversations between Bombay and Dhond. They are chiefly used for service but form also a reserve for the radio telephone traffic.

Future extension by one or a few additional telephone channels on either stretch is possible.

Frequency Allocation.

The carrier system supplied to meet these service conditions is of course of a special design, but in the main it is in accordance with the standard multi-channel system, Type ZM, described in Catalogue 176, »Carrier Systems», and also in a previous article, in the Ericsson Review No 2, 1933.

As in this latter system, the frequencies immediately above the voice frequency range are utilized for telegraphy. On account of the greater number of telegraph channels, 6 in each direction, the telegraph range has been extended to about 12 000 c/s, as compared with 8 000 c/s in the standard system having a maximum of 4 duplex telegraph channels. The principle governing the choice of carrier frequencies and band widths is however the same, *i. e.*, the relation between the frequencies of two adjoining channels is constant, and this is also the case for the corresponding band width, *i. e.*, the relation between the upper cut-off frequencies of the different bands. The table below shows the carrier frequencies and the band widths for the 12 channels, which number represents the final capacity. The six frequencies forming the lower group are used for the channels from Bombay to Kirkee; the six higher frequencies for the channels in the opposite direction Dhond to Kirkee and on to Bombay.

channel	carrier frequency c/s	band width c/s
1	4 600	200
2	4 898	213
3	5 215	228
4	5 553	241
5	5 913	256
6	6 296	273
7	7 138	310
8	7 600	330
9	8 092	352
10	8 616	374
11	9 174	399
12	9 768	424

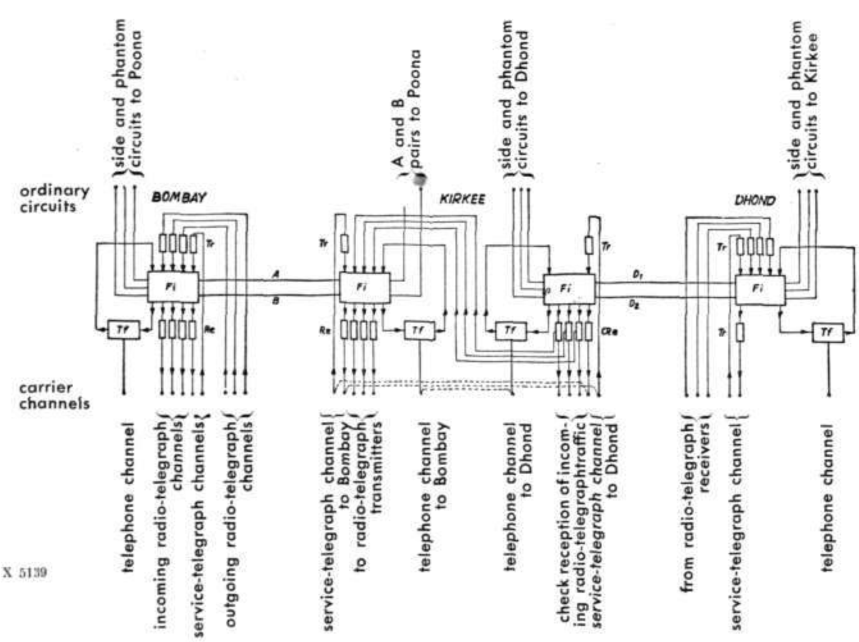
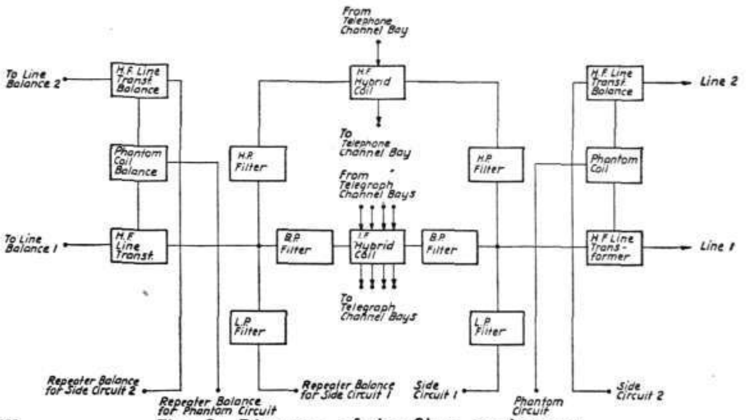


Fig. 2. Diagram of the carrier system.

Tr telegraph channel
CRe check receiver
Re telegraph receiver
Fi filter equipment
Tf telephone-channel bay



X 5126 Fig. 3. Diagram of the filter equipment.

As may be seen from the table the band width varies from 200 c/s for the lowest to 424 c/s for the highest channel. The lowest channel, which is used for service, thus permits of a telegraph speed of about 200 words or 160 Baud; for the upper channels the telegraph speed is not limited by the band width of the filters but by the properties of relays, machine transmitters and undulators.

As in the standard system, the carrier frequencies of the telephone channels are multiples of 5 000 c/s. The lowest carrier frequency of the standard system is however left out on account of the extent of the telegraph range. The same carrier frequencies are used for the two channels installed Bombay—Kirkee and Kirkee—Dhond, *viz.*, 15 000 c/s and 20 000 c/s; 20 000 c/s being used for outgoing speech from Kirkee in both directions and 15 000 c/s for outgoing speech from Bombay and Dhond respectively. For future extensions the frequencies 25 000 and 30 000 c/s, and if required 35 000 and 40 000 c/s also, will be used.

The carrier frequency and the lower side band are transmitted over the line. The band width is 3 000 c/s.

Design.

Fig. 2 shows a simplified diagram of the whole system, which in the first place indicates how the different channels go. In order to make the diagram clear it is necessary to give a more detailed description of the various parts of the equipment used in the system, these being indicated by squares only in the diagram.

Line Filters.

In order to separate in the stations the various kinds of channels transferred over one line, filter equipment is used and this is of the same type as that described in the papers above referred to; a diagram is given in Fig. 3. It comprises low pass filters for the ordinary telephony, band pass filters for the telegraph frequencies 3 000—11 850 c/s and high pass filters for the telephone frequencies. The cross-talk attenuation between the two pairs along the same pole line at times being rather low, low pass filters have been provided also for the other pair which does not carry high frequency, in order to prevent the overhearing of telegraph impulses. Different frequencies are used for the two directions, but differential transformers aid the separation of the two directions from each other, so that less severe requirements have to be made of the band filters of the different channels. In order to facilitate phantoming, special Ericsson high-frequency line transformers are used, which pass the whole frequency range used. Finally the filter equipment comprises the necessary balancing filters for the balancing of two-wire repeaters, which perhaps will be connected to the voice-frequency circuits in Bombay and Kirkee and jack fields for switchings, in the first place for allowing the carrier system to be connected to the one or the other of the pairs of the quad.

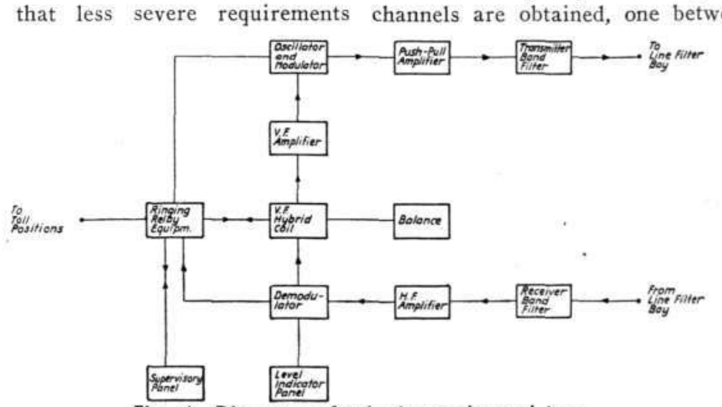
A filter equipment of the above described type has been installed at each of the stations at Bombay and Dhond; at Kirkee there are two equipments, one for the lines to Bombay and one for the line to Dhond.

Telephone Equipment.

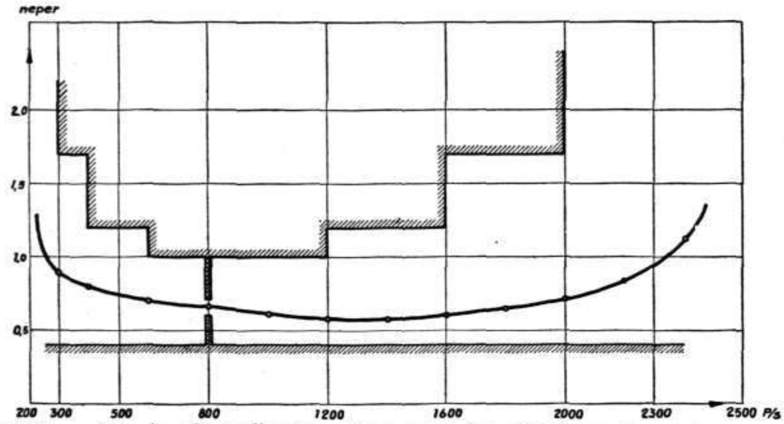
The telephone equipment consists of channel bays corresponding to Type ZM 231, *i. e.*, in general of the Ericsson standard design, and provided with arrangements for level indication, which give acoustic and optic alarm when the overall attenuation varies by more than ± 0.2 neper. A diagram is shown in Fig. 4, while Fig. 5 shows an overall-attenuation curve measured on one of the channels when in service.

The stations at Bombay and Dhond have each one bay of this type with the transmitter frequency 15 000 c/s, and at Kirkee there are two bays with the transmitter frequency 20 000 c/s.

In this way separate telephone channels are obtained, one between



X 5125 Fig. 4. Diagram of telephone-channel bay.



X 5138 **Fig. 5. Overall-attenuation curve for telephone channel Kirkee—Dhond,**
measured on the channel when in service.

Bombay and Kirkee and one between Kirkee and Dhond. These channels may of course be connected on the voice frequence side for through conversations between Bombay and Dhond.

For through conversations between Bombay and Dhond it might be an advantage to carry out a tail-to-tail connection at Kirkee. The carrier telephone channels are in principle four-wire circuits with voice-frequency hybrid coils on the low-frequency side of the terminal stations. If the line and balance sides of these hybrid coils be connected, the additional attenuation of the hybrid coil will be eliminated, and there will be no need for adjustment of the overall attenuation of the channels. With ordinary connection on the line side only an overall attenuation is obtained, which is the sum of the overall attenuation of the two channels, and the gain usually therefore requires to be adjusted.

Finally the hybrid coils, for instance at Dhond and Kirkee, may be excluded and the two single-direction channels thus obtained operated separately. This is the case when the carrier system is used for the rural line Dhond-Kirkee of the radio telephone. As mentioned above, the telephone receiver is situated at Dhond, while the transmitter and the hybrid coil have been installed at Kirkee. Consequently only one single-direction telephone channel is required for this purpose between Dhond and Kirkee.

Telegraph equipment.

The details of the telegraph equipment also correspond in the main to the normal design as shown in the catalogue, but must in this case be joined up in a different manner, the equipment of one duplex-telegraph channel being divided among three stations instead of two.

The above-mentioned channel for telegraph service only may, like the telephone channel, be regarded as composed of two separate complete duplex channels, one between Bombay and Kirkee and the other between Kirkee and Dhond, which are connected on the DC side at Kirkee for through traffic Bombay—Dhond. Of the other channels which are used for the rural lines of the radio telegraph traffic, the ones leading from Bombay are limited to the range Bombay—Kirkee, while the channels in the other direction cover the whole range Dhond—Bombay and this without relay-repeating at Kirkee. It is of course desirable to avoid unnecessary relay repeaters at high telegraph speeds such as are used in this case. On the other hand there are check receivers at Kirkee for these channels, which operate in parallel with receivers in Bombay. The receiver amplifiers of these check receivers act also as intermediate carrier repeaters for the transmission between Dhond and Bombay.

The three stations have therefore been provided with the following telegraph equipment:

At Bombay:
4 transmitters
4 receivers.

One of each kind is used for the service communications and the three others for the outgoing and incoming radio-telegraph traffic.

At Kirkee:
2 transmitters
5 receivers
3 check receivers.

The two transmitters and two of the receivers are used for service communications (one pair each in the direction of Bombay and of Dhond). The three remaining receivers are used for transferring the outgoing radio traffic to the radio transmitters, and the check receivers are for supervising the incoming radio traffic.

At Dhond:
4 transmitters
1 receiver

The receiver and one of the transmitters belong to the service channel, and the remaining three transmitters transfer the incoming radio traffic from the radio receivers to Bombay.

On extension in the future for two additional radio-telegraph channels there will be required 2 transmitters and two receivers at Bombay, 2 receivers and 2 check receivers at Kirkee and 2 transmitters at Dhond.

The design of the transmitters and receivers is in main the same as for standard types, though certain modifications have been made in order to improve the quality of the telegraph code at the high speeds used in some of the channels.

The transmitter is composed of a carrier oscillator with constant frequency, a carrier amplifier, and a transmitter band filter which is connected to the transmitter side of the hybrid coil of the line filter equipment. The modulation with the telegraph dot sequence is carried out by altering the grid bias of the amplifier valve so that the carrier is transmitted during marking and blocked during spacing. The alteration of the grid bias is produced by DC circuits controlled by the Wheatstone machine transmitters in the Bombay telegraph station, by the relays of the radio receivers at Dhond or in the case of the service channels by special telegraph keys or machine transmitters.

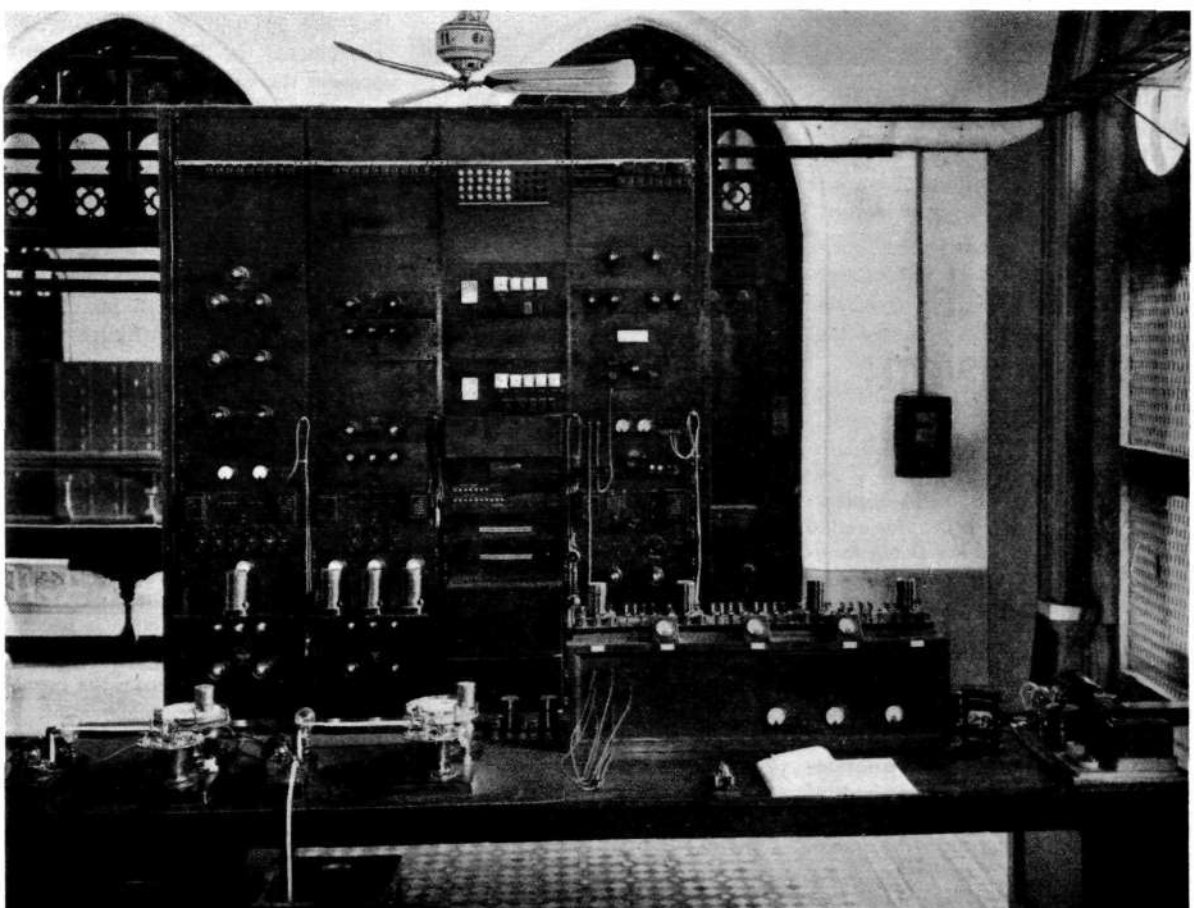
The receiver consists of a receiver band filter connected to the receiver side of the hybrid coil of the line-filter equipment, a carrier amplifier and a detector, which controls the receiver relay. The detector operates with combined anode and grid rectification and consequently it is insensitive to variations of the incoming voltage over a wide range. The receiver relay controls undulators or other telegraph receivers as usual. For the service communication there is also the possibility of receiving by means of loud-speakers, fed from an audio-frequency generator controlled by the receiver relay.

The check receiver at Kirkee differs little from an ordinary receiver. It contains a receiver band filter which is connected to the line filter equipment of the line from Dhond, and a carrier amplifier partly feeding a detector device of the same kind as that of the ordinary receive and partly feeding a transmitter band filter connected to the line-filter equipment of the line to Bombay.

Construction.

The equipment is fitted on bays of the ordinary type. Fig. 6 shows the bays in the Central Telegraph Office at Bombay. The bay to the extreme left is the telephone-channel bay which, in addition to the telephone equipment proper, contains a measuring and supervisory panel, level-indicator panel and current-distribution panel. On the next bay there is the line-filter equipment with the necessary jacks for the switching of the lines and main fuse and alarm panels. The telegraph equipment is placed on the two left bays. The left bay of these two contains the four transmitters, the receiver of the service channel and the audio-frequency generator for audible reception and one measuring panel. The three receivers for the radio traffic are joined on the other bay. As may be seen the receiver relays are fitted on horizontal brackets.

At Kirkee there are 6 bays arranged in two rows, Fig. 7. The front row consists of the line-filter bays with the two telephone-channel bays on either side. In the back row there are the two transmitters and the two receivers of the service telegraph on the central bay, the three receivers for the outgoing radio

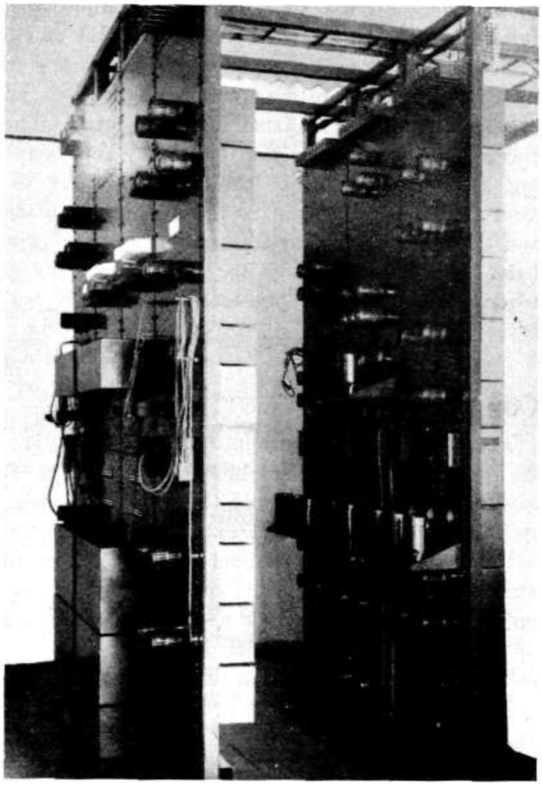


X 7052

Fig. 6. The carrier equipment in Bombay.
Left to right, two telegraph-channel bays, line-filter equipment and telephone-channel bays.

Fig. 7. The carrier equipment in Kirkee.
Front row, between the two telephone-channel bays, the line-filter bays; back row (left to right) telegraph receivers, service-telegraph transmitters and check receivers.

X 1298



traffic on the bay and the three check receivers on the right bay.

At Dhond three bays only are required: one line-filters bay, one telephone-channel bay and one telegraph-channel bay. The latter contains the three transmitters for the incoming radio traffic as well as the transmitter and receiver of the service channel.

The whole system has been manufactured according to tropical specification so as to resist the severe climatic conditions. In Bombay where the climate is worst, owing to high temperature and extreme humidity occurring at the same time, the back of the bays has been built into a small protective cubicle which may be heated during the monsoon period; in the other stations no such arrangements have been considered necessary, humidity not being so high during the major part of the year.

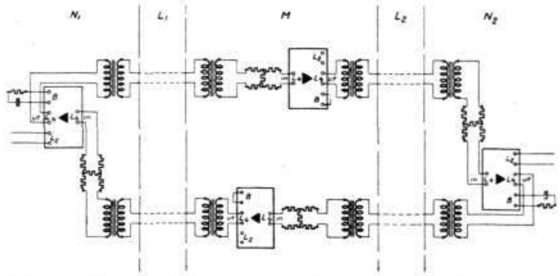
All the stations had previously filament batteries of 8 V and anode batteries of 220 V, intended for the radio equipment and for other purposes. The carrier system has therefore also been designed for these voltages instead of for the usual 24, 220 or 130 V. Blocking arrangements in the battery circuits prevent the various instruments connected to the same battery from disturbing each other.

A. Westling.

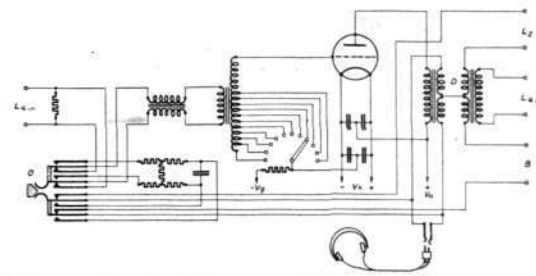
The Dutch Transmission System

Four years ago the application of new principles on the extension of the Dutch long-distance system was commenced. It was partly local conditions that led to the change, but later developments showed that sooner or later the same problems would present themselves in other places also and, consequently, a brief description will be given here of the main principles of the Dutch system and of the special repeaters, audio-frequency signalling equipment and loading coils which have been supplied by Ericsson for the extension of the line system.

Before 1930 development in Holland had proceeded much on the same lines as in other European countries, *i. e.* it had been characterized by loaded and phantomized two-wire and four-wire cables with fix intermediate repeaters and cord repeaters for the through traffic. However, in that year it was decided to undertake extensive automatization of local exchanges and rural line systems and at the same time work was put in hand for covering the road net with pavement, which made it necessary to lay at one time cables that would be sufficient for a long time ahead. The necessity was then realized of arranging a line system that would be more flexible from a traffic point of view, suitable for both great and small distances and easier adaptable from the point of view of connection. In addition it was considered desirable to reduce the cost of the underground system to be built at one time, even if it would involve an increase of station equipment on future extension. Mr. Bast, engineer of the Dutch Board of Telegraphs, then presented the proposition that the system be composed of four-wire circuits with non-loaded subscribers' cables without phantoming and provided with simple single-valve repeaters, which could be connected as intermediate or terminal repeaters should be adopted. Later it became evident that a special light loading was to be preferred from the economical point of view, above all in order to simplify attenuation equalizing. The screening between the four-wire directions is obtained by placing each direction in one cable. The signalling is carried out by means of audio frequency, and the intention is to impulse over the long-distance lines also by means of this type of current.



X 1306 **Fig. 1. Diagram of four-wire circuit.**



X 1307 **Fig. 2. Diagram of the repeater.**

Fig. 1 shows the diagram of such a four-wire circuit according to these principles, consisting of the line sections, L_1 and L_2, terminal repeaters at the terminal stations N_1 and N_2, and intermediate repeaters at the station M. The repeaters operate with practically the same gain, and the attenuation of each line is increased by means of attenuation networks to one and the same value. In this manner a certain uniformity of the long-distance line system is obtained, which is very valuable from the point of view of connection.

Repeater Equipment.

The repeaters are, as mentioned above, single-valve repeaters, the anode transformers of which may be switched so that they serve as four-wire terminal sets when the repeaters are used as terminal repeaters. In the diagram, Fig. 2, this transformer is indicated by D. When the repeater is used as an intermediate repeater the terminals B are short-circuited and L_2 are free; the lines for the incoming and outgoing speech currents are connected to the terminals L_4 *in* and L_4 *ut*. When the repeater serves as a terminal repeater the terminals L_4 *in* and L_4 *ut* are connected to the two lines of the four-wire circuit for incoming and outgoing speech currents, while the terminals L_2 and B are connected to the two-wire line or the compromise balance respectively.

The repeaters are provided with the special device of Ericsson design for gain adjustment, by means of which the gain may be supervised and adjusted with an accuracy of more than 0.015 neper without the use of separate measuring instrument or oscillator. In the main it is of the same construction as the corresponding device of the two-wire repeater, which has been described in the Ericsson Review No 10—12, 1931. The main principle is to switch the repeater valve with its transformer so that it will operate as an oscillator and to adjust the tappings of the input transformer until the valve starts to sing. In this case the measuring frequency is fixed to 1.000 c/s.

Four repeaters are fitted together on one panel as shown in Fig. 3. The potentiometers for gain adjustment are placed in a row below the repeater valves, and to the left there may be seen the keys for the gain supervision and the jacks, in which the singing tone may be heard. Fig. 4 shows some bays in the Zwolle repeater station fitted with 28 repeaters per bay. A recent design permits the number of repeaters in one bay to be raised to 48. In addition to the repeaters the bays are fitted with a jack panel with all the required switching and measuring jacks, alarm relays, compromise balances, fuses, etc. Separate switches are not used, but all repeaters of a station are connected to one of two groups; one group is in operation day and night and the other during the day only. These groups are switched on and off by means of common switches.

Loading-Coil Equipment.

The loading prescribed by the Dutch Board of Telegraphs is a light loading with 155 mH with rather great coil-spacing. With such light loading the attenuation will of course be high, which, however, is of minor importance as the repeaters are not costly. On the other hand the circuits will have a high velocity of propagation so that they will be well suited to be inserted in long international lines.

No abnormal requirements are imposed on the electric properties of the loading coils. An extremely high resistance to moisture is on the contrary required of the loading-coil cases. Fig. 5 shows such a loading coil as delivered by Ericsson.

Audio-Frequency Signalling Equipment.

As mentioned above, signalling is carried out by means of audio frequency. At present current of 500 c/s interrupted by 20 c/s is used, which corresponds to what the CCIF has recommended, but the intention is to change over in the future to pure 500 c/s current so as to make possible impulsing over the long-distance lines. The receivers used must therefore be sufficiently selective to

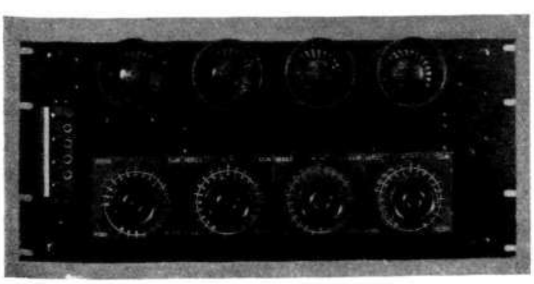


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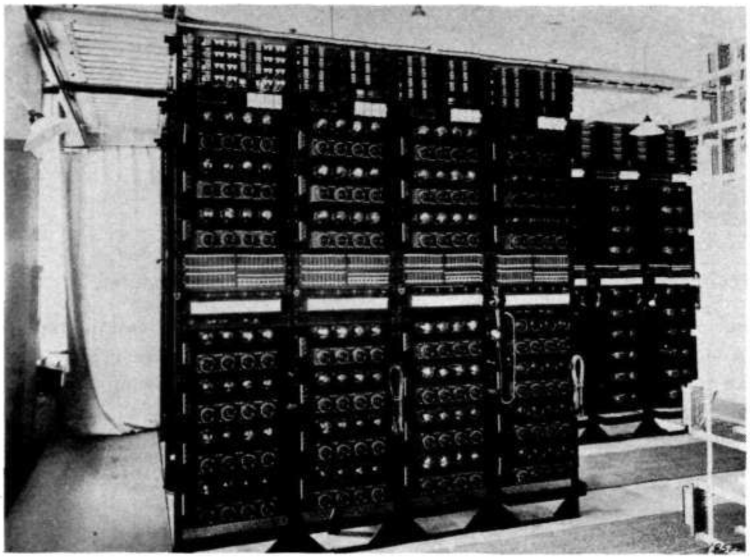
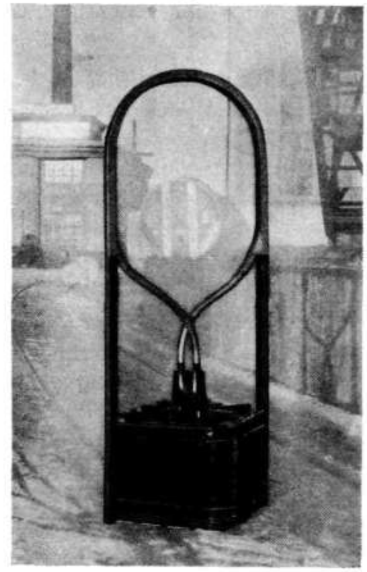
Fig. 3.
Repeater panel.

Four repeaters are assembled on one panel; below the amplifier valves, the potentiometers for gain adjusment; extreme left, supervision switches and jacks.



X 5118 **Fig. 4. Repeater station Zwolle.**
Each bay contains 28 repeaters.



X 3203 **Fig. 5. Loading-coil case.**

operate with pure 500 c/s current and without appreciable delayed-action. Ordinary audio-frequency signal receivers for current interrupted with 20 c/s will not fulfil this requirement, and their insufficient selectivity must be compensated by the delayed-action of the repeater, which will often exceed 1/2 second. The Dutch Board of Telegraphs therefore selected receivers on the Swedish system which fulfil the above-mentioned requirement. These repeaters can also operate with current interrupted with 20 c/s and with a delayed-action of not more than 0.1 seconds. When long circuits are set up over a great number of working positions, several repeaters from 500 to 20 c/s and vice versa will be inserted in the same circuit, and, consequently, this reduction of the delayed-action in each repeater is of great importance. It will, however, be possible to utilize all the advantages of the Swedish system only after the change to pure 500 c/s signalling current has been made.

Fig. 6 shows signal-receiver bays supplied to Holland, each containing 10 receivers. These are of standard construction and a more detailed description of their construction and the main properties of the system will be found in an article in the Ericsson Review No 4—6, 1931.

T. Laurent & A. Westling.

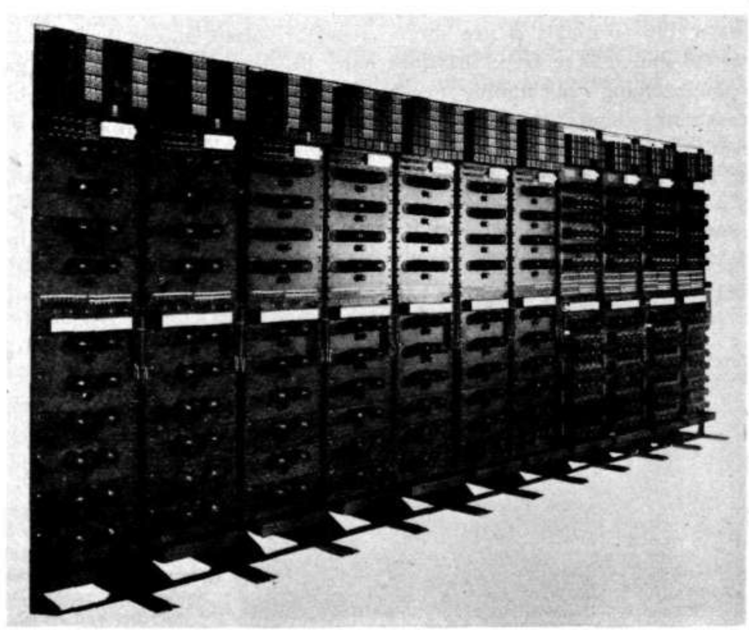


Fig. 6. Signal-receiver bays, delivered to Holland.

Each bay contains 10 receivers. In newer designs two signal receivers are assembled on one panel of the same size, which allows for the mounting of 20 receivers in each bay.

X 5119

Photo-Electric Talking Machines

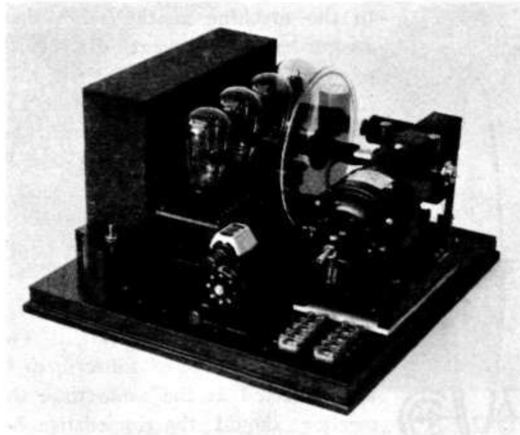


Fig. 1. Talking machine for 1-second's notices.

X 1333

It is no new idea to use talking machines for reproducing brief phrases frequently used in telephone stations. Up to the present the machines used have chiefly been based on the use of bands or discs of steel. These machines have however certain disadvantages: it has been found that the high frequencies of the speech, which are of great importance to the apprehensibility, are difficult to reproduce, and moreover copies of a record cannot be obtained in a simple manner, since each machine has to be recorded separately, and finally, the recorded part of the steel disc or band is not distinguishable to the eye from the part where no recording has been made.

These inconveniences have been eliminated in the Ericsson photo-electric talking machines, which are based on the principles of the ordinary talking pictures. The film used is a circular disc rotating around a shaft. The film disc is protected from injury by two glass discs between which the film has been fitted. The film is traversed by a ray of light which impinges on a photo-electric cell.

As the film keeps its shape during its rotation and is not submitted to friction or bending and in addition is protected against injury, it will easily be understood that all wear of the film is eliminated and that the same film may be used for a practically unlimited time.

Telefonaktiebolaget L. M. Ericsson has designed three types of talking machines:

A: for notices lasting about 1 second, or, if desired, for several shorter notices, together lasting about 1 second,

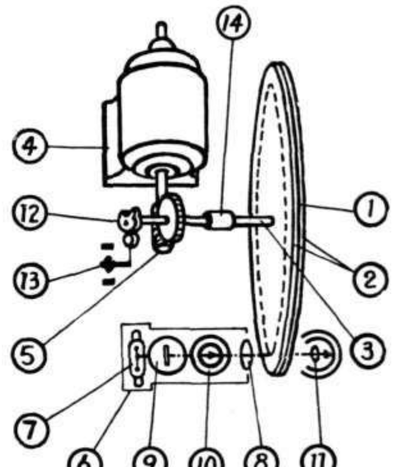
B: for notices lasting up to 20 seconds,

C: for automatic time indication.

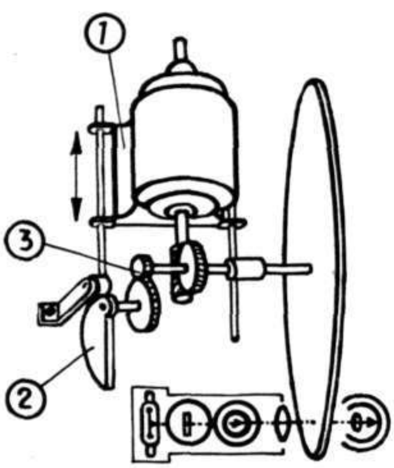
In the first case the notice is recorded along an arc near the edge of the film disc, in the second case the recorded speech forms a spiral on the film disc, and in the last, where several film discs are used, each disc is provided with several concentrical record bands one inside the other.

A. Talking Machine for Notices of 1 Second's Duration.

As stated above the machine, Fig. 1 and 2, consists of a flat film disc *1*, which is protected and supported by two circular glass plates *2*, and which rotates around a shaft *3* through its centre, the shaft being driven by a motor *4*. The reduction of the speed of the motor to about 1 rpm is carried out through a worm gear *5*. On one side of the film disc there is the projector *6*, which consists of a 12 V lamp *7*, with a straight filament, a lens *8*, and a slot *9* near the lamp. The slot, which has a length of 15 mm and a width of 0.1 mm, is provided for fixing the dimensions of the pencil of rays which is thrown from the filament through the slot to the lens. The latter reproduces, on the film in a reduced scale the light from the slot so that there appears on the film a light streak about 2.5 mm long and about 0.02 mm wide. A diaphragm *10* prevents the reflection of rays in the projector tube. The bunch of rays passes through the film and is received on the other side by a photo-electric cell *11*. The projector is adjusted so that the streak of light on the film will be perpendicular to a tangent to the record band. The intensity of the light that passes through the film varies with the opaqueness of the rotating film. The variations of the current thus created in the photo-electric cell are amplified in a four-valve amplifier, which receives its anode current from the driving motor *4*, which motor serves as a con-



X 3214 Fig. 2. Diagram of talking machine for 1-second's notices.



X 3213 **Fig. 3. Diagram of talking machine for 20-seconds' notices.**

verter as well. A cog disc *12* is fitted to the shaft of the film disc, and this cog disc actuates a contact group *13* as the shaft rotates. The contact group is provided for controlling auxiliary relays in the telephone exchange, which in the right moment, and if desired once only, connect the calling subsriber to the talking machine.

The talking machine has also been fitted with a rheostat in the field circuit of the motor for speed regulation and a series resistance for the projector lamp for regulating the light intensity. The amplifier has also been supplied with a means of regulation, *viz.*, a potentiometer between the first and second valve.

The operating tension of the motor is 24 V DC. No anode current need be supplied since it is produced by the machine proper as stated above.

The amplifier valves used are of the same type as those of telephone repeaters. These valves are superior in respect of uniformity and long life to the valves used in broadcasting receivers. Though the number of valves might have been reduced by the use of such radio valves, in view of their higher factor of amplicifation, the need for reliability has caused the former type of valve to be used.

The amplifier has an output of 50 mW at 5 % harmonics, and a great number of subscribers may therefore be connected in parallel to the machine at the same time. In order to prevent disturbance of the transmission by their talking into their microphones, the following relation has been utilized: if the maximum output of the amplifier is to be utilized when a certain number of subscribers are connected, the internal impedance of the amplifier should be equal to the impedance of the subscribers' lines when connected in parallel. The higher the number of subscribers to be connected at the same time the smaller should the impedance be. This impedance may be altered by changing the ratio of the output transformer. With speech currents coming from one of the telephone instruments connected in parallel the talking-machine amplifier acts as if it were connected in parallel with the other instruments. The smaller its impedance the more it will shunt the other instruments, and the less a subscriber will be capable of disturbing the transmission.

The amplifier should consequently be large enough for as high a number of subscribers as possible. With the type of valves used the limit is 100—150 subscribers. The attenuation for conversations between two subscribers will then be 4.6 to 5 neper, which is quite satisfactory in this case.

The amplifier manufactured has an output impedance of 4 ohm, which corresponds to 150 subscribers connected at the same time. The low value of the internal impedance will also have the result that connection or disconnection of one or more instruments will not alter the sound intensity appreciably in the other instruments.

The motor supports the worm gear and the film disc, and by suspension on a rubber sheet it is acoustically insulated from the other parts of the machine so as to prevent the transferring of the inevitable vibrations of the motor to the photo-electric cell and the amplifier, where they would cause troublesome noise. The shaft of the film disc which is driven by the worm gear has a speed that is not perfectly constant. Every new contact of a tooth in the worm thread will cause a small acceleration with a subsequent retardation of the worm wheel. These variations of speed are prevented from reaching the film disc by a flexible clutch *14* between the worm wheel shaft and the hub on which the film and glass discs are fixed.

All parts described are fitted on a base of black oak and protected by a cover of sheet-iron.

B. Talking Machine for Longer Notices, Maximum 20 Seconds.

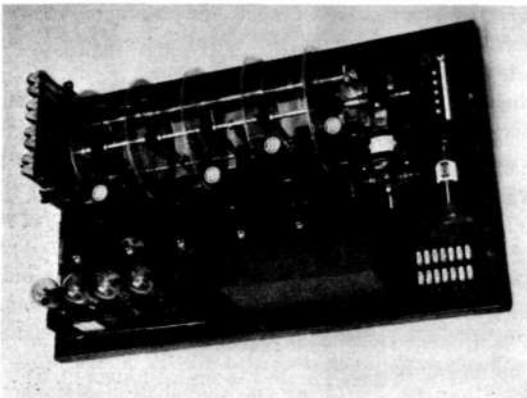
The second type of talking machine, Fig. 3, which is used for notices of up to 20 seconds' duration, differs from the former type only in the motor, and consequently also the film disc, being mobile in relation to the light system. The motor is fitted on an easily mobile carriage *1*, which during the rotation of the film disc is moved to and fro by a cog disc *2*, which is driven by the motor over a gearing *3*. The film thus moves in relation to the light system so that the pencil of rays follows the record band of the film exactly. On restoring, a relay disconnects the amplifier from the listener as he would otherwise hear fragments from those parts of the record traversed.

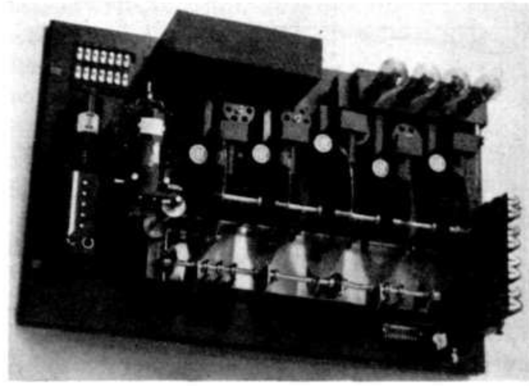
In other respects the machine consists of the same parts as the type previously described.

C. Talking Machine for Automatic Time Indication.

The third type of talking machine, the time-indicating machine, Fig. 4 and 5, is a combination and extension of the two previous types, inasmuch as the films have been provided with serveral circular record bands, one inside the other, and that the light systems are moved for reproducing one after the other the different record bands in the order and at the times determined by the rest of the mechanism.

The indication of the time is divided into separate parts for hours, minutes and if wanted seconds,





X 1331 X 1332 **Fig. 4 and 5. Talking machine for automatic time indication.**

which are combined in succession to a complete time indication. The hours, minutes and seconds are recorded on separate film discs, and the time is indicated every tenth second. An indication may consequently be: »eight, thirtysix, forty».

A machine for the transmission of hours and minutes but not seconds will be described in connection with Fig. 6.

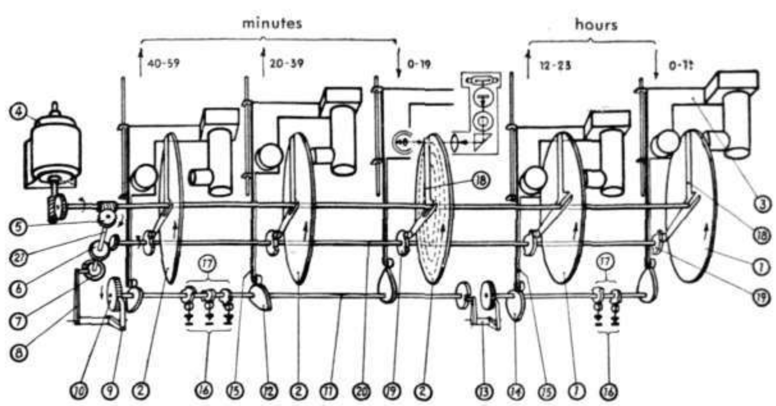
Five film discs of which two are for 24 hours, *1*, and three for 60 minutes, *2*, are fitted between glass discs on one shaft, which rotates at a speed of about 1 revolution per second (54 rpm). The film discs hace several concentric record bands one inside the other, of which each hour disc has 12 and each minute disc 20, containing digits, as those indicated in the illustration.

For each film disc there is a mobile light system *3*, which is moved step by step by the driving motor *4*, over a mechanism in such a manner that the movement from an outer band to the next one inwards is carried out once in an hour or once in a minute respectively. The mechanism operates as follows: over a worm gear 5 the film disc shaft drives a shaft *21*, the speed of which should be exactly 1 rpm. In the bottom end of this shaft there is a wheel with a sliding surface, against which the arm *8* is pressed by a spring. The sliding surface, shaped as a helical line, during its rotation lifts the arm *8*, which at *7*, *i.e.* once in a minute, falls down from the top part of the sliding surface to the bottom part. At the same time the ratchet *9* performs a movement similar to that of the arm *8*. The gear wheel *10* having 60 teeth, the shaft *11* will rotate 1/60 of one rpm. On the latter shaft there are 3 cog discs *12*, which, by means of the arms *15*, move the light systems *3* to and fro. The cog discs *12* are fitted at angles of 120° to each other, and, consequently, the light system of the disc 0—19 moves from the outer to the inner record band during the first 20 minutes of the hour. The next light system will move inwards during the next 20 minutes, and finally during the last 20 minutes of the hour the light system of the disc for 40—59 minutes will move inwards. The cog discs are of such a shape that the movement takes place by one band pitch at a time during the inward movement, while this is not the case during the outward movement.

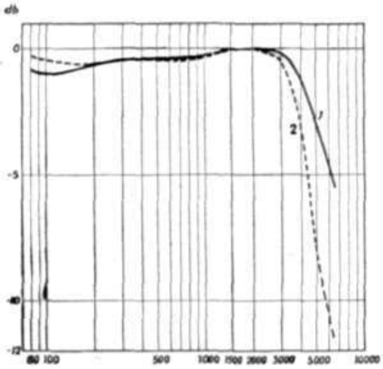
To the right of the shaft *11*, at the end there is a mechanism *13*, which in main operates in the same manner as the mechanism *7*—*10*, although once only for each revolution of the shaft *11*, *i. e.* once in an hour. The light systems of the hour discs *1* will consequently be moved inwards or outwards respectively at a speed of 1 step an hour. The cog discs are in this case fixed at an angle of 180° to each other.

During the time an hour or minute light-system is in motion inwards its projector lamp is lit while the other light systems are idle, their lamps being unlit. The lighting and putting out of the lamps is carried out by the contact groups *16*, which are actuated by the cog discs *17* on the hour and minute shaft respectively.

The five photo-electric cells are connected in parallel to the amplifier. For most of the time they are however in the dark, the rays from the projector lamps being kept away by screens *18*, one for each light system. These screens are operated



X 5141 **Fig. 6. Diagram of talking machine for automatic time indication.**



X 3215 **Fig. 7. Frequency caracteristic of photo-electric talking machine.**

by the cogs *19* on the shaft *20*, which rotates at a speed of 1 revolution in 10 seconds driven by the gearing *6* schematically indicated in the illustration. The cogs *19* are deplaced in relation to each other so that simultaneously during one second the two hour-cogs let their screens give passage to the pencil of rays and during the next second the three minute-cogs let down their screens. The light from the hour projector, when its lamp glows, will consequently during one second pass through the film and arrive at the photo-electric cell, after which it will be screened again. During the next second the same will be the case with the light from a minute projector. The respective photo-electric cells have consequently been in action during one second each, and the amplifier will have received the corresponding currents, which together form a complete time indication. The photo-electric cells will then remain dark for the next 8 seconds, after which the process will be repeated. The change-over from minute to minute and from hour to hour respectively takes place during every sixth dark period, *i. e.* a few seconds before the right time. Whether the right time is given by this hour and minute indication is of no importance, as in this case it is not the question of astronomic exact time.

The recording of the discs is of course carried out in such a manner that the indication starts at about the same moment in all bands of one disc.

Since photoelectric cells, projector lamps and film discs are not uniform, each projector lamp has been provided with a separate rheostat so that the sound intensities from all discs may be adjusted to the same value. In addition the total sound level may be regulated by means of the potentiometer of the amplifier.

The speed of the motor is regulated by hand to nearly the right value by means of a rheostat in the shunt circuit. Automatic synchronization to the right time is then carried out in the following manner: on the shaft *21* there is a cog disc (not shown in the illustration) which actuates a contact group, and this closes a contact once for each revolution of the shaft. The current impulse obtained in this way for each minute is made to actuate a set of relays. A different minute impulse received from a chronometer actuates another set of relays. If then the impulses do not arrive simultaneously within an interval determined by the operating times of the relays, the set of relays will bring about a small change of the motor's speed upwards or downwards according to which impulse was received first. If for some reason or other the difference in time between the impulses should be greater than permissible or equal to the adjustable time required for the heating of a thermo-contact, an alarm signal will be given and the transmission will be discontinued. Lamp signals will then indicate whether the speed has been too high or too low.

Alarm lamps will also be lit should a projector lamp go out or the anode current of the amplifier fail. In this case also the connection between the machine and the rest of the telephone exchange will be cut off.

The operating tension of the machine is 24 V, and this is the only voltage required. In this case also the anode current is supplied by the driving motor, which has been made as a rotary converter.

If it should be desirable to indicate 12-hour time instead of 24-hour, two equal hour discs *1* are fitted each recorded for 12 hours.

If the machine shall also transmit indication for every tenth second, it is completed with a second disc recorded with the numbers 0, 10, 20, 30, 40, and 50 and a light system with the necessary mechanism.

Regarding the quality of the reproduced sound from the Ericsson talking-machines we refer to Fig. 7, which presents frequency curves, including amplifier for recording, the photographic process and the photo-electric amplifier. The curves do not take account of the frequency curve of the microphone, since various types of microphone may be used for the recording. The curves have been measured so that AC of constant amplitudes but of different frequencies have been connected instead of the microphone and photographed on one disc. The frequency of the uttermost record band was 6 500 c/s, that of the next band 80 c/s whereafter the frequency from band to band was increased and decreased respectively so that the 19th band contained 80 c/s and the 20th band 6 500 c/s. The AC was then reproduced in an ordinary talking machine after the photographic treatment. From the curves it may be seen that the frequency range goes far beyond the limits usual in telephony both upwards and downwards, and, consequently, the quality may be considered very high for the purpose in question.

C. Ahlberg.

The Ericsson Centralized Radio System

The centralization of equipment for the reception and amplification of broadcasting programs, which is necessary when a great number of listeners has to be served, will in many cases carry with it considerable advantages.

The range of apparatus for centralized radio systems as developed by Ericsson constitutes a complete series suitable for all sizes of installations. The great installations are composed of units, and it is consequently easy to carry out such additions and extensions as may be found necessary.

By centralized radio is meant the installation at one point of the equipment for taking up and amplifying broadcasting programs, where this is necessary for the supply of a group of listeners in a certain area. From the centralized point the programs are sent on to the listeners by wire. In this way the listeners in question are relieved of the trouble and cost of providing separate radio receivers for themselves. In many cases it is only by the use of centralized radio equipment that certain groups of people are enabled to hear the broadcasting programs.

This is particularly the case with the patients of hospitals and sanatoriums. For such people the hearing of the broadcast programs is often an active stimulant and a great aid in helping them to resist the strains involved in their stay in the hospital. The entertainment derived from the broadcasting programs does without doubt greatly facilitate the recovery of patients. It is of course impossible to install a separate receiver for every patient, and the centralized radio equipment therefore is the rational solution.

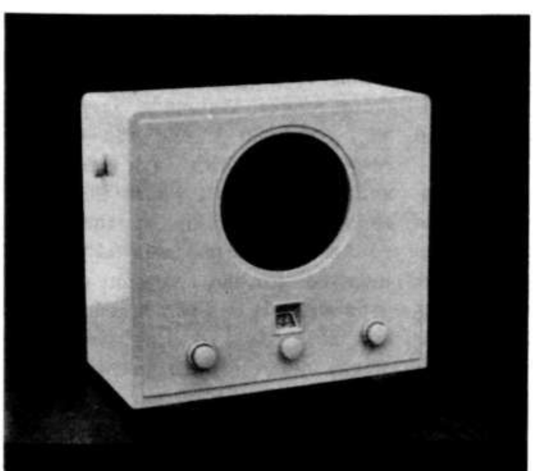
At each bed a wall-socket for the connection of an earphone is installed and in the common rooms loud speakers are provided. A switching clock makes it possible to ensure that the reproduction of the broadcasting programs is made only during the hours which suit the time-table of each section of the hospital.

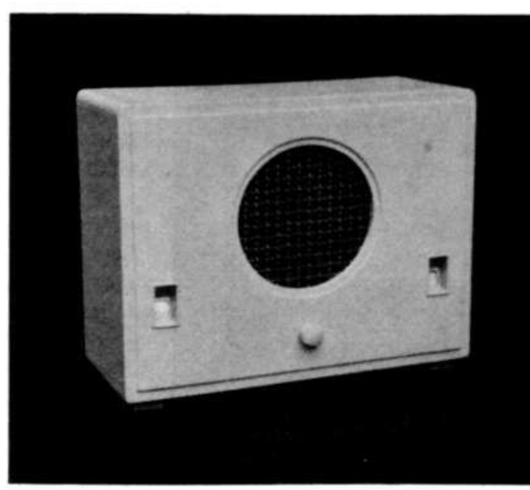
The favourable influence on the recovery of patients derived from hearing broadcasting programs has roused great interest among medical authorities. The number of hospitals which have installed centralized radio equipment increases steadily, and such apparatus will no doubt soon be part of the normal equipment of every nursing institution.

There is also the case of homes for the aged poor who cannot afford to purchase radio receivers. The centralized radio equipment solves this problem in an efficient and inexpensive manner.

In education the use of broadcasting is steadily increasing for the propagation of knowledge. In order to make is possible for school broadcasting programs to be heard in any part of the school building, a centralized receiver and amplifier equipment is desirable. This is the only satisfactory manner of utilizing school broadcasting. If ordinary receivers were used, which have to be moved from one classroom to another, difficulties will soon arise in regard to the time-table of the broadcasting, since the receivers may not be available in the right room at the right time or they may have been damaged by the repeated transportation.

For tenement-houses also the provision of centralized radio equipment will have several advantages. The centralization of the equipment required for the distribution of the broadcasting programs to all the tenants of such a building is economical, taken as a whole. It might of course be objected that by this





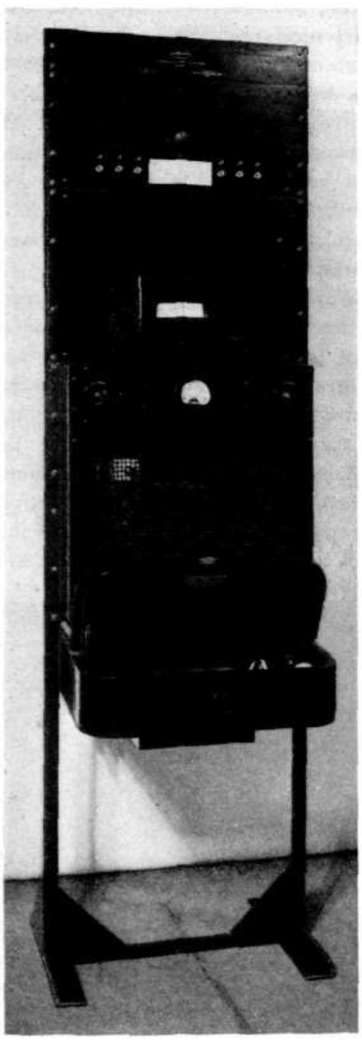
X 1297 X 1296

Fig. 1 and 2. Radio central, Type CR 14 (left) and Type CR 13 (right).

system the listeners will only have one program at their disposal, but in the cities especially conditions of reception are often so bad that with the ordinary separate receivers which such tenants could afford, they would in any case only be able to hear satisfactorily the nearest great transmitter station. Even for local reception with separate receivers it will often be difficult to avoid disturbances due to electric mains, etc.

With a centralized radio system it is as a rule possible to avoid these disturbances entirely. With one aerial only a convenient position may be chosen for its erection and its connection to the receiver can be efficiently screened.

In hotels, clubs, etc. the centralized radio equipment has proved itself an ideal arrangement for making the broadcasting programs available to guests who wish to hear them.



X 3281 **Fig. 3. Radio-central rack.**
From top down: line panel, receiver panel, amplifier panel and electric gramophone.

The centralized radio equipment has one distinct advantage, namely that of transmitting local programs. A microphone and an electric gramophone may be connected to the apparatus.

This is of special interest to public establishments such as sporting grounds, swimming baths, race courses, public parks etc., where speech and music has to be broadcasted over a wide area.

In order to provide for the requirements of the different types of installations mentioned above, special care had to be taken in designing the apparatus. The system must be absolutely reliable and of such a design that efficient supervision from a central point is possible. The central apparatus must be easy to extend so that when additional listeners are connected everybody would obtain sufficient sound volume. It was therefore not merely a question of producing a centralized radio equipment composed of an ordinary broadcasting receiver and a powerful amplifier.

The Ericsson centralized radio equipments for great output are specially designed for the purpose. Each unit of which they are composed has its special purpose. These units are joined in bays, and experience gained in the manufacture of apparatus for long-distance telephony, built up according to similar principles, has proved useful in arriving at a practical construction for the central radio equipments.

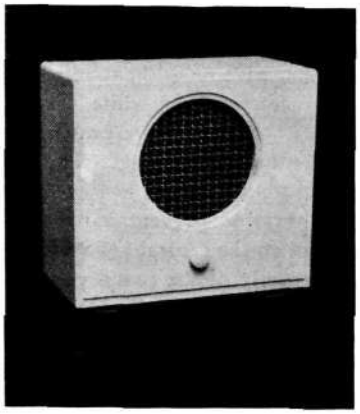
The size of a centralized radio-equipment depends on the number of listeners to be connected and whether loudspeakers or earphones are to be used. A loudspeaker takes 0.25—2.0 W according to nature of the room and the sound volume desired. It is assumed that only moving-coil loudspeakers are to be used. It might be said that a loudspeaker takes about the same output as 1 000 earphones.

X 3191 **Fig. 4. Electric gramophone.**

The series of radio centrals at present manufactured by Ericsson comprises apparatus which produce an undistorted output of 2—60 W and even more.

Radio Centrals for Small Installations.

The smallest of the radio centrals, Type CR 14, gives an output of 2.0 W and is designed for earphones only. The central is illustrated in Fig. 1. The apparatus contains everything necessary for operation and tuning and requires no additional equipment. The earphones are connected to an output transformer built into the apparatus, the listeners thus being effectively protected against high tension. The apparatus may be connected to AC or DC mains and may be switched for two different voltage ranges. By the provision of a special regulator valve these ranges are made very wide, *viz.*, 100—180 V and 180—260 V respectively, which is a great advantage in places where there are abnormal variations of the mains voltage. The apparatus is chiefly intended for the reception of local programs. It has two tuned circuits and three valves (one high-frequency stage, detector and low-frequency stage). It has two ranges of wave lengths, 200—600 m and 900—2 000 m. By means of filter, which may be switched, the high and low-tone ranges may be cut off. A moving-



X 3189 Fig. 5. Loudspeaker.

coil loudspeaker is built into the apparatus.

The next size of apparatus, Type CR 13, gives an output of 2.5 W. This apparatus, Fig. 2, is particularly suitable for small hospitals where it is wanted to install in the wards loudspeakers the sound volume of which is not too high for the bed cases, and where in addition a number of earphones are to be connected. Like Type CR 14 this apparatus is complete, inclusive of an output transformer for the earphones. It is manufactured for connection to AC mains only, and this is the case with all apparatus except the smallest type, CR 14. It may of course be switched for different voltages. If there is only DC available, a converter is necessary between the mains and the apparatus, and rotary converters will be the most suitable type for this purpose.

The selectivity is greater in Type CR 13 than in Type CR 14, as the number of tuned circuits is increased to three. The apparatus has four valves (one high-frequency stage, detector and two low-frequency stages) and is provided with tone-control filter and supervisory loudspeaker as for Type CR 14.

Radio Centrals for Great Installations.

Radio centrals for great output are composed of units, each having its separate purpose. In this way it will be easy to carry out extensions or other alterations that may become necessary. The different units are manufactured as panels, which are joined in a bay.

The units manufactured at present are as follows:

receiver panel,	Type A 3,
amplifier panel, 60 W,	Type B 2,
amplifier panel, 10 W,	Type B 3/10,
amplifier panel, 20 W,	Type B 3/20,
line panel,	Type D,
loudspeaker panel,	Type E,
microphone-amplifier panel.	

Fig. 3 shows a complete radio central, the panels of which are, reading from the top: line panel, receiver panel, amplifier panel 60 W and an electric gramophone.

The receiver panel, Type A 3, contains a superheterodyne receiver with four valves. The receiver has automatic volume control, arrangements for efficient noise killing and adjustable tone-correction filter.

The amplifier panel, 60 W, Type B 2, gives an undistorted output of 60 W. On the same panel there are fuses and switches for the whole system. The fuses are provided with an electro-magnetic releasing device, with thermic delay in order to prevent release when the system has been switched on. On a strip there are two neon lamps for the supervision of the grid and anode voltages, and measuring instruments with the necessary keys for measuring the anode currents of the valves. The amplifier is designed so that the anode voltage is not switched on until the filaments of the valves have been heated to operating temperature. By this arrangment the lifetime of the valves is considerably increased. The anode voltage will be switched off automatically should the grid bias fail, and this prevents the valves being spoilt.

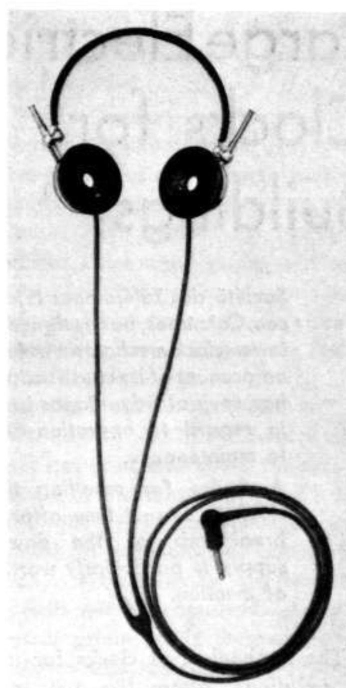
The valves and the fuses are fitted behind a grid, and when this grid is detached the voltage is switched off immediately. The amplification is practically constant within the frequency range 50—6 000 c/s.

The amplifier panel, 10 and 20 W, Type B 3, is fitted with parts the same as those mentioned for Type B 2. For a 10 W output the amplifier has two valves in push-pull connection. Two additional valves may be fitted and the output will then be 20 W. The frequency range is the same as that of the amplifier panel, Type B 2.

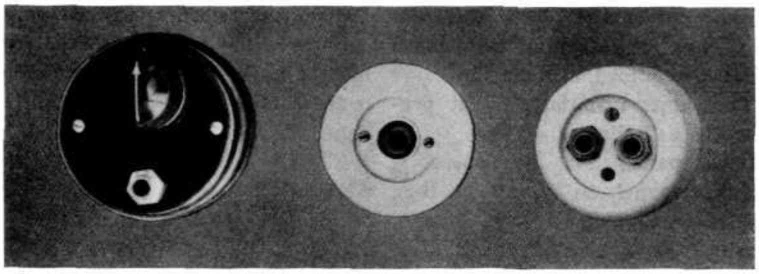
The line panel, Type D, is fitted with switches for 6 outgoing distributing lines. For each line there is a jack for the insertion of a supervisory loudspeaker. A neon lamp *serves as an voltage indicator.* Thanks to this optical indicator it is very easy to adjust the sound volume.

The loudspeaker panel, Type E, contains a supervisory loudspeaker with volume regulator. By means of a cord with a plug the loudspeaker may be connected to the supervisory jacks of the line distribution panel.

A radio central composed of the above-mentioned units may be furnished with an electric gramophone, see Fig. 3. The gramophone is fitted with stopping device, which operates automatically when a record finishes. The gramophone may also be fitted in a separate bay, see Fig. 4. In addition a microphone with the necessary battery may be connected.



X 3190 Fig. 6. Earphones, with rubber-covered cords and two-pole plug.



x 5115 Fig. 7. Wall sockets for centralized radio system,
left, single socket with regulating resistance; middle, single socket for flush mounting; right, double socket for external mounting.

The amplifier required for the microphone may either consist of a portable amplifier for battery supply, or else it may be made as a panel for mounting in the bay along with the other units described above. In the latter case the amplifier is designed for mains supply and has three amplifier stages.

According to their requirements listeners will be served by loudspeakers or earphones. The loudspeakers are of the moving-coil type with permanent magnets and volume control, see Fig. 5. In hospitals the earphones should be fitted with rubber-covered cords, Fig. 6, which can be washed and desinfected, and are consequently perfectly satisfactory from the hygienic point of view.

It is of great importance to prevent loudspeakers becoming connected to mains sockets. Not only will connection to the mains damage the windings but it might be dangerous to the listeners. Ericsson manufacture a series of special sockets, in which connection is established in one hole only by means of a two-pole plug. The series comprises sockets for flush and external mounting, for one or two connections, with or without regulating resistances, and of white or black bakelite. Fig. 7 shows examples of various types of sockets. The connecting plug is shown in Fig. 6.

In order to prevent variation of the load on the central apparatus and consequently of the sound volume to the listeners when the loudspeaker is switched on and off, the sockets may be fitted with compensating resistances. In the sockets with volume control this resistance is inserted by means of the dial of the volume control, in sockets without volume control when the plug is withdrawn.

All listeners are connected in parallel to the central over two-wire lines. The problem of dividing the listeners into separate groups depends partly on local conditions, partly on whether separate groups, *e. g.* patients and staff in a hospital, are to be supplied with the programs at different hours, and partly on other circumstances. *S. Friberg.*

Large Electric Clocks for Buildings

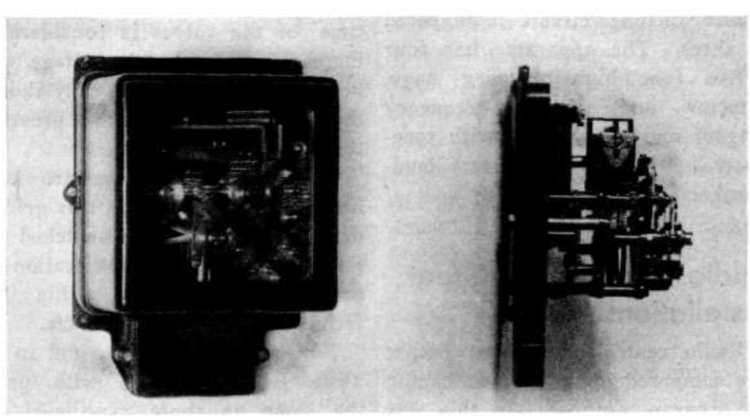
Société des Téléphones Ericsson, Colombes, has designed a tower-clock mechanism which, on account of its construction, has several advantages both in regard to operation and to maintenance.

A device for resetting the clock to correct time after a breakdown of the power supply is particularly worthy of mention.

The mechanism of clocks for use on buildings, where the dials are very large — about 4 m diameter — must have a greater torque than for driving ordinary clock hands. The hands of such great clocks have to withstand heavy strain particulary during storms when the wind pressure may mount up to 140 kg/m². Wind pressure is moreover not constant and the mechanism must consequently be able to stand sudden violent blasts.

Such clocks are mostly placed at the highest parts of buildings, and are often difficult of access, so that supervision is only possible at long intervals.

With a view to these special conditions of operation, Ericsson, Colombes, has perfected a tower-clock system composed of:



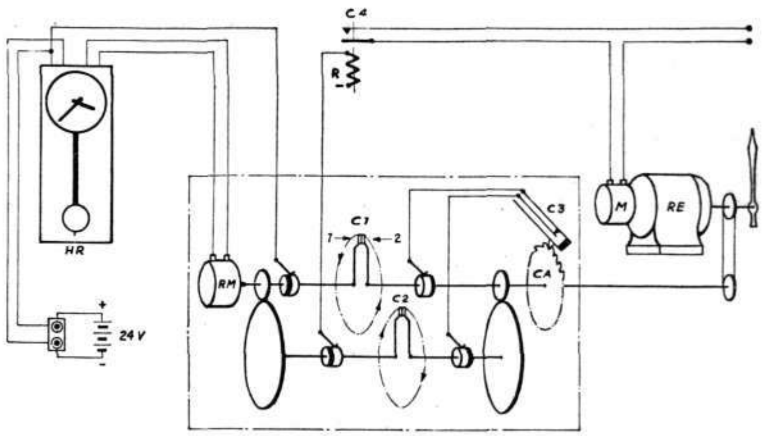
x 5122 Fig. 1. Control apparatus,
for transmitting the impulses from the master clock to the tower-clock motor.

one master clock with electric winding, provided for remote control of the tower-clock mechanism; the master clock may be placed anywhere, even at a great distance from the tower clock,

a control apparatus which is connected electrically with the master clock and mechanically with the minute-hand shaft of the tower clock,

a geared motor, fed from the mains and controlled by the control apparatus,

a hand mechanism, which is fitted on the dial of the tower clock and connected mechanically with the geared motor.



X 5124 Fig. 3. Diagram of electric tower-clock plant.

C_1-C_3	regulating contacts	M	motor
C_4	operating contact of the motor	RE	planet gear
CA	cog	RM	secondary clockwork
HR	master clock	R	operating relay

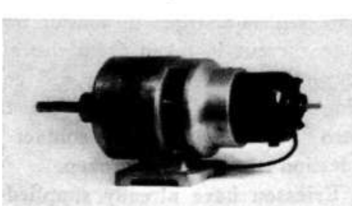
Design.

The master clock is of the Ericsson standard type, with electric winding and contains a contact device which every minute transmits an impulse over the line to the control apparatus. It is fed from a storage battery of 12 or 24 V.

The control apparatus, Fig. 1, contains a secondary clockwork, which is used as circuit-breaker in the supply circuit of a relay. This relay actuates a contact group inserted in the circuit of the geared motor. The power comsumption of the control apparatus is about 15 mAh at 24 V.

The geared motor, Fig. 2, consists of an asynchronous motor running at 2 800 rpm. The motor is connected to a planet gear over an elastic clutch; this gear has the ratio 1: 15 000 and runs in oil in a hermetically closed case. The planet gear gives about 3.5 kgm/second at the working shaft.

The hand mechanism gives the reduction of speed which is necessary for the driving of the hour hand and is fitted to the back of the dial. Mechanically it is connected to the motor direct over a gearing, according to local conditions.



X 3192 Fig. 2. Electric motor, direct coupled to a planet gear, for driving the hands of the tower clock.

Operation.

The operation of the system may be seen from the diagram, Fig. 3.

Each minute the master clock *HR* transmits an impulse over the line connecting it with the control apparatus. When the secondary mechanism *RM* of the control apparatus receives this impulse, an arm is moved one sixtieth of a revolution while at the same time the contact *C1* breaks the supply of the relay *R*. The contact *C4* will then be closed, the motor *M* is started and drives the hand of the tower clock over the gear *RE*.

The working shaft of the gear, being connected mechanically to the control apparatus, will during its rotation carry with it the shaft on which is fitted the second contact of the contact group *C1*. This contact will meet the first contact when the hands have moved a distance corresponding to one minute.

The circuit of the relay *R* will however not be restored until the exact moment when the minute is full, since the contacts *C3*, which are connected in parallel with the contact group *C1*, will be closed rapidly over the cog *CA*. When the circuit through the relay *R* is closed, the contact *C4* is broken and the motor will be stopped.

The time taken by the hands of the tower clock to move forward one minute is about 5 seconds.

Arrangement for Automatic Resetting to Right Time.

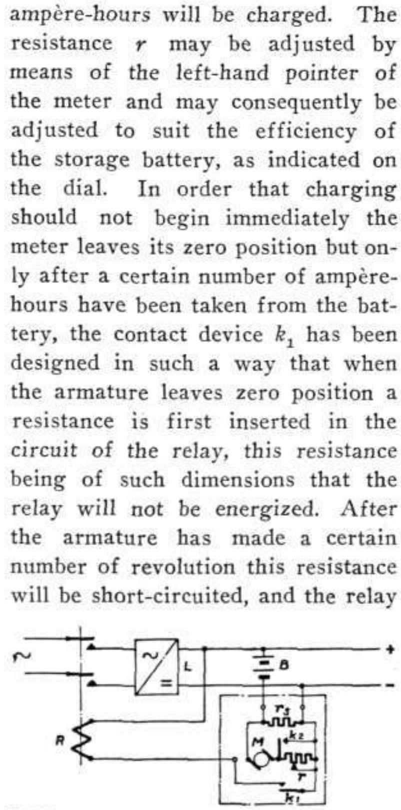
In case of breakdown of the power supply, the closing and breaking of the contact *C4* has no influence on the motor. The master clock *HR* will however continue to run and to transmit its one impulse a minute. The relay *R* will remain in home position and the contact *C4* will be closed.

The secondary mechanism *RM* receives the impulses and moves the first contact of the contact group *C1* one sixtieth of one turn. After sixty minutes have elapsed the two contacts of the contact group will consequently meet again. At this moment the breakdown will have lasted exactly one hour. If now the mains current should return during the sixty-first minute, the motor will be started anew, and in accordance with what has been said above the second contact of the contact group *C1* will meet the first contact after one sixtieth of a revolution; but as the clock is sixty minutes late the relay *C4* will not be energized. Another contact group *C2* is then connected in series with the contact groups *C1* and *C3*; this latter contact group is driven over two gearings with the ratio 1: 12 so that the circuit of the

Automatic Charging with Battery Meter

A new automatic charging unit where the charging control is carried out by means of a battery meter of a new design, Type L 4 Ac, has been designed — especially for use in single-battery telephone, telegraph and signalling systems — on principles laid down by Messrs. H. Olson and S. Vigren of the Swedish Board of Telegraphs.

This meter is an ampère-hour meter of the motor type, provided with a special counter and arranged for rotation in both directions. A main pointer on the front of the meter, which indicates directly the number of ampère-hours taken from the meter, is connected to the armature. The diagram, Fig. 1, shows the meter connected in a system where the battery *B* is charged by a rectifier *L*. The armature *M* with its shunt *rs* is connected in series with the storage battery. The armature rotates in the one direction as the battery discharges and in the reverse direction during charging. When the armature leaves its zero position on discharge the contact k_1 is closed. This contact will remain closed until by rotation in the reverse direction, the armature reaches the zero position anew. The contact k_1 closes the current to the charging relay *R* thus connecting the rectifier for charging; charging and discharging will consequently take place simultaneously. If the current discharged is greater than the current charged the meter will rotate in the discharge direction, but when the discharge stops the meter will reverse and charging will go on until the meter marks the original position; the contact k_1 will then be broken and the charging will cease. The main principle of the charging unit is that the storage battery is charged with a number of ampère-hours corresponding to the number discharged. In order to take into account the efficiency of the battery, the resistance *r* is connected in series with the armature. This resistance is short-circuited by the contact k_2 when the armature rotates in the discharge direction but not during rotation in the reverse direction. On account of this the speed of the armature will be higher on discharge than on charge with the same intensity of current, and a greater number of ampère-hours will be charged. The resistance *r* may be adjusted by means of the left-hand pointer of the meter and may consequently be adjusted to suit the efficiency of the storage battery, as indicated on the dial. In order that charging should not begin immediately the meter leaves its zero position but only after a certain number of ampère-hours have been taken from the battery, the contact device k_1 has been designed in such a way that when the armature leaves zero position a resistance is first inserted in the circuit of the relay, this resistance being of such dimensions that the relay will not be energized. After the armature has made a certain number of revolution this resistance will be short-circuited, and the relay will receive full current. It will then remain energized until the armature returns to zero position.



X 3194
Fig. 1. Diagram of battery meter.
B storage battery
L rectifier
M ampère-hour meter
R charging relay

X 3176 Fig. 2. Battery meter.
The pointer indicates directly the number of ampère-hours taken out; the left dial serves to adjust the meter to the efficiency of the battery, and the right dial to regulate the forced-charging device.

If the battery is for feeding a telephone exchange it is desirable that disturbances from the charging unit be avoided during conversations. For this purpose an additional relay is provided. This relay is energized when current is taken by the telephone exchange and it disconnects the charging relay *R* so that charging is not carried on during conversations, but only when the exchange is idle. In order to protect the batteries of such plants from being discharged too far by abnormal loading of the telephone exchange, the meter contains also an additional contact, which may be adjusted for closing after a certain number of ampère-hours on discharge by means of the right hand pointer of the meter. When this position has been reached, the battery will be charged no matter whether current is taken from the battery or not; the charging will continue until the meter reaches the zero position anew, the contact in question then being broken.

Ericsson have already supplied a number of battery meters of this type to the Swedish Board of Telegraphs. *H. Heijkenskjöld.*

(contd. from page 93.)

relay *R* will not be closed until the sixty minutes lost has been taken up.

In this way on the return of the current the hands will travel only the distance from the stopped position to the position indicated by the master clock, no matter how long a time the breakdown may have lasted.

All these operations are carried out without manual aid and are perfectly automatic.

P. Mauborgne.

SVENSKA ELEKTROMEKANISKA INDUSTRIAKTIEBOLAGET HÄLSINGBORG, SWEDEN

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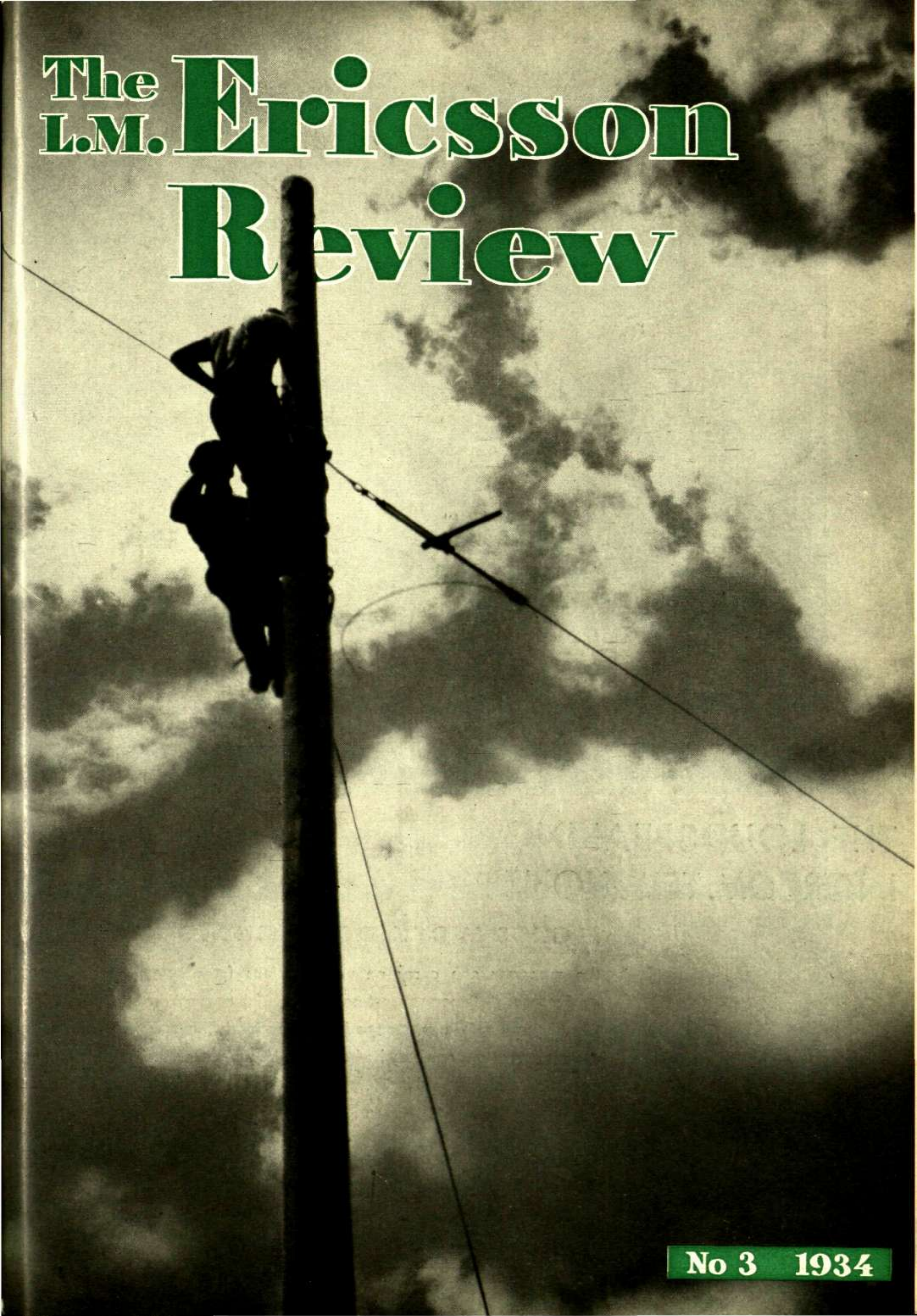

No 3 1934

The L. M. ERICSSON REVIEW

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

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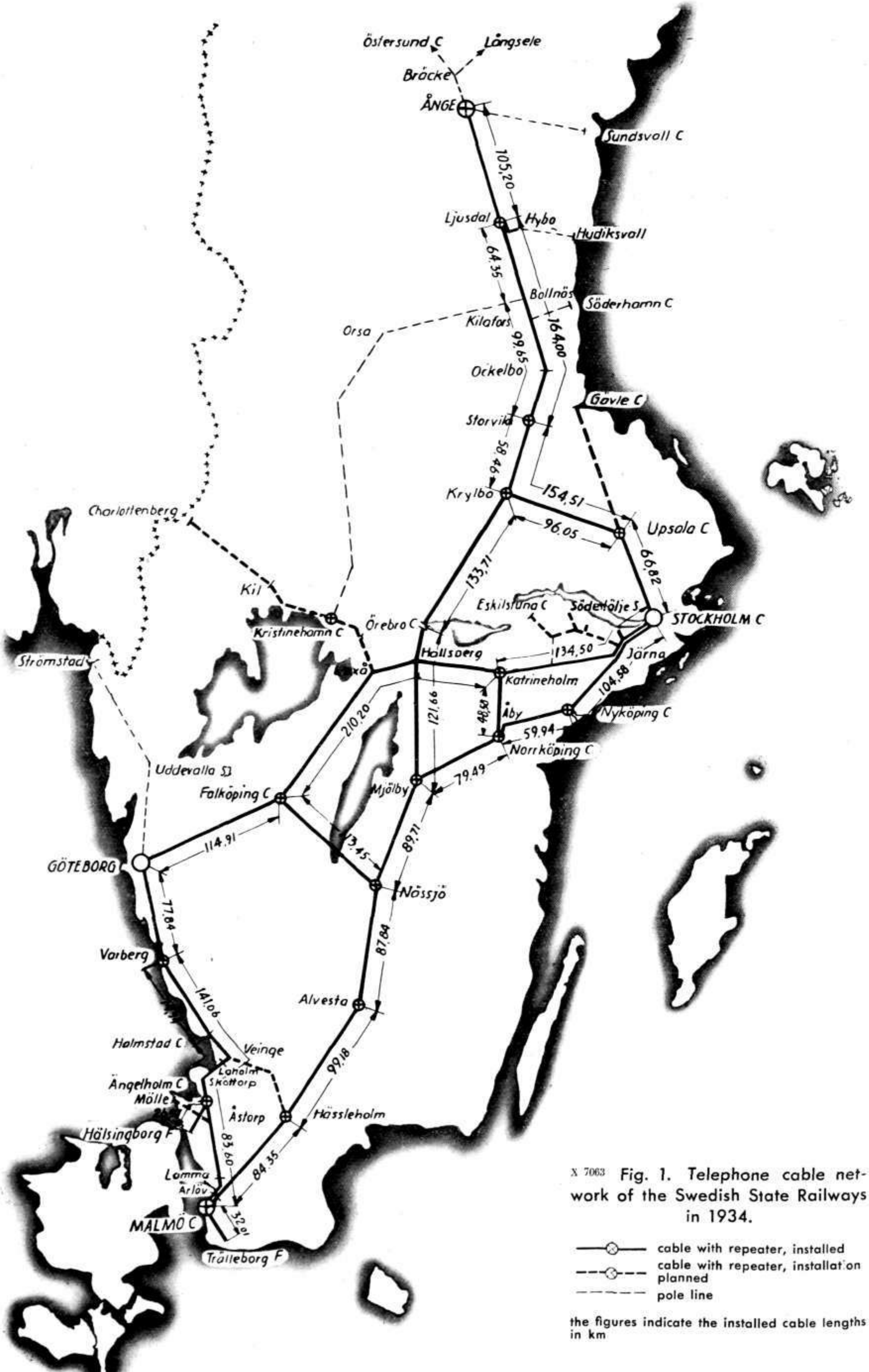
Printed in Sweden
Centraltryckeriet, Stockholm 1934



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

cable with repeater, installed
cable with repeater, installation planned
pole line

the figures indicate the installed cable lengths in km

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.

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]

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

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 requirements	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 × 2 × 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, μμF, 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.

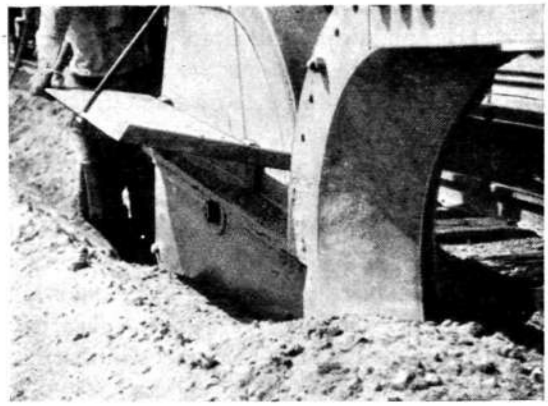
In addition to a large American excavator acquired for the work on the Gothenburg Line, the cleaning and cable-laying plough built in 1932 and employed on the Malmö line, has also been used; this plough is shown in detail in Fig. 4, and working on the simultaneous laying of main and local cables in Fig.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

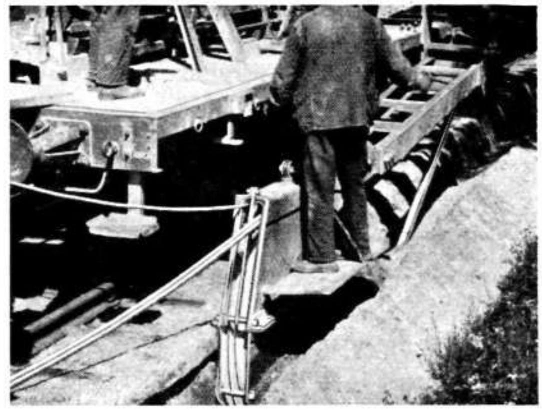
On account of the great number of station lines and the curves necessary at splicing boxes, loading-coil cases, distribution boxes, etc., the cable installed is considerably longer than the track. Extra length has also been caused by the necessity of laying certain additional lengths of cable so as to 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.

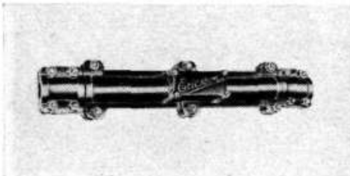
It should be observed that the lengths given above refer to the main cables of the State Railways, but that at the same time considerable lengths of other cables were laid including about 120 km local and distribution cables, considerable lengths of signalling cables, and in addition about 15 km cable 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.

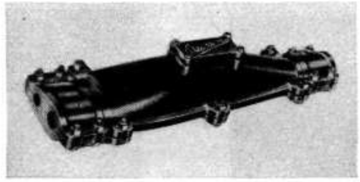
The installation work was carried out by Telefonaktiebolaget L. M. Ericsson, Stockholm, this being the first time work of this kind has been done by the Company for the State Railways. A few months before May 1933 when the work was to be started the firm arranged a school for splicers at Sieverts Kabelverk, 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.**

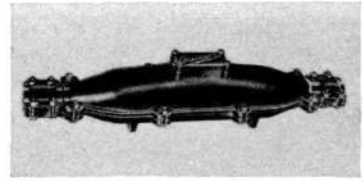
X 1354 **Fig 7. Cable train.**



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.

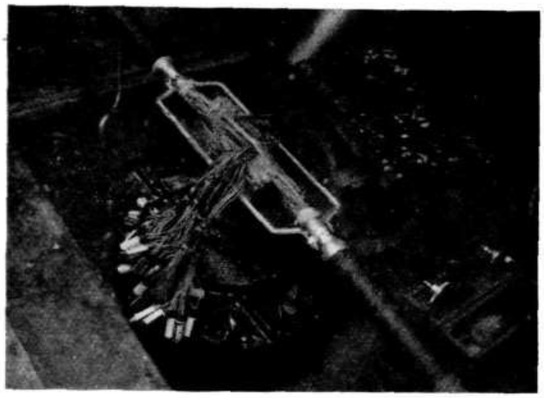
At stations and other places where electric power was available this was made use of. At places where electric power was not available a transportable motor generator was used, consisting of an air-cooled petrol engine of 3 HP, 2 200 rpm, direct coupled to a DC generator, 1.5 kW at 110 V. Lighting current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

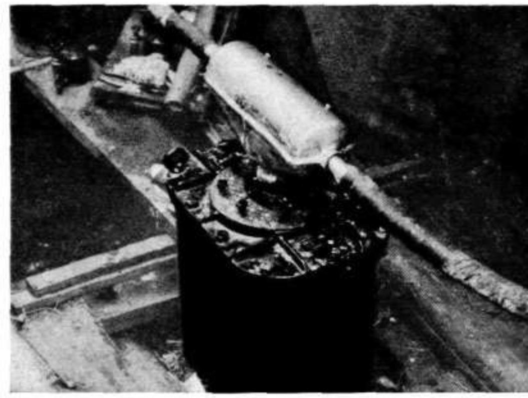
The terminal boxes used at the stations and for distribution and local cables are of a new design. After exhaustive investigation certain standard types were adopted. All types have uniform terminal blocks with 10 pairs of contact pins moulded into bakelite and a frame of tinned copper, see Fig. 14. 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 X 3235

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.

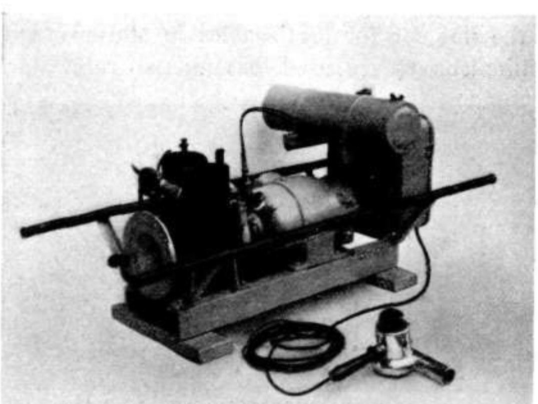
Terminal boxes are made in the following types:

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.



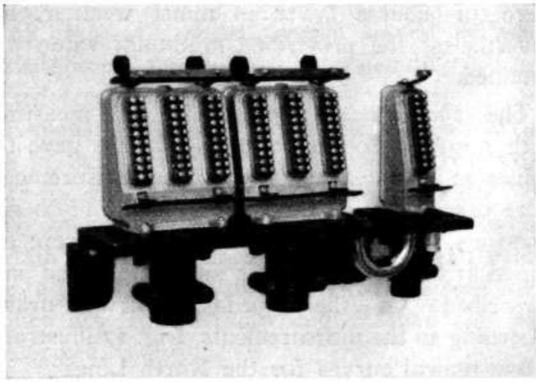
X 1362 Fig. 13. Motor generator with hot-air fan.

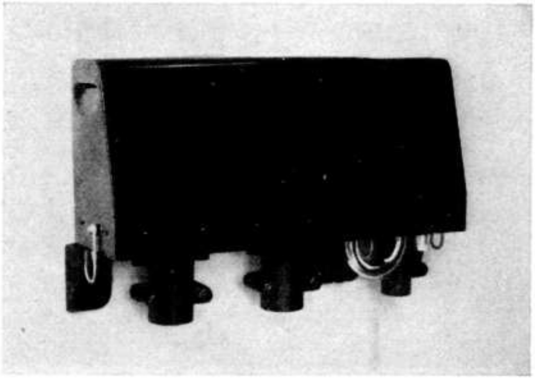
The numbers of station circuits and tappings on the main cables are rather great on account of the nature of the cable system. According to the contract about 90 station branches and 400 tappings have to be made on the North Lines, and about 68 station branches and 200 tappings on the West Lines, which 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 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.

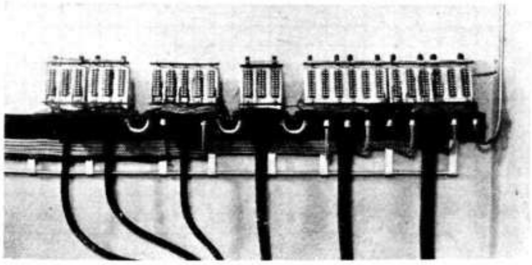
Finally on the Stockholm—Ånge line there are some special tappings, for connection to certain lines belonging to the Royal Board of Telegraphs at the same time serving as tappings to the linemens' houses. For these special tappings local cables with as a rule 7 or 10 quads have been used, so as to make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

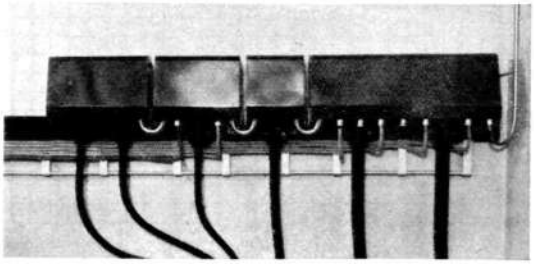
Connection between underground cables and bare-wire overhead lines, such as on not electrified branch railways belonging to the State as well as to private companies, have been made by means of pole boxes, Fig. 16, of a new design in two types, for 5 and 10 pairs. These boxes are fitted with rare-gas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

Properties of the Cables.

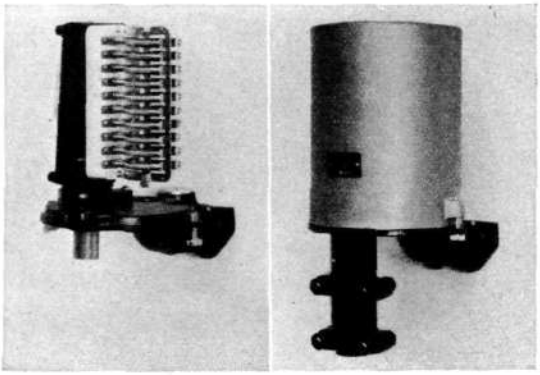
According to what was prescribed in the technical programme for these cable installations, tests have been carried out on each repeater section to ensure that the installed cables fulfil the prescribed requirements. The results of these measurements for some of the sections have been entered in Table 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 μμF for lines to be loaded, and 500 μμF 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.

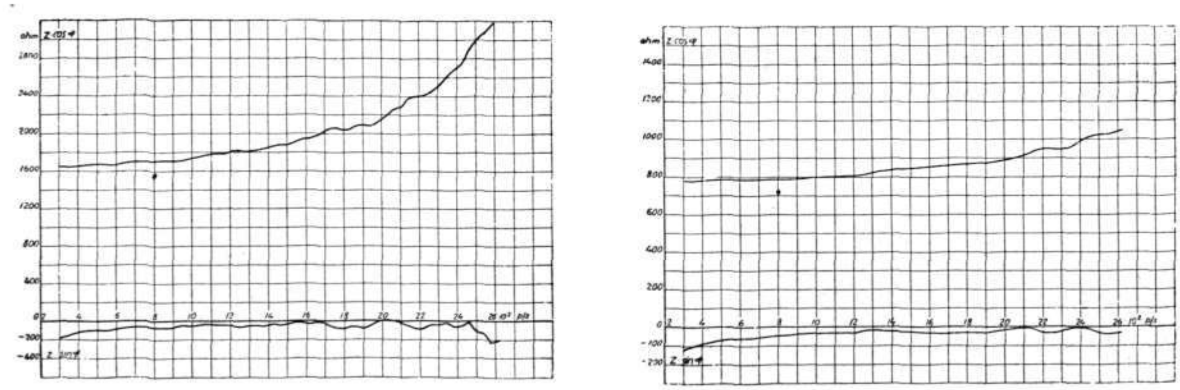
The *propagation constant* at 800 c/s had been fixed at the maximum values for various types of circuits indicated in Table 3. From the attenuation curves measured in the frequency range 300—2 600 c/s it may be seen that the propagation constant at 800 c/s is as a rule considerably lower than the maximum 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.

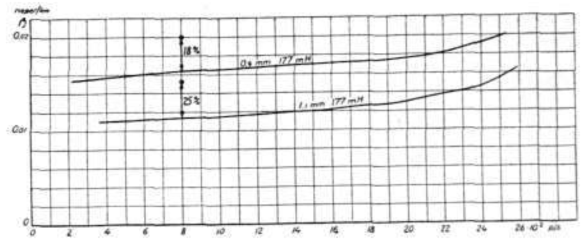
Regarding the cross-talk in quads, somewhat more severe requirements had, however, been imposed, inasmuch as the cross-talk-attenuation between the side circuits of a quad should not be less than 8.5 neper on the average for all quads in a repeater section.



x 1363 *Fig. 17. Characteristic impedance of cable, Type I, Stockholm—Upsala, 66.8 km.* x 1364
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.

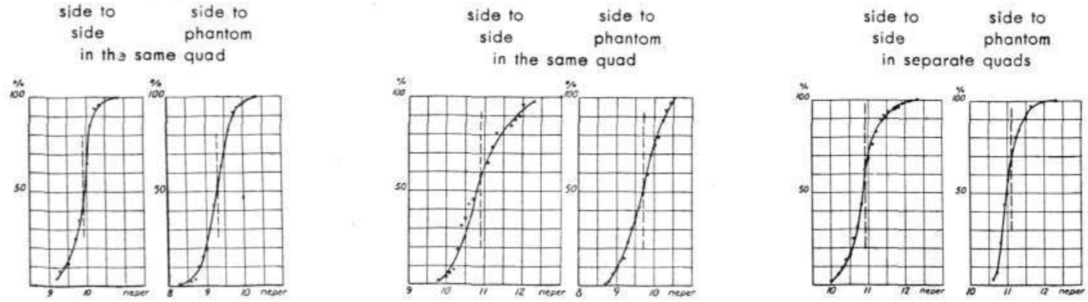


X 1365 **Fig. 18. Attenuation curves for cable, Type I Stockholm—Upsala, 66.8 km.**

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

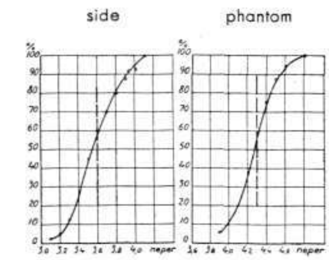
Fig. 19. Cross-talk attenuation curves for quads of loaded 0.9 and 1.1 mm cable, Stockholm—Upsala.

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.



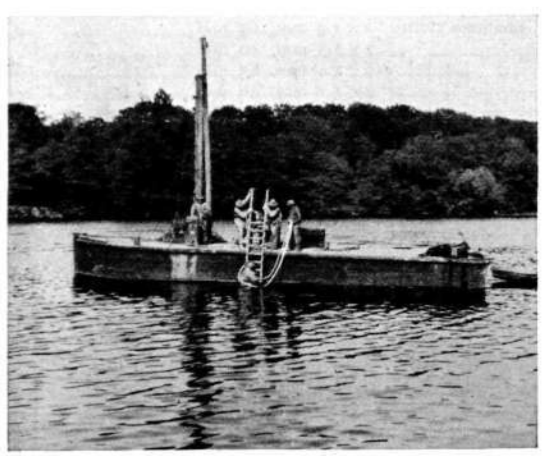
X 3239

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.

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.

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 substation 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.

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 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.

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

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-

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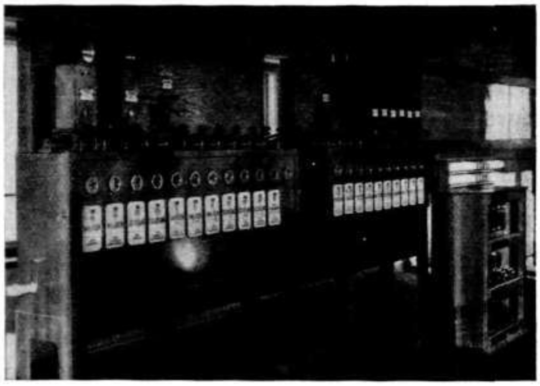


X 1367 **Fig. 4. Blocking apparatus.**
In the background, under the track diagram, relay box.

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.

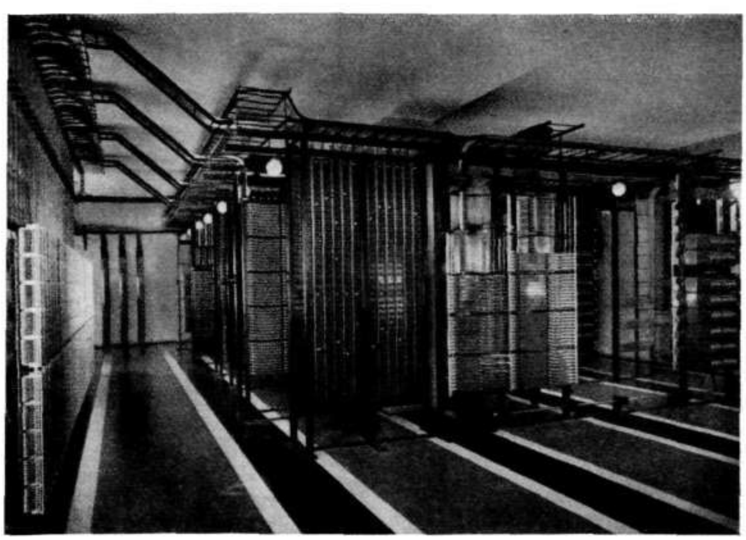
This is built on the Ericsson machine-drive system with 500-line selectors.

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.

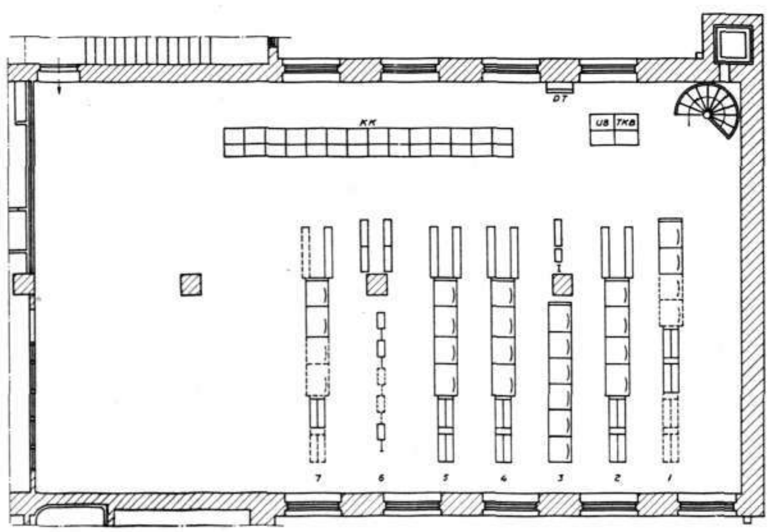
The registers are made with a maximum capacity of 18 000 numbers and 5 special directions.

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.

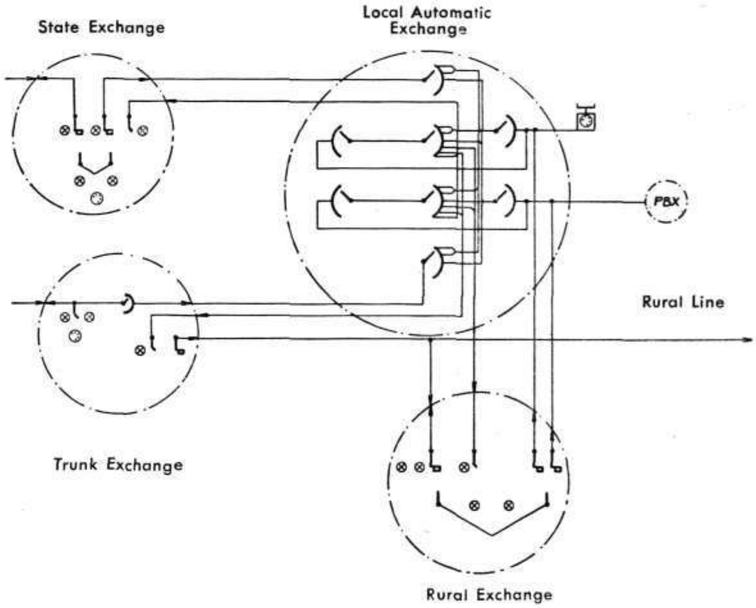
In order to make automatic intercommunication with other exchanges possible, *e. g.*, automatic rural exchanges and PABX exchanges, see the routing diagram, Fig. 4, the cord circuits have been arranged so that through-impulsing is possible, which for an incoming call means that as soon as the proper 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	7	PBX-rack
2	local rack	KK	main distribution frame
3	group-selector rack	UB	test position
4, 5	local racks	TKB	traffic-supervision position
6	rack for intermediate distribution frame and call meters	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 nessary 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 callboxes;

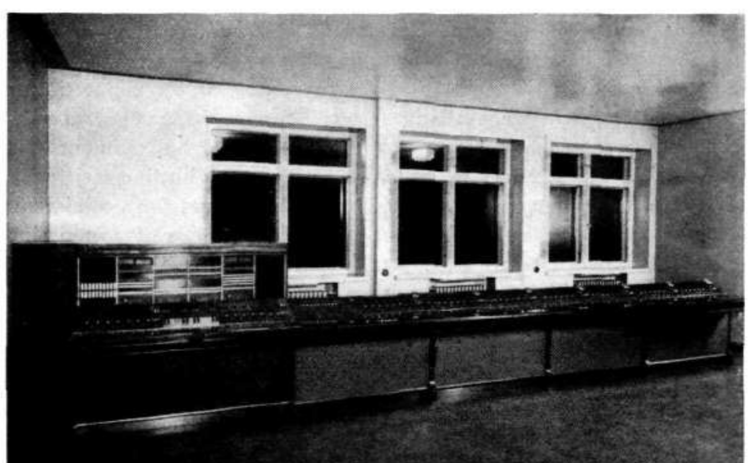
panel 3 and 4: concentration positions of the trunk circuits, with their transit multiple below;

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.

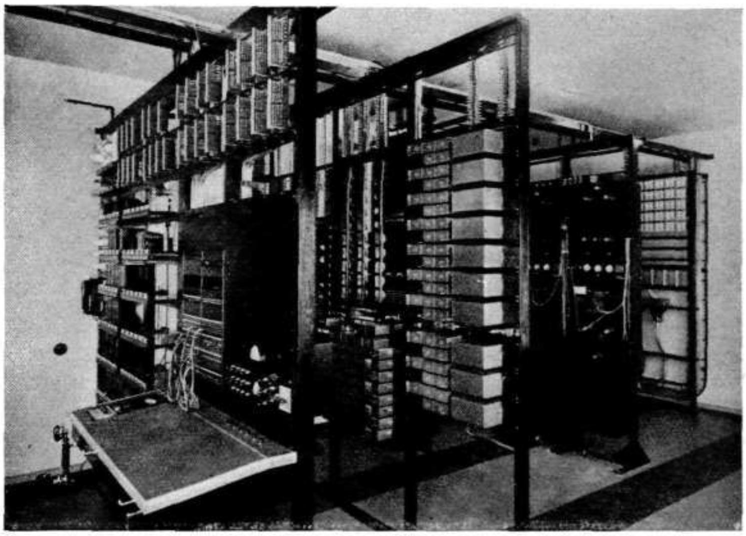
A trunk circuit is led in over lightning arresters and equipment for line measurements and testing to the line transformer, immediately



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:

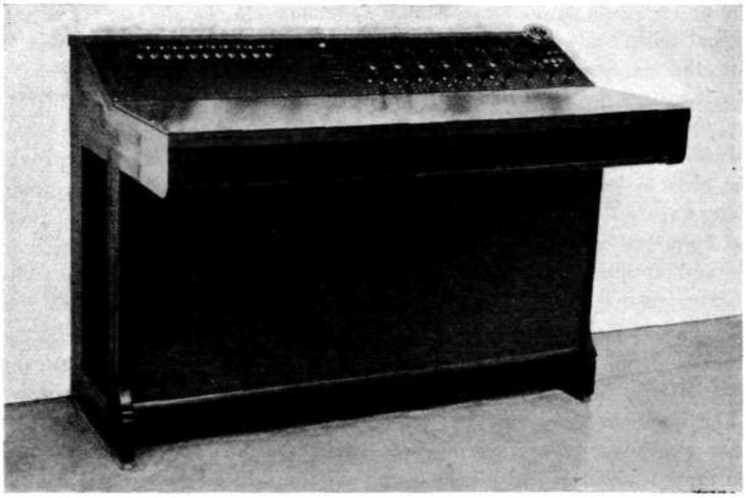


X 5135 **Fig. 8. Apparatus room of the trunk exchange.**
Right to left: line-protection bay, high-frequency and repeater bays, line-relay and selector bays, rack for transformers, line balances, distribution frame, and supervisory and test panel.

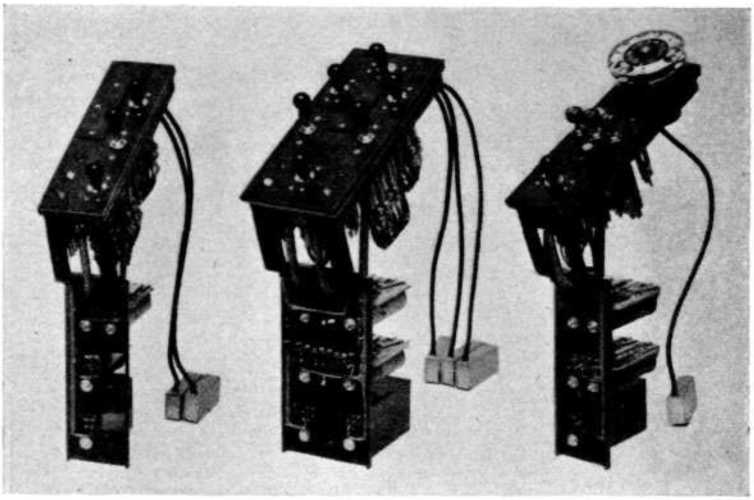
1. by throwing upwards the top of the three keys, a subscriber's selector is started, which finds a clear line to the *automatic local exchange.* To show when dialling may start, a red lamp lights up in the trunk position and, after the automatic setting up of the call has been completed in the local 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;

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.

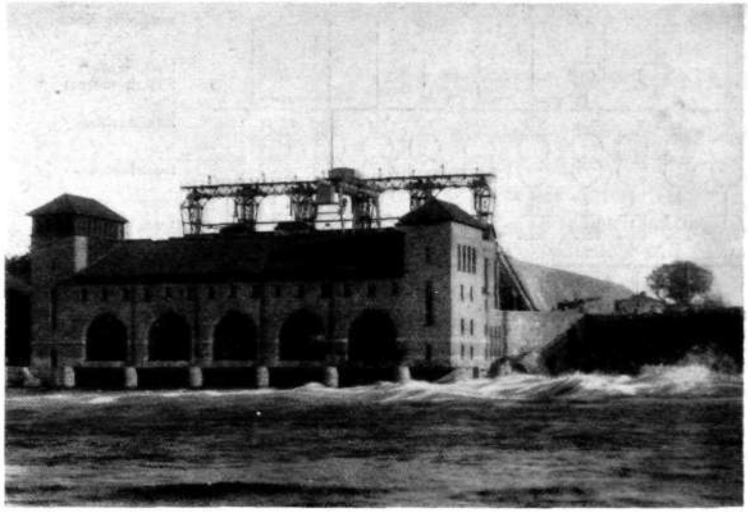
As has been mentioned above there are a number of service lines between various places in the trunk exchange. These lines are connected to the multiple-relay switchboard. In the concentration switchboard they are called from a special jack strip and in the ordering position by pressing a button. The 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



X 5123 View of Älvkarleby Power Station.

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.

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.

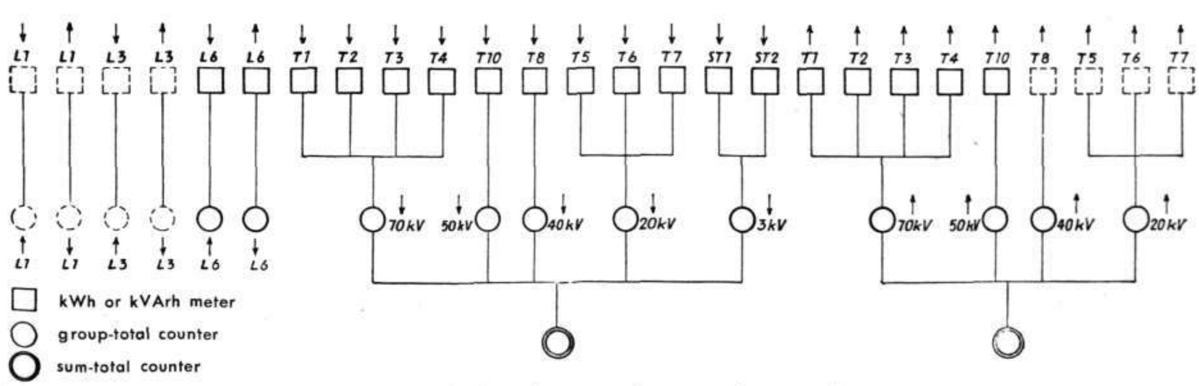
Design.

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.

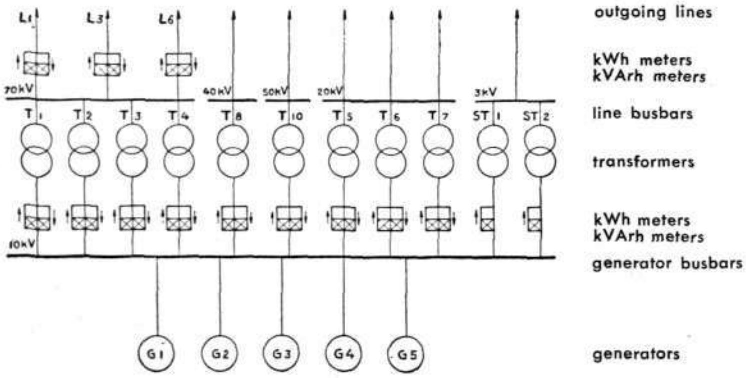
As may be seen from Fig. 1 the system answers two purposes:

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.



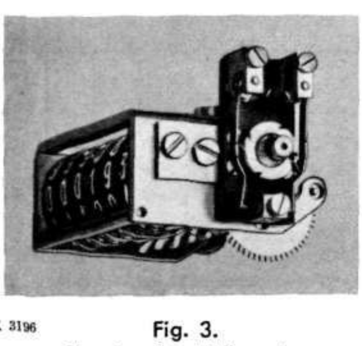
X 1301 Fig. 2. Diagram of the power plant.

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.

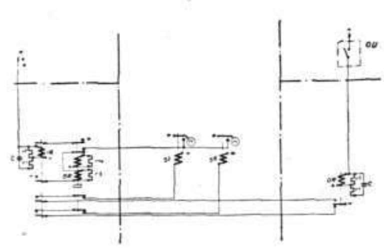
The sum-total counters are fitted with make contacts, which may be used for long-distance transmission of the total number of counted impulses. The Royal Board of Waterfalls has planned to transmit the impulses over an existing high-frequency channel to the central operating office in Stockholm, and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

Operation.

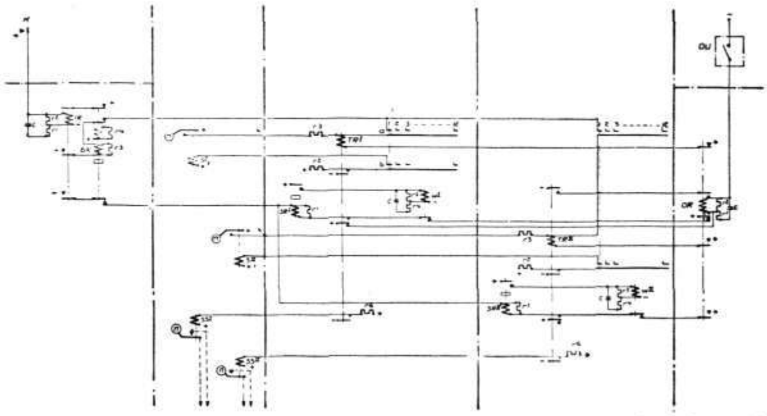
The operation of the part of the system used for the transferring and totalling of the impulses from the meters may be seen from the diagram, Fig. 5.

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, +;

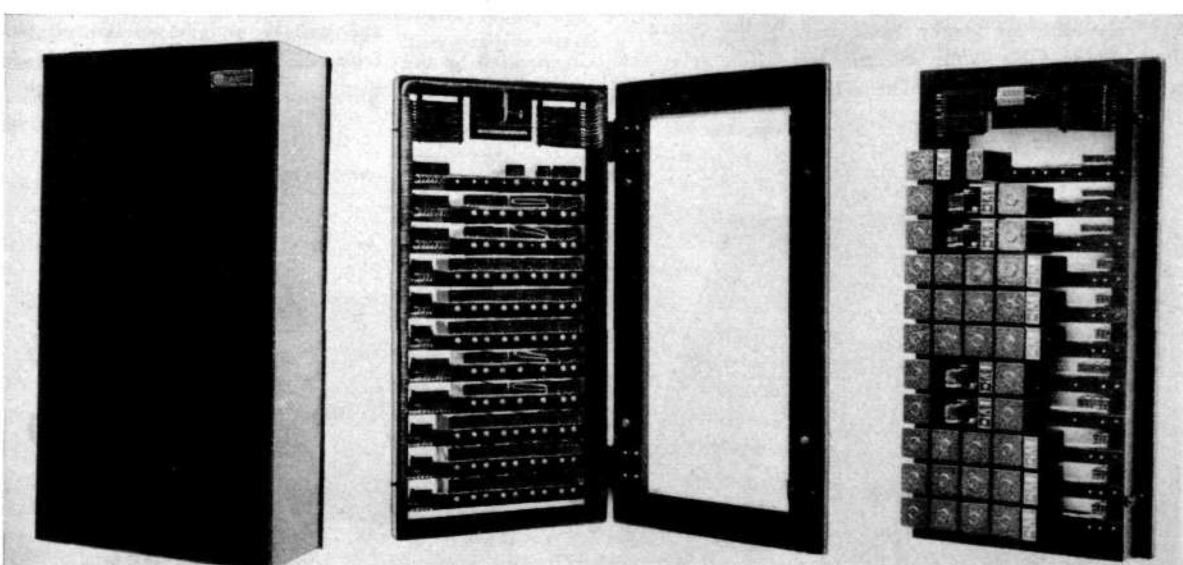
— make contact, *TR*, counter *SS*, +.

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.

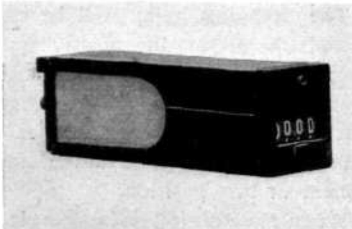
When the counter *S* is energized the following circuit will be closed:



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), +,

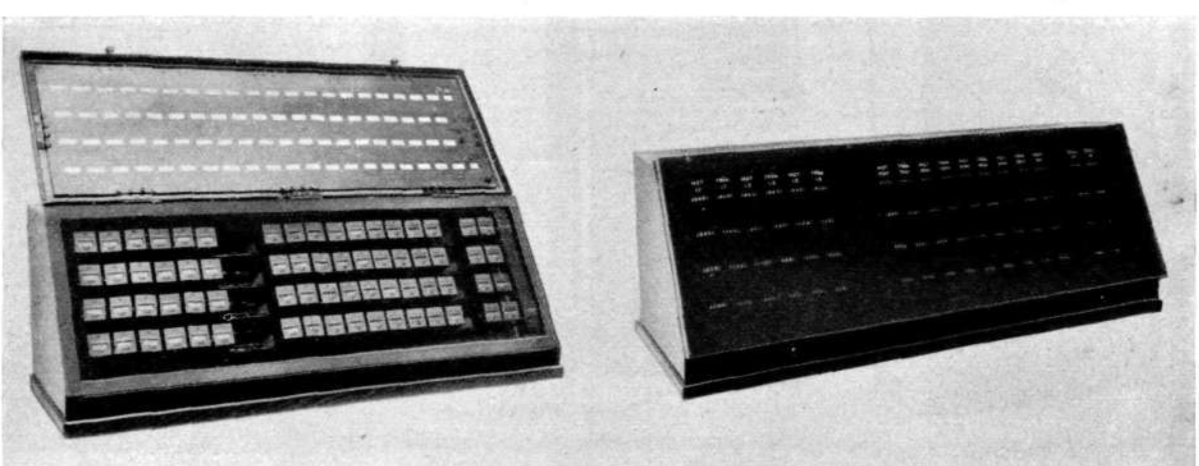
the relay *OR* will be energized and become connected direct to the positive pole over its own make contact. Should the relay *TRI* on the contrary be energized, *i. e.*, when an impulse is being counted, the circuit through the relay *OR* will not be closed until *TRI* is released, and consequently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

X 5154 Fredriksberg Fire Station.

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.

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

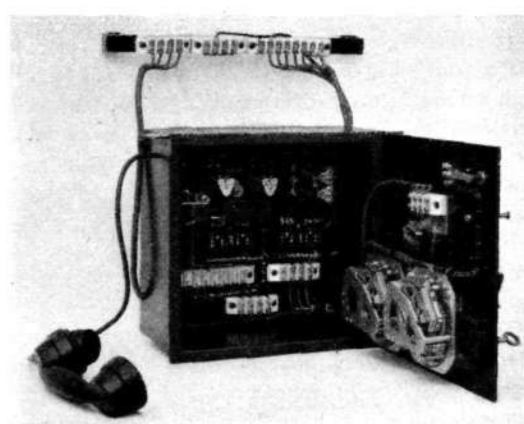

X 1371

Fig. 2. Signal-transmitter inset.

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.

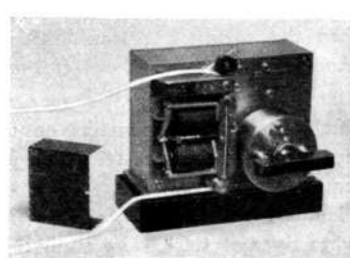
On a separate desk at the telephone switchboard there is supervisory Morse receiver of a stamping type, and there all incoming signals to the alarm board may easily be read. The stamping instrument has two magnet systems for stamping holes in a common paper ribbon, in correspondance with the code-signalling 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.

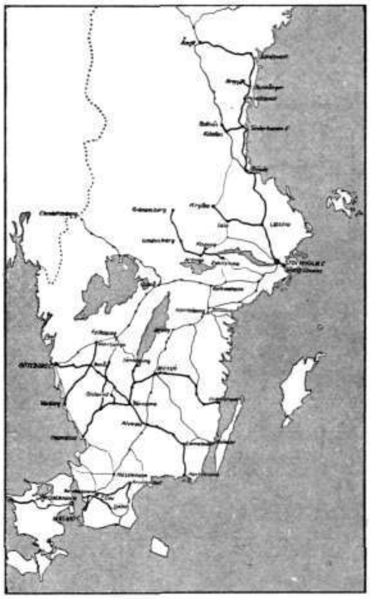
The telephone instrument fitted on the desk is made of black bakelite and fitted with three press buttons and dial. By means of the press buttons *L1* and *L2* the instrument can be connected to the fire-alarm loops of the two line panels, and by means of the third press button *L-aut* to a local automatic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

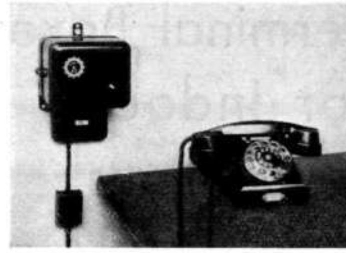
The signalling apparatus consist of four keys and a supervisory lamp fitted in a case of black enamelled sheet-iron. The four keys correspond to the four fire-alarm loops connected to the alarm board. On calls the key is thrown that corresponds to the loop on which signalling is wanted. The policemen 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.

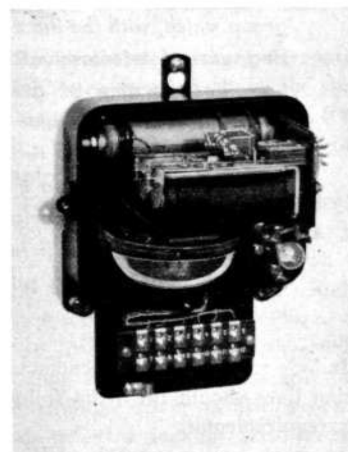
Selective-Calling Telephone Plants in Sweden



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.

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.

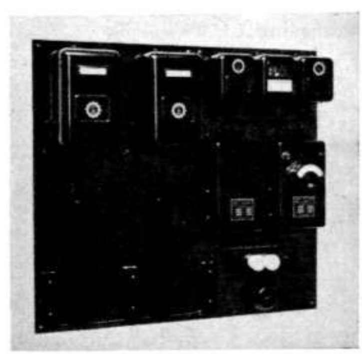
In order to simplify the work of installation, the main telephone equipment and the power plants are supplied completely fitted and wired. Fig. 4 illustrates a station equipment for two selective-calling lines and one automatic power plant for connection to AC mains.

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.

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

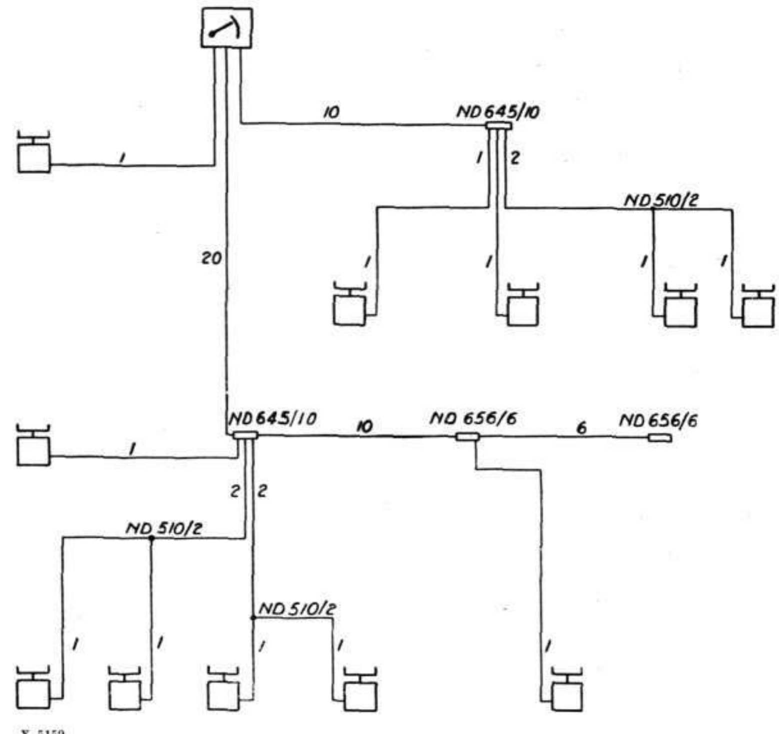
The lines are chiefly overhead lines. An exception is the section Stockholm—Upsala—Krylbo which is made as loaded cable.



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.

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;

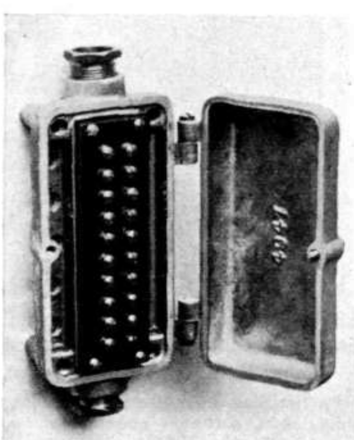
4. *few types of terminal boxes, terminal blocks etc.:* this involves: fewer mounting instructions to be learnt; simpler storing; lower prices, as larger quantities of individual types can be ordered;

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

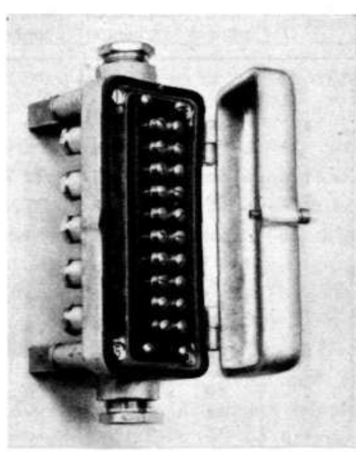
6. *it should be possible to seal* the distributing apparatus so that only authorised persons can have access to the connections;

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.

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



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.

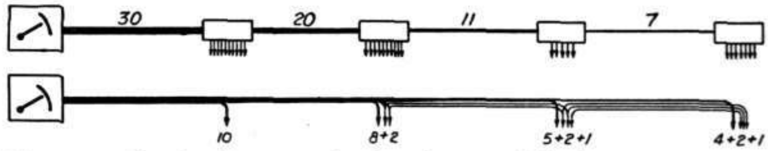
also be used for other kinds of wiring. The wires may either be run along the walls or set in the walls in lead plated piping. In the latter case the distributing and connecting points are placed partly in lead coated boxes and partly in special terminal boxes built into recesses, the distributing apparatus 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.

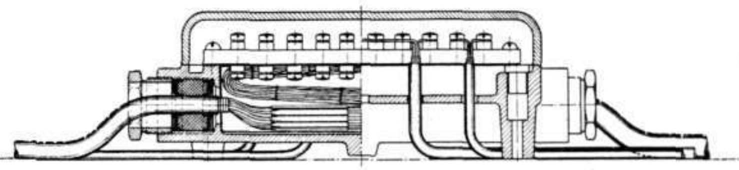
Fig. 3 illustrates how the boxes are used. From this picture it is evident that not only can the boxes be used for end distribution, but a cable from the exchange to the box (max. 30 pairs) can partly be distributed and partly *continue*, say as as 20-pair cable to the next terminal box; in this latter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

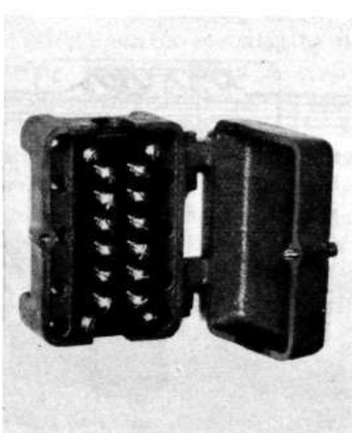
The silumine cover is fixed to the case by a special screw, which can be sealed.

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.

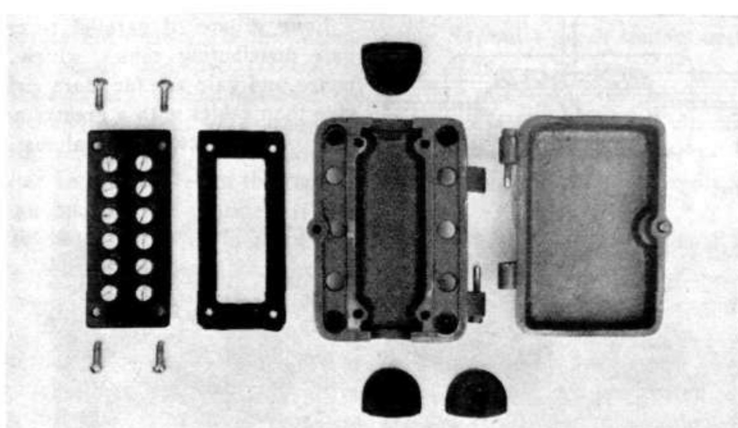
The smaller distributing cables, as a rule 1, 2 or 4-pair cables, are drawn through the 10 holes on the long sides of the box, Fig. 1 and 4. If special tightening is required for these cables, glands with rubber packing are fixed in these holes and the silumine cover is also provided with an extra packing,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

Terminal Boxes, Type ND 655 and ND 656.

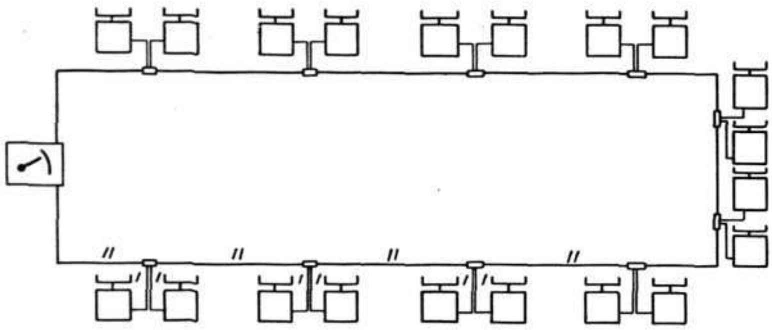
These boxes, Fig. 5 and 6, are similar to those described above. They are made of light-metal, Type ND 655, or of cast iron, Type ND 656,



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.

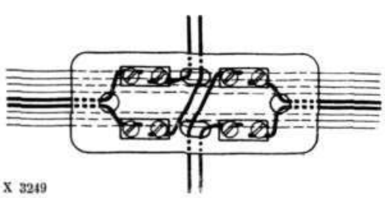
A telephone installation on this system with a 10-pair cable can have 20 subscribers connected.

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.

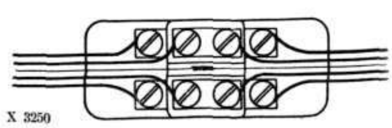
For fire alarm installations where 2-pair cables with earth wire are used or where the conductors are of unusually large diameter, blocks, Type ND 530/2, Fig. 10, are used. These blocks have extra heavy terminals, slots for the earth wire and a sealable cover identical with that used on the distribution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



X 3249



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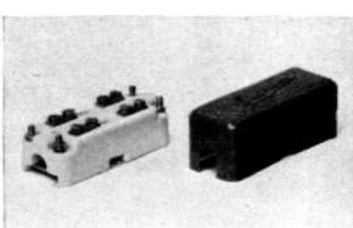
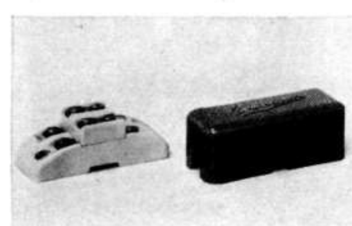


X 3243 **Fig. 8. Terminal block, Type ND 610/2.**

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.

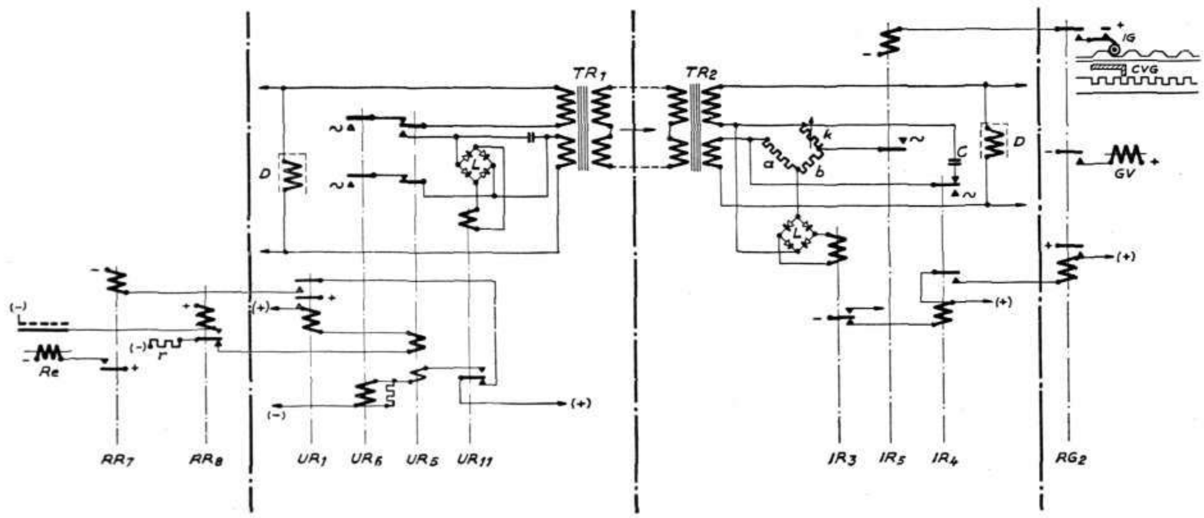
If, on the other hand, the line is dead when the relay *RR8* is energized, the relays *UR11* and *UR6* will be released which will cause the two relays *UR5* and *UR1* to be released, Stop signal will then not be transmitted to the selector until during the next impulse, *i. e.*, when AC is again sent 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.

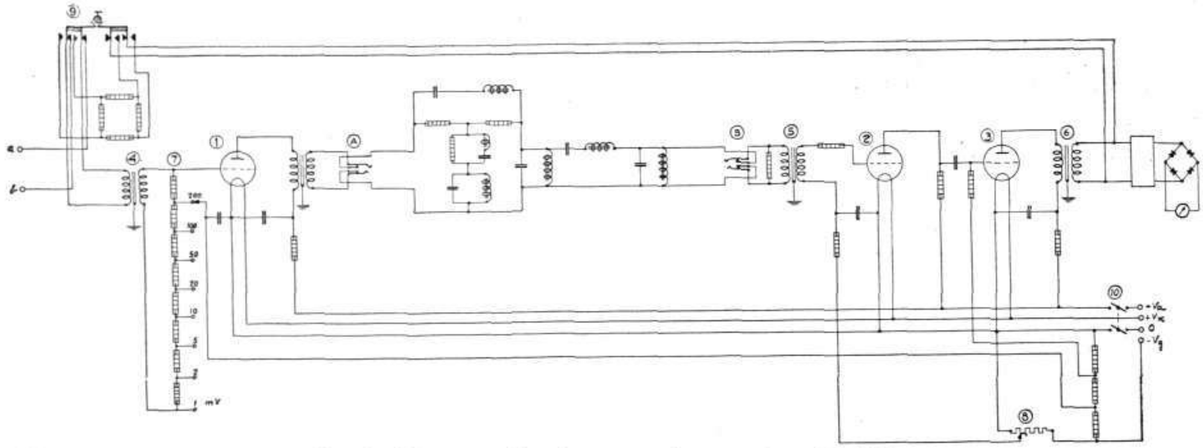
Measurement 11 evidently ensures that all lines from the central point of a line system can be checked by means of only one instrument of this type placed at a central point, and that only one skilled person is required for the checking. The usual measurements require, as will be known, instruments and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

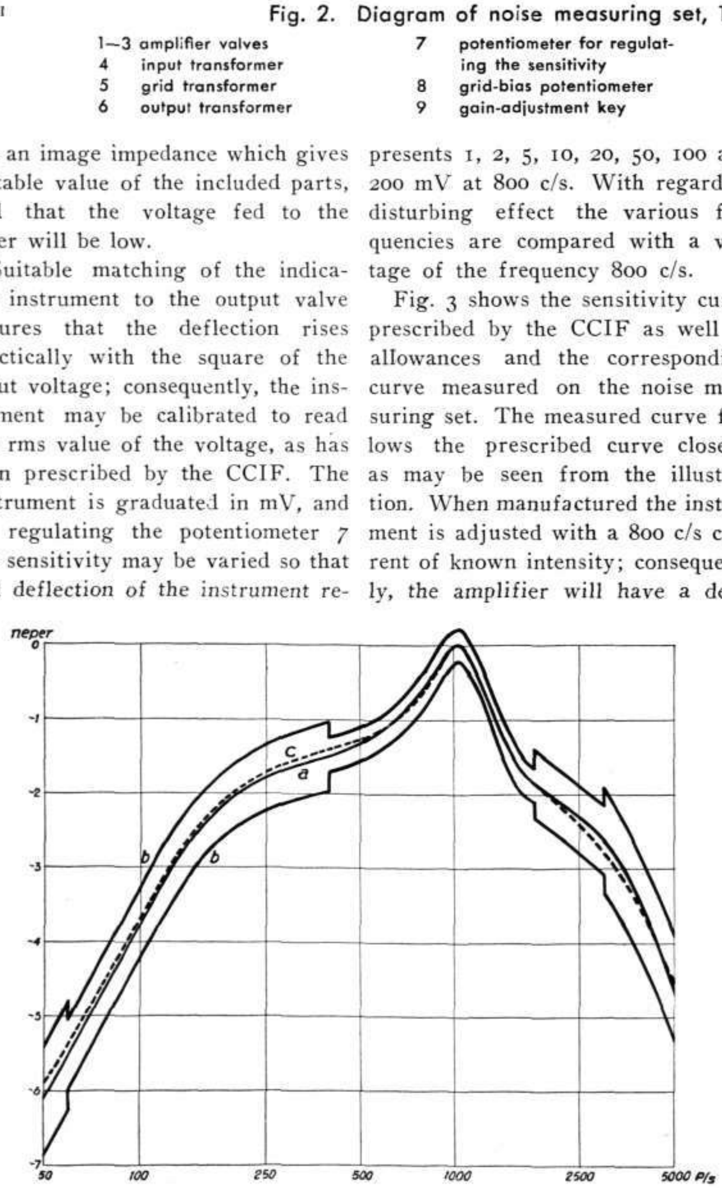


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Fig. 3. Sensitivity curve of noise measuring set.

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

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

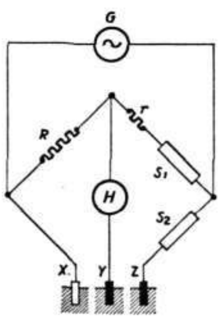
A and *B* the adjustment may remain the same and the instrument may then with sufficient accuracy be used as a direct-indicating instrument for the measurement of low voltages.

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:

$$\frac{X}{R} = \frac{Z + S_2}{r + S_1} \quad \ldots\ldots\ldots\ 1$$



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:

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

For the case when $S_1 = S_2$ we get

$$X = R \quad \ldots\ldots\ldots\ 3$$

From equation 1 it is evident that if

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

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.

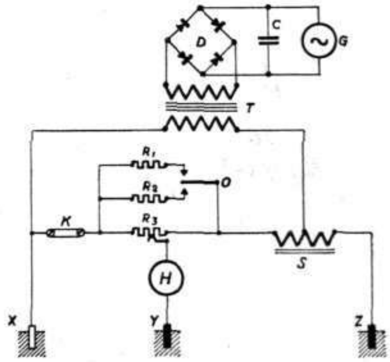
The earth-resistance *X* to be measured is read directly on the scale of the slider of the resistance R_3, except for one multiple of 10, which is determined by the position of the key *O*.

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.**

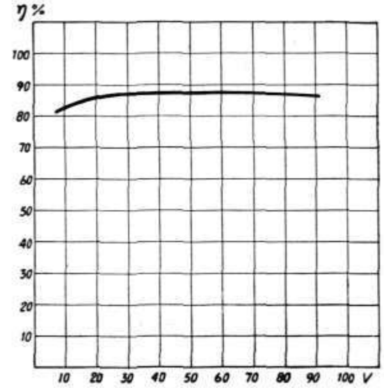
X 3223 **Fig. 8. Line transformer, Type RM 550.**

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 ≤ 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.

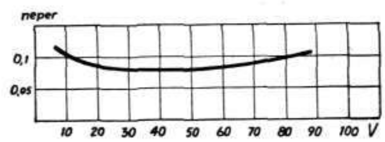
The properties of the transformer at ringing frequency cannot be obtained from one measurement only. The CCIF prescribes that the power efficiency must be greater than 55 % when the transformer is terminated by a resistance of 2 000 ohm on the line side and the voltage on the primary side is 45 V.

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.



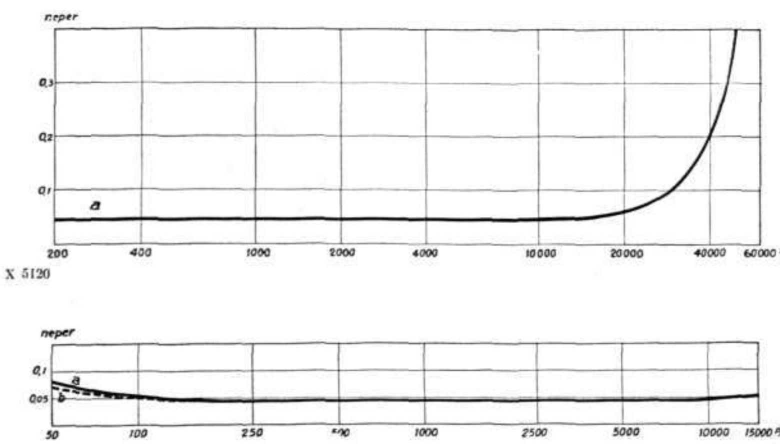
X 3228 **Fig. 11. Effective attenuation of Type RM 550, 800/800 ohm,**
as a function of the primary voltage at 20 c/s, matching impedance 2 000 ohm.

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.

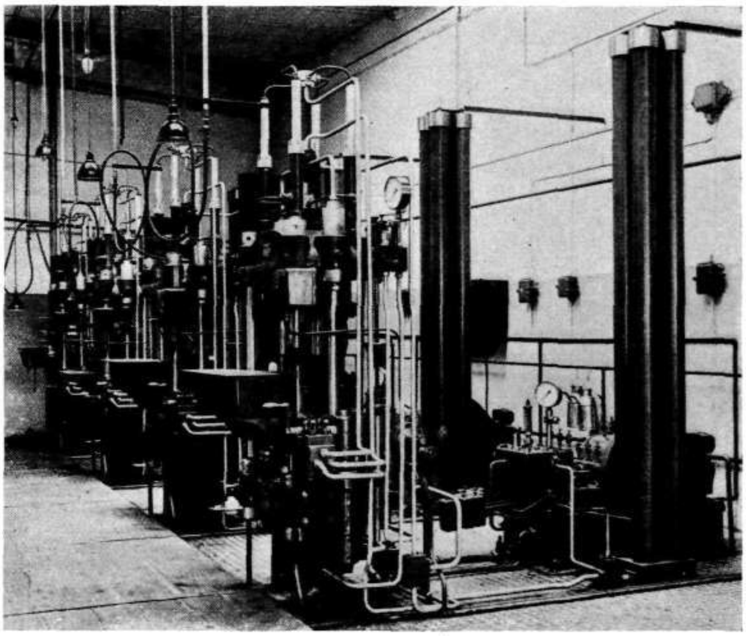
T. Laurent & K. Styrén.



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.

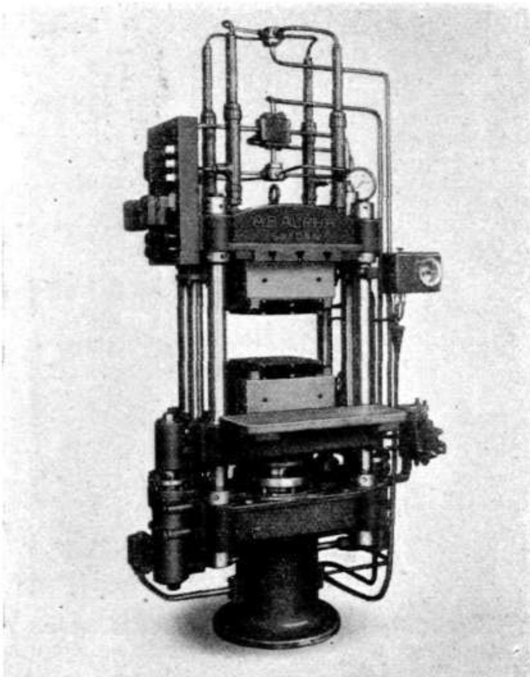
High and Low-Pressure System.

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.

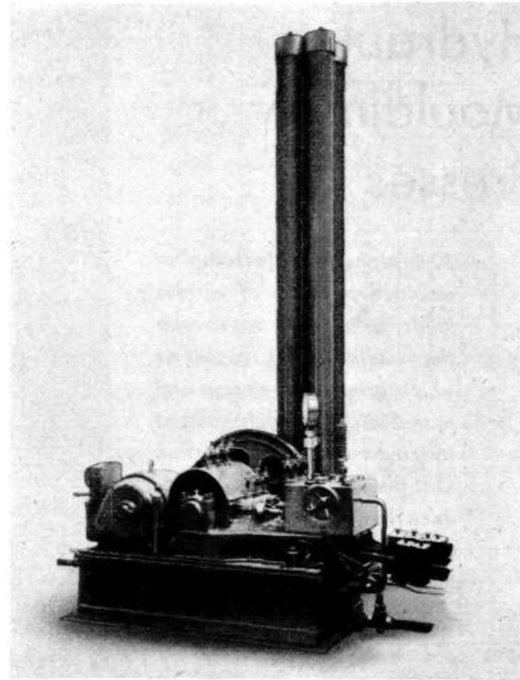
By the use of the semi-automatic controlling device great advantages are obtained: on the one hand the curing time is adjusted by the foreman for each article, and cannot be interfered with by the moulder; on the other the moulder's work is reduced to a minimum, so that in most cases he can attend to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

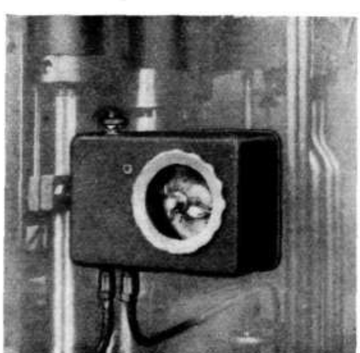
The control box, Fig. 3, contains an alarm clock, allowing a setting from 1/2 to 30 minutes. When the time set in each case has elapsed the clock closes the governing valve so that the diaphragm valve releases the high-pressure liquid from the main cylinder. By means of high pressure in the two push-back 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.

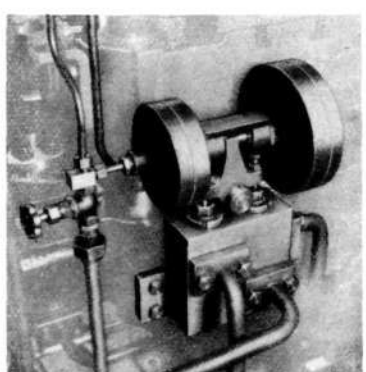
The ejection of the mouldings can be made by a mechanical device which comes into action when the press opens. The double-acting hydraulic ejection device with four cylinders at the top, operated independently by a lever-type valve located to the right, Fig. 1, is to be recommended, as the ejection can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



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



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

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.

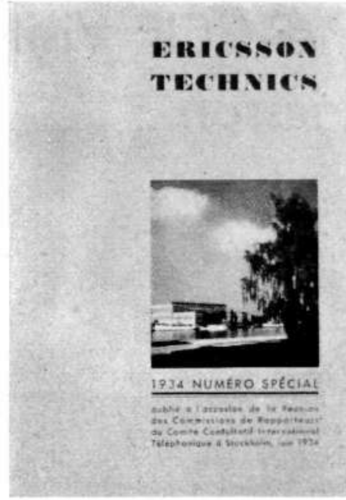
Ericsson Technics No 1, 1934.

T. Laurent: A Selective Echo Suppressor.

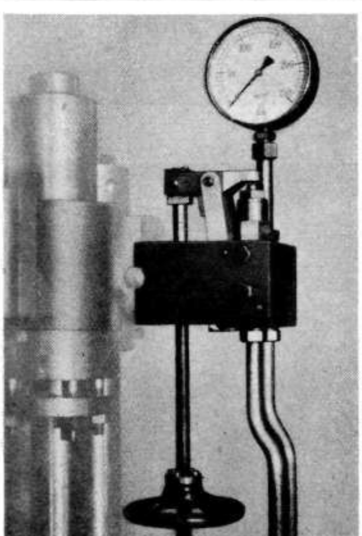
The carrier transmission of telegraphy and telephony on cable circuit is one of the foremost problems of the day in the field of long-distance telecommunication. Carrier transmission is designed to effect more economical operation on lines covering very long distances, which are very expensive per unit 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 calculated 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.

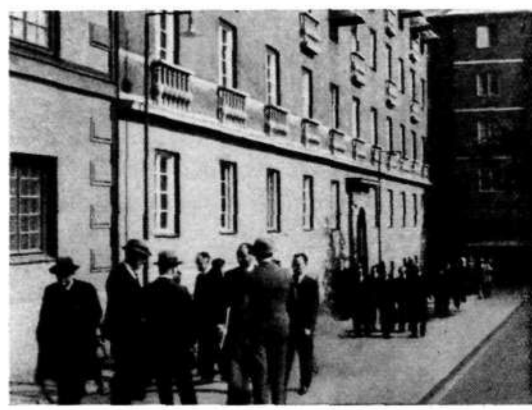
On June 13th an exhibition arranged at the head office of Telefonaktiebolaget L. M. Ericsson was visited. This exhibition was composed partly of telephone material, *e. g.*, telephone instruments for various purposes, automatic switchboards for rural automatization, selective-calling telephone systems, 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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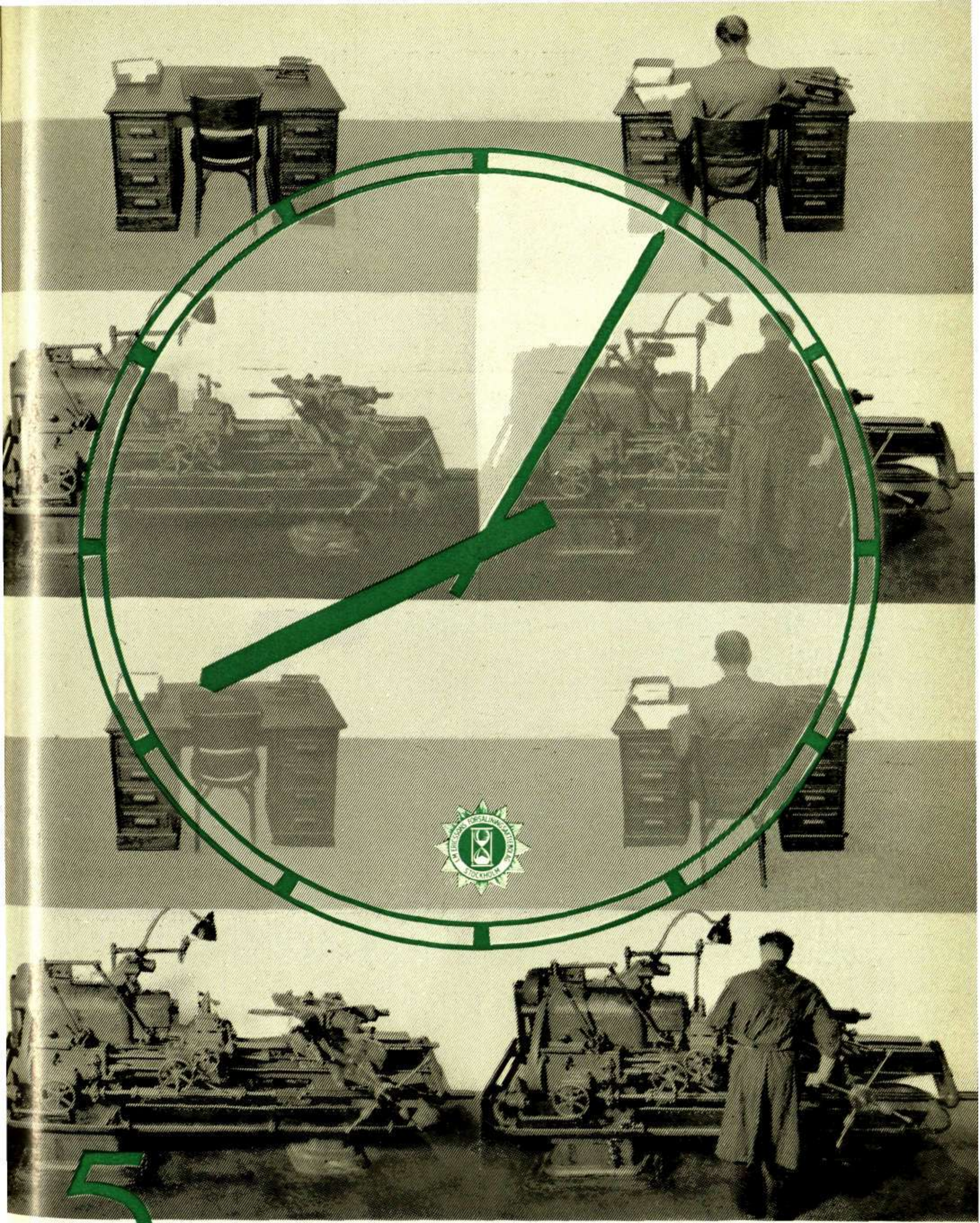

electrical time always right time

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a synchronous clock need never be wound once connected to the mains it runs year after year without supervision

for connection to DC mains or dry cells we supply clocks with automatic winding —

high-precision clockworks ensure accurate running

Telefonaktiebolaget L. M. Ericsson

The L.M. Ericsson Review

No 4 1934

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COOKING
IRONING
HEATING

REX kitchen range,
Type H-3

REX hot-water tank in an
Indian home in Calcutta

chinese boy
with REX flat-iron

with

REX

electric

kitchen ranges
hot-plates
flat-irons
radiators
stoves
hot-water tanks

A/S ELEKTRISK BUREAU

The L. M. ERICSSON REVIEW

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

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Printed in Sweden
Centraltryckeriet, Stockholm 1934

THE ECONOMY REGISTER

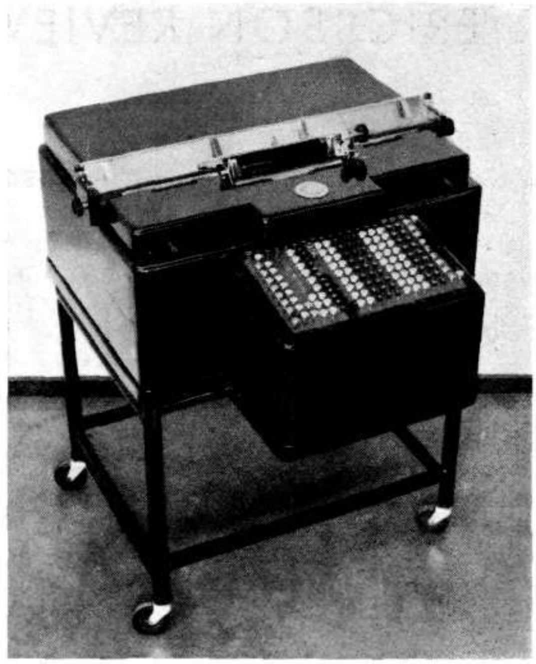
by K. G. HÄGERSTRÖM,
Aktiebolaget Ekonomiregister,
Stockholm.

The main principles of a new type of book-keeping machine, called the Economy Register, which has been invented by Mr. W. Svensson, manager of Aktiebolaget Ekonomiregister, Stockholm, are described in this article. Telefonaktiebolaget L. M. Ericsson has been entrusted with the manufacture of the machine.

In their function the new machines differ considerably from the usual type of book-keeping machines at present on the market. The most important of these machines have as a purpose, as far as the calculating functions are concerned, to balance the individual book-keeping accounts in horizontal calculators, and at the same time to accumulate in vertical calculators similar amounts from separate accounts. Debit entries and the corresponding credit entries in a series of accounts are dealt with separately, in many cases even in separate machines. The working out of the standing of each individual account and the statistics based thereon as regards customers and purchases accounts, stockbook and ledger etc. is in main the purpose of machine book-keeping of this kind.

The purpose of the Economy Register on the other hand is in the first place to provide a means of financial control, by which is meant a control to make sure that the figures and economic contents of the vouchers are represented accurately in making up the books, so that no amounts have been omitted, added or altered. Vouchers for certain transactions and amounts can of course from the logical and mathematical point of view give but one accurate result and through the Economy Register the primary documents are compulsorily bound up with the balance-sheet figures, while at the same time the machine carries out the intermediate stage: the systematic accounting.

The basis of the function of the Economy Register is consequently the transactions indicated by the vouchers, and simultaneously with the accounting the machine states how the economic position and the result based on the vouchers



X 1393 Fig. 1. The Economy Register.

change from transaction to transaction. This function is based on the fact that all the transactions as far as their influence on all balance-sheet and profit-and-loss-account factors is concerned can be assorted into eight types or classes.

Principles.

An inevitable basis for the functioning of the Economy Register is that the accounting, which is the object of book-keeping, must consist exclusively of a description of the *changes* occurring in the economic position which existed at the outset of a period of accounting, and that these changes are recorded only as *transactions*. The position at the end of the period must be arrived at exclusively with this as a basis if book-keeping shall serve as a means of financial control.

The changes represented by the transactions consist of course in increases and decreases of the various assets, liabilities, income factors (profits) or expenditure factors (losses) of the business. As is known each transaction has to be accounted for doubly in double-entry book-keeping: as an increase or decrease in one place (debit entry) and at the same time as a corresponding increase or decrease in another place (credit entry). If assets and liabilities are regarded as the positive and negative capital of a business and are indicated T and S[1], and the causes of profits and the causes of losses are regarded as the positive and negative result factors and are indicated V and F, the contents of these debit and credit changes, as representing increases (+) or decreases (—) of T, S, V and F, can be illustrated in the following manner:

debit			credit
positive changes of capital	$T+$ $S-$	$T-$ $S+$	negative changes of capital
negative changes of result	$F+$ $V-$	$F-$ $V+$	positive changes of result

If, *e. g.*, there is a transaction involving an increase of assets ($T+$) as a debit change, the cause must be found in *one* of the four credit changes, *viz.*, in the decrease of another asset ($T-$), *or* in the increase (arising) of a liability ($S+$), *or* in an increase of income ($V+$), *or* finally in the correction of a previous opinion according to which the asset was considered lost ($F-$), etc. Each of the four debit changes can evidently be explained by four different credit changes or vice versa, and consequently we find, as is shown in Table 1, that logically only 32 combinations are possible. Of these combinations 16 must of course be duplicates, so that actually there are in fact only 16 combinations logically possible. If these cases are investigated it will be found that four, indicated as *9* to *12*, are only combinations of changes in profits and losses without affecting the capital. These cases will cause no change in the composition of the assets and liabilities and should therefore not be regarded as actual transactions, so they can be eliminated. Further there are four cases, indicated as *13* to *16*, which are only reversions of the cases indicated as *1* to *4*; so is, *e. g.*, the case *13* ($T+$ $F-$) only a reversion of the case *1* ($F+$ $T-$) etc. In the table the reversions have been indicated by an x. Consequently there remain only eight possible combinations (with reversions) of explaining the contents of various transactions, and in the following these are indicated as *1* to *8*.

There are four cases of interchange between two capital factors only, (*5* to *8*). These cases must always involve a *positive change in capital*, *i. e.*, an increase of assets ($T+$) or a decrease of liabilities ($S-$) on one side (debit change), and at the same time a corresponding *negative change in capital*, *i. e.*, a decrease of assets ($T-$) or an increase of liabilities ($S+$) on the other side (credit change); both these changes are of the same amount so that they counteract each other and produce no positive or negative difference between T and S. These four cases are: *5* ($T+$ $T-$), *6* ($T+$ $S+$), *7* ($S-$ $S+$) and *8* ($S-$ $T-$).

Further there are two cases of profit transactions, (*3* and *4*), *i. e.*, a *positive change of capital:* increase of assets ($T+$) or decrease of liabilities ($S-$) (debit change), without any corresponding negative change of capital, which causes a surplus by a profit factor occurring ($V+$) (credit change). These cases are *3* ($T+$ $V+$) and *4* ($S-$ $V+$).

Finally there are two cases of loss transactions, (*1* and *2*), *i. e.*, a *negative change of capital:* de-

Table 1.

logically possible types					
type	debit	credit	type	debit	credit
5	$T+$	$T-$	5	$T+$	$T-$
6	$T+$	$S+$	8	$S-$	$T-$
13	$T+$	$F-$	1	$F+$	$T-$
3	$T+$	$V+$	15	$V-$	$T-$
8	$S-$	$T-$	6	$T+$	$S+$
7	$S-$	$S+$	7	$S-$	$S+$
14	$S-$	$F-$	2	$F+$	$S+$
4	$S-$	$V+$	16	$V-$	$S+$
1	$F+$	$T-$	13	$T+$	$F-$
2	$F+$	$S+$	14	$S-$	$F-$
9	$F+$	$F-$	9	$F+$	$F-$
10	$F+$	$V+$	12	$V-$	$F-$
15	$V-$	$T-$	3	$T+$	$V+$
16	$V-$	$S+$	4	$S-$	$V+$
12	$V-$	$F-$	10	$F+$	$V+$
11	$V-$	$V+$	11	$V-$	$V+$

mathematically remaining types			corrections		
type	debit	credit	type	debit	credit
1	$F+$	$T-$	1 x	$T+$	$F-$
2	$F+$	$S+$	2 x	$S-$	$F-$
3	$T+$	$V+$	3 x	$V-$	$T-$
4	$S-$	$V+$	4 x	$V-$	$S+$
5	$T+$	$T-$	5 x	$T+$	$T-$
6	$T+$	$S+$	6 x	$S-$	$T-$
7	$S-$	$S+$	7 x	$S-$	$S+$
8	$S-$	$T-$	8 x	$T+$	$S+$
9	$F+$	$F-$	these types are disregarded since they do not express any actual transactions.		
10	$F+$	$V+$			
11	$V-$	$V+$			
12	$V-$	$F-$			
13	$T+$	$F-$	these types are equal to the types 1 x, 2 x, 3 x and 4 x according to above.		
14	$S-$	$F-$			
15	$V-$	$T-$			
16	$V-$	$S+$			

[1] For the sake of uniformity with other languages, the following designations have been used, *viz.*,

T = assets,
S = liabilities,
D = difference between these,
V = profit-factors (income),
F = loss factors (expenditure),
R = result,
Om_1 = total journal entries,
Om_2 = debit turnover,
Om_3 = credit turnover.

crease of assets ($T-$) or increase of liabilities ($S+$) (credit change) without any corresponding positive change of capital, which causes a deficit by a loss factor occurring ($F+$) (debit change). These cases are *1* ($F+$ $T-$) and *2* ($F+$ $S+$).

Whatever transaction one might choose out of the innumerable transactions of the business of a commercial enterprise it must consequently always be possible to classify it in accounting in one of the above-mentioned eight cases (if the eight corrections of the same types are disregarded).

After each transaction in this manner has been classified into one type, there remains to be investigated the economic *consequences* of each of these types in respect of a complete financial accounting as to capital and result. These consequences can be seen from Table 2. If type *1* is taken as an example and the table is read horizontally, it will be seen that transactions of this type, in addition to the self-evident entries on the primary document and in the journal, call for the entering of the increase of loss-causes in the debit column of an individual expenditure account and of decrease of assets in the credit column of an individual asset account. In order to render clear the influence of the type in direct connection with the general accounting as to capital and result, a simultaneous *calculation* in calculators is required to show how the transactions of this type increase the previous turnover figures of the primary material ($P+$), increase the previous turnover of the journal entries ($G+$), increase the debit turnover ($D'+$) on account of the individual loss-factor (expenditure) which is of course accounted for in debit, and increase the credit turnover ($K+$) on account of the individual decrease of assets which is of course accounted for in credit; further how they decrease the previous total money-value of the assets and consequently influence in negative direction the difference between assets and liabilities, *i. e.*, the difference (D), and finally increase the previous loss-causes and on account of this reduce the previous working result (R), *i. e.*, the difference between income and expenditure.

If this whole series of calculations, which according to table 2 varies for each type, is carried out in connection with the accounting of each transaction, the following nine totals will be permanently available as they must be, due to transactions accounted, viz.:

1. the total turnover of the journal entries (Om_1);

2. the debit turnover (Om_2) due to transactions accounted = the total of $T+$, $S-$, $F+$ and $V-$;

3. the credit turnover (Om_3) due to transactions accounted = the total of $T-$, $S+$, $F-$ and $V+$;

4. the total money-value of the assets due to transactions accounted (T) = the difference between $T+$ and $T-$;

5. the total money-value of the liabilities due to transactions accounted (S) = the difference between $S+$ and $S-$;

6. the total money-value of the profit causes (income) due to transactions accounted (V) = the difference between $V+$ and $V-$;

Table 2.

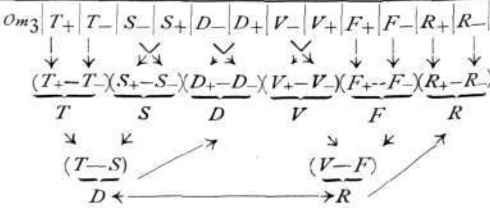
type	entry consequences										calculation consequences															
	voucher	journal entry	debit entries on individual accounts				credit entries on individual accounts				turnover of				assets		liabilities		difference		profit		loss		result	
			t_+	s_-	f_+	v_-	t_-	s_+	f_-	v_+	P_+	G_+	D'_+	K_+	T_+	T_-	S_-	S_+	D_-	D_+	V_-	V_+	F_+	F_-	R_+	R_-
1	×	×	—	—	×	—	×	—	—	—	×	×	×	×	—	×	—	—	×	—	—	—	×	—	—	×
2	×	×	—	—	×	—	—	×	—	—	×	×	×	×	—	—	—	×	×	—	—	—	×	—	—	×
3	×	×	×	—	—	—	—	—	—	×	×	×	×	×	×	—	—	—	—	×	—	×	—	—	×	—
4	×	×	—	×	—	—	—	—	—	×	×	×	×	×	—	—	×	—	—	×	—	×	—	—	×	—
5	×	×	×	—	—	—	×	—	—	—	×	×	×	×	×	×	—	—	—	—	—	—	—	—	—	—
6	×	×	×	—	—	—	—	×	—	—	×	×	×	×	×	—	—	×	—	—	—	—	—	—	—	—
7	×	×	—	×	—	—	—	×	—	—	×	×	×	×	—	—	×	×	—	—	—	—	—	—	—	—
8	×	×	—	×	—	—	×	—	—	—	×	×	×	×	—	×	×	—	—	—	—	—	—	—	—	—
											total	Om_1	Om_2	Om_3	T_+	T_-	S_-	S_+	D_-	D_+	V_-	V_+	F_+	F_-	R_+	R_-

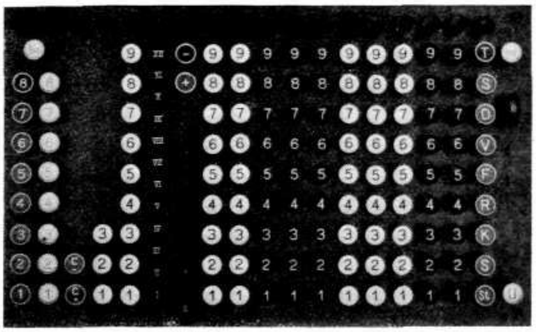
control: $Om_1 = Om_2 = Om_3$

$T + F = S + V$

$T - S = V - F$

$D = R$





x 1394 **Fig. 2. Keyboard of the Economy Register.**

7. the total money-value of the loss causes (expenditure) due to transactions accounted (F) = the difference between $F+$ and $F-$;

8. the total money-value of the difference between assets and liabilities (D), produced by the transactions accounted, *i. e.,* surplus or deficit;

9. the total money-value of the difference between profit causes and loss causes (R), produced by the transactions accounted, *i. e.,* net profit or net loss.

By this method is made possible a mathematical control that the amounts of the balance-sheet and the profit-and-loss-account are those caused by the transactions which are recorded in the chronological journal entries, and at the same time also a control of the book-keeping on accounts, since the totals of the individual account balances of asset, liability, profit (income) and loss (expenditure) nature respectively will be given before-hand in direct connection with the primary material. At the same time as each transaction is entered in the respective accounts, its figures are also bound up with the total capital and result position.

Design.

The Economy Register book-keeping machine is illustrated in Fig. 1. The most characteristic features of the machine are the analysis keys and the four sets of printers working simultaneously.

The machine has one analysis key for each of the eight above-mentioned types of transactions, and by the setting of one single key both the selecting of the calculators actuated in each case and the nature of the calculations (addition or subtraction) is determined. The sets of printers can take in decimal systems 10 digits (9 999 999 999), in sterling 7 digits (£ 9 999 999.19.11).

Three of the four sets of printers are placed on top of the keyboard and their printing is visible to the operator, while the fourth set is placed under lock inside the machine. Of the three former the middle one serves for control stamping the vouchers, the left one for debit entries, if wanted in accounts, and the right one for credit entries, if wanted in accounts. By the fourth set of printers a continuous list is obtained of all amounts entered in accounts and calculators.

Operating Devices.

As can be seen from Fig. 2 the keyboard contains the following columns of keys and key groups, reading from left:

first column: eight analysis keys, each corresponding to a type of transaction and together covering all requirements for complete financial accounting under strict financial control of any economic enterprise. One operation of the machine for the complete accounting of a transaction takes about two seconds;

second column: eight keys for correction, which are used for restoring faulty recordings both in calculators and by means of the set of printers; these corrections are automatically printed in red;

(on top of the first and second columns there is a repetition key in common for these two columns);

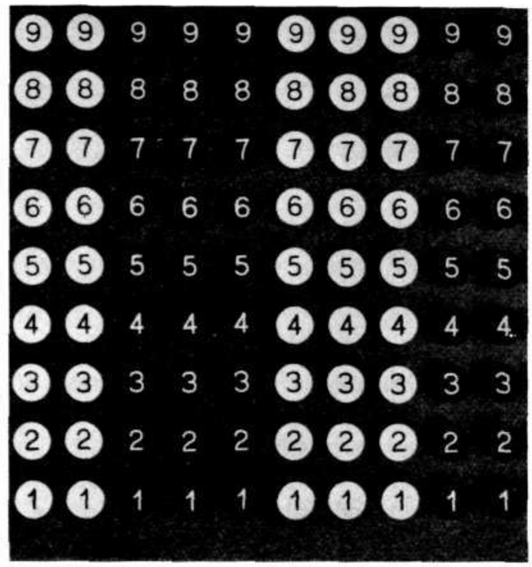
third column: two keys for cash transactions, which operate the calculator for recording cash received and cash paid out. These keys also cause the symbols $C+$ and $C-$ to be printed automatically on the voucher (middle set of printers), entered in the journal (fourth set of printers) and in the account columns of the debit changes of the cash (left set of printers) and credit changes (right set of printers). If considered desirable these keys can also be used for separate recording of, *e. g.*, the current assets of the business;

fourth, fifth and sixth columns: date keys which are set each day and stamp the date on the voucher and the journal entry as well as on the debit and credit entries at one operation of the machine;

seventh column: six locks for book-keeper's keys and two balance keys. The machine functions for accounting only when unlocked by a book-keeper's key. The book-keepers' keys, for each of which a receipt has been given by the operator, serve to identify the operator who has carried out a certain recording, the corresponding key mark (*A—F*) being printed automatically. Finally, these keys, as explained later, are also used for changing the amounts on the keyboard to figures for reference purposes. The two balance keys in the seventh column are connected with a calculator, in which the individual balance or the group totals of similar transactions can be calculated (compare with the balance keys in the eighteenth column);

eighth to seventeenth columns: digit keys for amounts which can also be used for reference purposes. These keys, which allow ten-digit amounts (100 millions), are normally locked and are brought into function only by the analysis key or by a book-keeper's key first having been depressed; zeros are printed automatically.

The machine illustrated is designed for decimal calculation: the machine can however be



supplied for pounds, shillings and pence with seven-digit capacity (10 millions).

These digit keys are used also as reference keys for simultaneous numbering of two accounts or of a debit and a credit change, which can be carried out after the book-keeper's key has been depressed. By this the machine automatically selects a new account column for the debit and credit printers, and the calculators are locked, so that the digit keys can be used for writing figures and groups of figures only for reference purposes, which entries are automatically printed in red;

eighteenth column: seven report keys and (below) two balance keys.

The report keys serve for extracting a printed financial report containing the above-mentioned nine control amounts for capital and result which have been calculated by the machine and stand mechanically in accurate mathematical relation to the money-values of the transactions recorded. The report keys are kept under the lock so that only the person having the key of the lock (*R* in the nineteenth column) can obtain the report, which is carried out in a few seconds.

The balance keys, the last two in this column, are for the purpose of taking out an individual balance or group total, with the amounts of it either printed and brought forward (*S*) or only printed (*St*), after which the counter is returned to zero;

nineteenth column: reading downwards repetition key for the digit keys, lock for the report keys, motor bar and a common release key. This latter releases simultaneously all the keys pressed except the date and analysis keys. At the top of the keyboard there are in addition 18 release keys, one for each column of keys.

Safety Devices.

All keys of the keyboard except the date keys are normally locked so that they cannot be pressed. As has already been mentioned, the machine is provided with three locking devices with corresponding keys, *viz.*, book-keepers' keys, report key and a key for the lock of the journal list (see below). The book-keepers' keys are receipted by the respective operators, while the keys for the report keys and the journal list are kept by the person in charge of the book-keeping (or by the auditors).

After a book-keeper's key has been inserted and turned, all keys with the above-mentioned exception remain locked except the analysis keys; the book-keeper is obliged to indicate by pressing an analysis key what type of transaction he intends to record before any amount can be entered by means of the digit keys, which are only unlocked when an analysis key is pressed.

If, after being turned, the book-keeper's key is pressed down, the digit keys are unlocked, but the analysis keys are locked instead and the calculators disconnected, so that the digit keys can be used only for writing reference numbers, quantities, etc.

No operation whatever can be carried out on the machine without being printed on the journal list, which is kept locked in the machine. When the journal list is full, this is automatically indicated by a signal and the keys are locked.

No report key can be used without the sets of printers automatically indicating the key used. Different types of print are used in the debit and credit sets, so that confusion of the debit and credit entries is easy to discover.

The voucher is automatically stamped with a consecutive order-number by means of a calculator, which cannot be restored to zero or in any manner actuated by the operator, and this order-number is printed by all four sets of printers operating synchronously so that it is found in all entries carried out at one time. Each entry on the continuous list, in debit and in credit is consequently connected direct with the voucher concerned.

Function.

In order to explain in a simple manner the operations for the complete accounting of a series of transactions by means of the Economy Register, we will assume that the vouchers have been provided in advance by a person in charge of the accounting with notes of the type number (*1—8*) of the transaction recorded by the voucher in question and the reference numbers of the accounts in question for the accounting of each transaction. In this manner a person with no book-keeping training can serve as an operator.

The operator inserts the voucher in the middle set of printers and selects the account cards in question in accordance with the information written on the voucher and then inserts the cards in the credit and debit printers respectively.

After the book-keeper's key has been inserted and turned, the first operation will be to indicate the reference numbers of the accounts in question. For this purpose he presses the book-keeper's key and sets up on the digit key-board the numbers of the selected debit and credit accounts after which he starts the machine by means of the motor bar. The machine then prints in red the individual symbol of the book-keeper's key and the numbers of the accounts simultaneously in all four places, *viz.*, on the voucher, in the journal list and in the debit and credit accounts in the correct columns. The meaning of these text informations will be treated further below.

In the next operation the analysis key for the type of transaction in question is pressed, and in addition the digit keys corresponding to the amount of the voucher and the motor bar. In the movement which follows the machine functions in the following manner: at the same time as the voucher is control stamped, the transaction is entered on the journal list and entries are made in the corresponding debit and credit columns, and at the same time the effect of the transaction in different respects is calculated in the calculators of the machine, so that an exhaustive accounting of the transaction is obtained in respect of its consequences for the capital and result of the business. The entries which are printed in the same manner by all sets of printers consists of: automatically consecutive order-number, type number (*1—8*) — which gives information of the principle contents of the transaction — symbol for cash transaction, if required, date and amount.

If a series of similar transactions are to be recorded, *e. g.*, a number of sales invoices, in which a great number of debit entries correspond to one or a few credit entries, this is possible by means of separate calculators for collating the credit amounts in question. This type of machine also allows the balancing of either the debit or the credit account, although in respect of the type described here this is considered rather unnecessary and beyond the purpose of complete financial transaction accounting.

Text References.

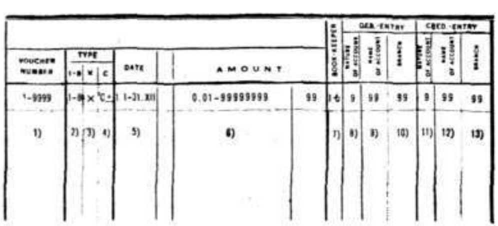
The purpose of the text reference figures of the Economy Register is to furnish a check on the contents of the vouchers. From Fig. 3, which illustrates in diagram half an account, can be seen the information which is obtained concerning the contents of the transaction recorded:

the *first column* gives information regarding the order-number of the transaction, and this is also to be found on the voucher, in the journal entry and in the debit and credit entries. The order-number also indicates the chronological sequence of the vouchers and the number of journal entries, debit entries and credit entries carried out. The number in this column changes automatically from 1 to 9 999, and after that it is automatically restored to 1;

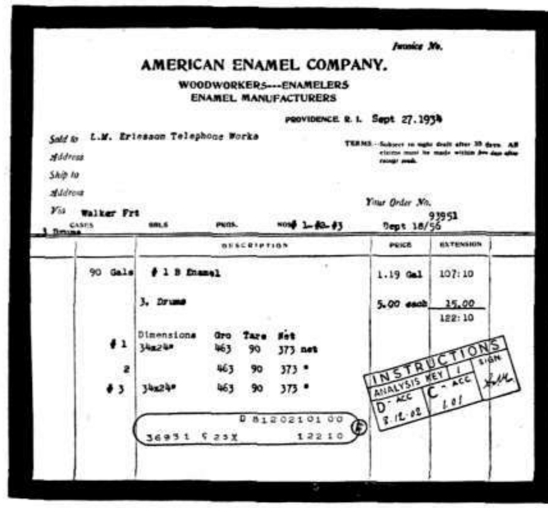
the *second column* gives information regarding the type number of the individual transaction represented by the voucher. At the same time as this number is printed, the systematical working out of the position is set in operation, so that one can see whether this has been done in accordance with the contents of the voucher and its amount. The text in this column consists of the accounting type *1—8*;

the *third column* gives in a similar manner information regarding the type number for the reversion or correction of an individual transaction in red print. The text in this column consists of correction type 1*x*—8*x*;

the *fourth column* gives information regarding the nature of cash changes due to an individual transaction and consists of *C*+ or *C*—;



X 1426 **Fig. 3. Text references on an account card.**



X 1427 **Fig. 4. Voucher.**

An invoice for $ 122:10 has been paid. The voucher has been stamped with a »posting-order» instruction, which has been filled in by the person in charge of the accounting and contains the type number for the transaction in question and the number of the debit and credit-account cards. In accordance with these instructions the operator has made the registration and caused the framed entry to be stamped.

the *fifth column* gives information regarding the date and month, the month being indicated in Roman figures;

the *sixth column* gives information regarding the money-value of the transaction up to ten digits;

(the above mentioned entries in columns 1—6 are obtained by *one* movement of the machine after the type number and the amount of the individual transaction have been depressed on the keyboard);

the *seventh column* gives information regarding the operator who has carried out the accounting, and contains the corresponding identification mark *A—F;*

the *eighth, ninth and tenth columns* give information regarding the debit contents of the primary document and indicate the reference numbers of the debit account;

the *eleventh, twelfth and thirteenth columns* give information regarding the credit contents of the primary document and indicate the reference number of the credit account;

[in the account numbering shown here the first digit of the account number (*i. e.,* in columns 8 and 11) indicates the fundamental nature — whether asset, liability, profit (income) or loss (expenditure) — of the economic factor accounted for on the account, the next two digits (*i. e.,* in columns 9 and 12 respectively) indicate the individual factor and the last two digits (*i. e.,* in columns 10 and

13 respectively) the number of the branch to which the factor accounted for on the account is considered to belong. By this last note it is made possible to follow the changes of the result factors in the various branches of the business].

How the machine functions will be described by a practical example; we assume that the accounting refers to a bill of $ 122: 10 which has been paid in cash. The transaction involves a loss of the nature *(F+ T—)* and consequently it belongs to type *1*. The debit change consists in an increase of a loss-cause (expenditure) which should be entered on the expense account, which we assume to have the number *8 12 02*. The digit *8* in this case represents the general loss factor, the digit *12* the special nature, *i.e.,* expenses, and the digit *2* the branch of the business to which the factor in question belongs. The credit change consists in a decrease of assets which is to be entered on the asset account in question, *i.e.,* the cash account, which we assume to have the number *1 01*. The digit *1* in this case indicates the general asset factor (in current assets) and the digit *01* the special nature of the assets, *viz.,* cash.

The note made on the voucher by the person in charge of the accounting for the guidance of the operator should consequently be of the following appearance:

1 8 12 02 | 1 01

The operator *D* selects the account cards stated and inserts the bill in the middle set of printers, the account card number *8 12 02* in the left set and the account card number *1 01* in the right set of printers. He then presses his book-keeper's key and sets up the account numbers on the digit keys, *viz., 8 12 2 1 1,* and starts the machine. Afterwards he presses the analysis key *1*, the key *C—* and the keys for the amount *122 1* and starts the machine.

In about two seconds the machine then carries out the following work:

entries

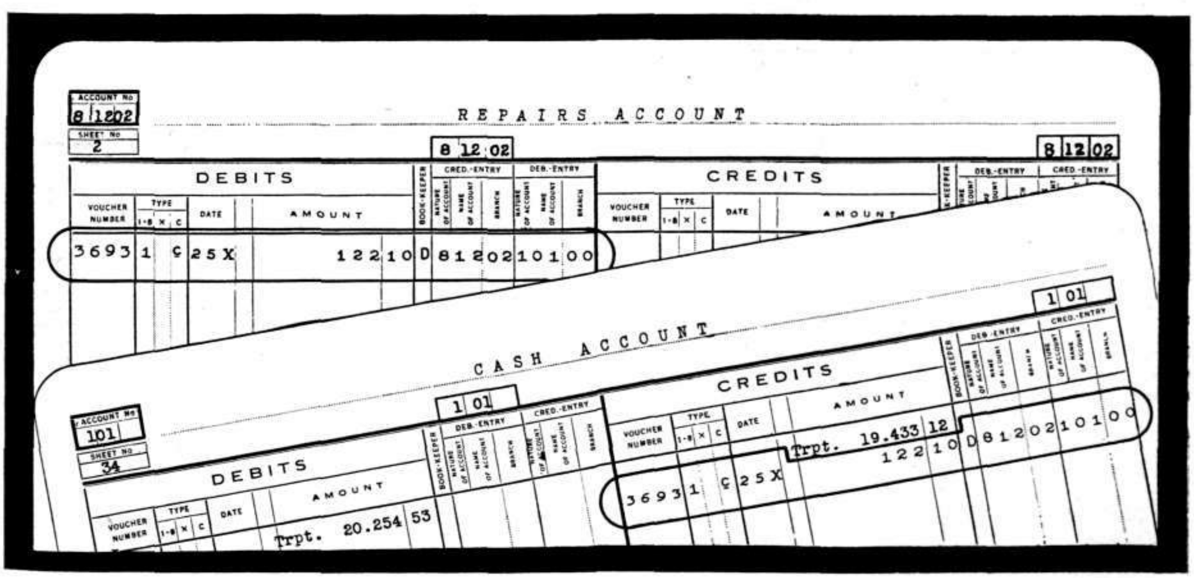
1. the voucher is automatically numbered and stamped with the number of the type, the symbol *C—* for decrease of cash, date, amount, the operator's indentification mark, the number of the debit and credit accounts, see Fig. 4;

2—3. the same entry has been printed on the debit and credit accounts, Fig. 5;

4. the same entry has been entered in chronological order on the journal list, locked up inside the machine, see Fig. 6;

calculations

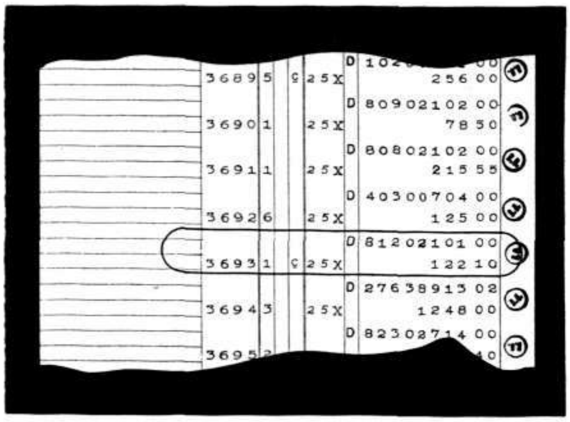
5. at the same time the previous total amount of the journal entries and the debit and credit totals have been increased by the amount of the voucher (122: 10). Further the previous total assets, the difference between the assets and liabilities (surplus), the previous working result (net profit) and the previous total amount of the cash



X 7069

Fig. 5. Account cards.

At the same time as the voucher has been stamped entries have been made on the account cards, when repairs account has been debited and cash account credited. The voucher numbers in the debit and credit printers are of different types, so as to eliminate mistakes between the debit and credit entries.



X 1428 **Fig. 6. Journal list.**

This list, which is kept locked up in the machine, is stamped at the same time as the voucher and the account cards and gives a check on the registrations made by the machine.

have been reduced by the amount of the voucher, and finally the previous total of the loss-causes has been increased by the same amount.

Financial Report.

Fig. 7 illustrates an example of a financial report. The examination of such a report, which can be supplied by the machine at any time independenty of the accounting and through the recording of the vouchers only (*one* easily controlled stamping on each voucher), gives information regarding the amounts which the capital and result figures must have on account of the transactions recorded within a certain period and

Accounting period
from 1/10 1933
until (date of report)

Vouchers
from number 2348
to (see control number)

Day-List
fr. no 2348, to no 4160
Total 530.000:—

Control number	Date	Amount		Subject headings	
4161	31X	165000 00	T	Assets	4
4161	31X	160000 00	S	Liabilities	5
4161	31X	5000 00	D	Difference	8
4161	31X	55000 00	V	Income	6
4161	31X	50000 00	F	Expenditure	7
4161	31X	5000 00	R	Result	9
4161	31X	1000 00	K	Cash in hand	4 sp.
4161	31X	530000 00		Vouchers	1
4161	31X	530000 00		Debit turnover	2
4161	31X	530000 00		Credit turnover	3

X 1429 **Fig. 7. Financial report.**

During October 1933 the vouchers 2348—4100 have been registered through the machine. A separate addition of the journal list shows the same total, $ 530 000, as given by the total turnover counter of the machine.

which are described in the vouchers, the numbers of which are indicated in the report. As can be seen the amount of capital difference (*D*), which is the difference between assets and liabilities, must be equal to the amount of the working result (*R*), which is the difference between profit causes (income) and loss causes (expenditure), so that the machine in this respect is *self-checking.*

This report which contains only the totals of capital and result factors and the turnovers, provides an absolute check of the balancing of the books, which is carried out as usual, based on the individual accounts. Fig. 8 illustrates a concentrated balancing of the books, which contains:

in the *first column* the names of the assumed number of factors;

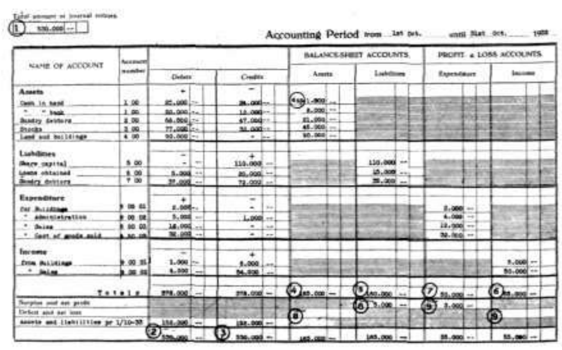
in the *second column* their identification symbols;

in the *third and fourth columns* the trial balance taken from the accounts;

in the *fifth and sixth columns* the balances of the capital factors (balance sheet);

in the *seventh and eighth columns* the balances of the result factors (profit and loss account).

The amounts entered are assumed to refer to the same accounting period as those of the financial report shown in Fig. 7. On a comparison it is seen in what manner the totals (*1—9*), given in the financial report by the machine, correspond to and act as a check upon those of the account-balancing report.



X 1430 **Fig. 8. Account-balancing report.**

The totals 1—9 given in this report correspond to and are checked by those of the financial report.

AUTOMATIC FIRE-ALARM

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In most cases, destructive fires have been started by a small flame which could easily have been extinguished if it had been discovered in time. The lapse of a few minutes before the extinguishing work is commenced is usually of decisive importance.

The greater number of conflagrations occur in the night hours, mainly because of the greater possibility then of the fire being allowed to take a good hold before it is discovered.

The best means for detecting an outbreak at an early stage, and therefore the safest protection against loss of life and property from conflagrations, is found in efficient automatic fire-alarm installations, particularly those with arrangements for automatically calling the fire brigade.

With fire-alarm installations which automatically call the fire brigade reliability is of particular importance. While they must give alarm without fail, there must be a certain guarantee against false alarm due to faults of any kind in the system.

Such plants should in addition be provided with apparatus which indicates automatically fault signals to the fire station. When the functioning of the system is disturbed by causes other than fire, special fault signals are sent out automatically and immediately to the fire station by this apparatus.

An installation for automatic fire alarm with automatic signalling to the fire station is composed of the following parts:

signalling contacts — thermo-contacts for automatic signalling and press buttons for manual signalling, auxiliary fire-alarm boxes,

alarm board with apparatus for the electric supervision of the system, testing the condition of the system, reception of alarm and fault signals, connection of local alarm and fault-signalling apparatus, and for automatic fault and alarm signalling to the fire station,

alarm apparatus,

main fire-alarm boxes and fault-signalling mechanisms,

current supply.

Signalling Contacts.

Thermo-contacts are mounted in the ceiling of each room to be protected, to the number of at least one thermo-contact for each 40 m^2 of floor space. They should be divided into groups, each group containing a maximum of 30 contacts within a definite section of the building.

The thermo-contacts of each group are connected in series in a separate loop, and all loops are connected to the alarm board.

The *auxiliary fire-alarm boxes* for manual alarm signalling, Fig. 1, are fixed on walls and inserted in the loops in series with the thermo-contacts in the rooms. One auxiliary fire-alarm box for testing purposes should be mounted beside the alarm board. The auxiliary fire-alarm box is composed of a press-button switch with two break contacts fitted in a metal cover. The press button is guarded by a thin glass disc to be broken when alarm is given.

Two-wire loops are used in the fire-alarm system described below. Consequently the thermo-contacts have two normally closed contacts which are inserted one in each branch of the loop. Thermo-contacts of such design were described in the Ericsson Review No 1, 1934.

In normal position the two branches of the loop are permanently under supervision by a closed-circuit current. When fire occurs and a thermo-contact is actuated by the heat, its two contacts are opened and the current is interrupted in the two branches of the loop, fire alarm thus being given on the alarm board.

When line faults occur, such as rupture of one of the branches, short circuit between the branches and insulation faults, fault signal is given on the alarm board.

The apparently complicated arrangement with two-wire loops and double thermo-contacts has many important advantages, of which the following are worthy of mention:

1. the thermo-contacts operate in a simple and

Fig. 1. Auxiliary fire-alarm box, Type TH 401.

X 3271

reliable manner: they contain contacts for the closed-circuit current with *all* acting parts supervised by this current; the thermo-contacts contain no normally open contacts and no resistances;

2. in case of a fire, if one of the two contacts of a thermo-contact should not be actuated, a signal will still be transmitted to the alarm board by the other contact, at least as a fault signal, which is better than no signal at all;

3. on rupture faults in one of the branches, the loop continues to function for fire alarm as a single-wire loop;

4. the number of relays and relay contacts which transmit the alarm and fault signals to the alarm board is reduced as far as possible, giving increased reliability and simplification of operation.

5. perfect safety is ensured against false alarm on intermittent rupture or on incomplete rupture in a thermo-contact circuit. Intermittent rupture and incomplete rupture in a circuit may occur — generally after the plant has been in service for a long time — when a screw contact gets loose, a soldered contact is broken or a conductor has become corroded. Such a rupture in a thermo-contact circuit, which in the case of single-wire loops may easily cause false alarm, will in the case of two-wire loops always cause fault signals;

6. the lines to the thermo-contacts need not be such as are used for lighting current but cables such as are used for telecommunication plants may be employed without the perfect functioning of the system being affected. This causes considerable reduction in the first cost of which the cost of line construction forms the greatest part.

For the connection of the thermo-contacts a special type of cable is used, composed of two-wire lead-sheathed telephone cable with a braiding impregnated with minium or paraffin.

For the connection of remote thermo-contacts to the alarm board multi-conductor cables of a special design are used. Each conductor in these cables is covered with tinfoil tape outside the cotton braiding, and these conductors are joined to a cable along with one or more bare tinned copper conductors. The cables are lead sheathed and are covered with a minium-impregnated braiding. On installation the bare conductors of these cables are connected with the lead sheath and with the earth terminal of the alarm board. This arrangement has the advantage that leakage signal is obtained automatically on the alarm board immediately insulation faults occur in the cable. Also on short-circuit between two conductors under the same tension leakage signal will be given, as in this case the conductors must come into electrical contact with the tinfoil tapes and, through these tapes and the bare conductors, with the earth terminal of the alarm board.

Alarm Board.

The alarm board, Fig. 2, should preferably be mounted on the ground floor in a light and dry room (not a workshop or store), where there is always some person and where it will be easily accessible for the fire brigade.

Beside the alarm board there should be instructions for the operation of the plant and a clear list of the various sections, preferably in the form of drawings illustrating the areas of the various sections.

The alarm boards are made in two sizes, according to the number of loops to be connected to them. The alarm boards for up to 10 sections are made for an operating tension of 12 V DC and larger types for 24 V.

At the top of the alarm board there are two DC *signalling bells* which ring on alarm and fault signals. The alarm board has terminals for the connection of additional signalling bells.

The optical signalling equipment of the alarm board, which shows the nature of the signal and from where it comes, consists of lamps, two for each type of signals to ensure perfect reliability.

On the top part of the instrument panel there are the *section lamps,* two for each loop. When alarm or fault is given from a loop the corresponding lamps light up and indicate from which section of the building the signal has been given.

Below the section lamps there are the three-way *section switches.* Under normal conditions when the loops are without fault these switches are in horizontal position. After the reception of a fault signal the relay contacts of the loop are switched over for provisional operation by throwing the switch handle downwards; the section lamp will then go out, the fault signalling on the alarm board will cease and the right lamp in the row between the measuring instruments, *the line-fault lamp,* will light up. This lamp will be lit as long as any of the section switches is not in home position. For provisional switching after the reception of an alarm signal, the switch handle is thrown upwards, which will render the alarm contacts of the relays in question idle.

The switches are compulsory acting in their three positions. For instance, when a loop disconnected after alarm has been completely or partly repaired, a fault signal will be received, and this signal will not cease until the switch has been thrown in the corresponding fault or home position.

The lamps with the large windows indicate, the left with a green window »fault», the right with a red window »fire».

The switches below these windows are (from left to right):

one three-way *alarm-bell switch,* which is used for the disconnection of the alarm bells following alarm signals (right position) and for connecting these bells when testing the bells (left position). The signalling lamp on top of the switch lights up when the alarm bells ring and when they have been disconnected by means of the switch;

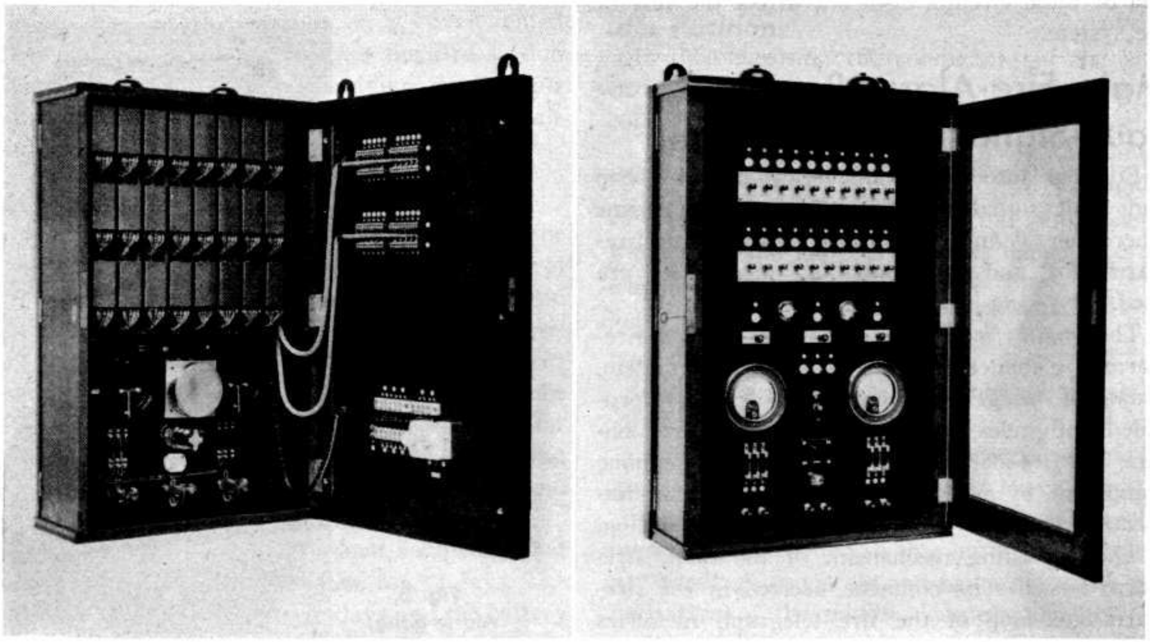
one two-way *fire-alarm-box switch* which is normally in left position. On automatic or manual signals from the main fire-alarm box or on rupture in the supervisory circuit of the release magnet, the fire-alarm box lamp above the switch lights up and fault or alarm signal is given. For provisional switching of the system the switch is thrown in right position; the signalling lamp will then go out, the signalling will cease and the fire-alarm-box fault-lamp to the left below the switch will light up. When the fire-alarm box has been wound the fire-alarm-box lamp will light up anew and fault signal will be given. The system is returned to normal position by restoring the switch;

one three-way *earth-testing switch* with the handle normally in central position. By throwing this switch in left or right position the voltmeter of the alarm board is connected between earth and the positive and negative pole respectively of the operating battery; on insulation faults in the system the voltmeter gives a deflection the extent of which depends on the resistance and position of the fault. If there is heavy leakage the earth-signalling lamp above the switch lights up and a fault signal is given. Provisional switching is obtained by throwing the switch in left position; the fault signalling will then cease but the earth-signalling lamp will remain lit.

The tension of the batteries is measured by means of the *voltmeter,* which is connected for measuring by means of press buttons in the middle of the lower part of the panel. The current consumption of all thermo-contact loops is indicated on the *ammeter.*

Between the measuring instruments there is the winding crank of the *fault-signalling mechanism* as well as a release press-button which is used for manual release of the mechanism on testing. Above the press button there is, between the fire-alarm-box fault and line-fault lamps, the supervisory lamp of the fault-signalling mechanism which is connected to a signalling bell when the mechanism has run down after a fault signal has been given.

Below the measuring instruments there is a four-way *battery switch* with a knob. In two of



X 7064

Fig. 2. Alarm board, Type TH 883/20.
Left, back view; right, front view.

the positions the one or the other of the batteries is switched on for service, and in the other two the spare battery is in addition switched on for charging, in which case the supervisory lamp below the switch will light up.

The *fuses* for the batteries, for the thermo-contact loops and for various groups of alarm and signalling apparatus are fitted on both sides of the battery switch. The fuses for the charging are fitted on the backplate.

The *press buttons* in the bottom right-hand corner are intended for disconnecting the automatic release of the fire-alarm box and the fault-signalling mechanism on testing the system. They are arranged so that on closing the door the pulled-out buttons, if any, are pressed by the door, which will switch on the automatic release.

In the bottom left hand corner there are two *test buttons*, by means of which it is ensured on testing the alarm board that the alarm and fault relays are operating perfectly.

Alarm Apparatus.

For local alarm signalling powerful electric gongs are usually employed. Such a gong, Type RA 3001, is shown in Fig. 3. One such gong should be mounted out of doors.

The number of alarm gongs is determined by local conditions. If their number is large, they are divided into several circuits with separate fuses arranged in such a manner that a fault in one of these circuits does not affect the rest of the system.

Main Fire-Alarm Box and Fault-Signalling Mechanism.

For the automatic transferring of the alarm and fault signals to the fire station in towns where there is an electric fire telegraph, main fire-alarm box and fault-signalling mechanism are used.

The *main fire-alarm box* consists of a fire-alarm box connected to the fire-telegraph system, usually Type TH 371, Fig. 4, or TH 351, provided with release magnet and supervisory contact. The fire-alarm boxes are fitted with telephone equipment, by means of which telephone communication is easily obtained with the fire station.

The signalling mechanism of the main fire-alarm box has its contacts inserted in the fire-alarm-box loop of the fire telegraph in series with the fire-alarm boxes in the streets. The signalling mechanism is usually wound, and for signalling to the fire station it is released either by hand or automatically. Manual signals are given, as from street fire-alarm boxes, by pulling a handle, Type TH 371, or pressing a button, Type TH 351. For the automatic release from the alarm board the signalling mechanism is provided with a remote-control magnet which releases the mechanism when its armature is attracted.

The signalling mechanism has a number disc with a series of cogs arranged according to the code of the fire-alarm box. During the running of the mechanism the number disc turns 4 times round, and by means of its cogs it actuates the contact device of the signalling mechanism, so that for each revolution a series of current impulses corresponding to the code number of the box are sent out to the fire station where they are recorded on the alarm board.

For electrical supervision of the condition of the signalling mechanism it is fitted with a supervisory contact which is closed when the mechanism has been wound and is opened when the mechanism has run down.

The supervisory contact and the winding of the release magnet are connected in series with the battery of the alarm board over a high-resistance relay. In idle position, when the mechanism has been wound, this circuit carries a feeble current. The relay is kept energized but the magnet cannot attract its armature and release the mechanism. On alarm the winding of the relay is shunted

Fig. 3.
Alarm gong,
Type RA 3001.

X 3272

in the alarm board which will increase the current through the magnet so that it releases the signalling mechanism and a signal is sent to the fire station. After the signalling has terminated, the supervisory contact of the signalling mechanism is opened. The relay remains energized as long as the mechanism is not wound and by means of its contacts it gives a signal on the alarm board. A similar signal will be obtained on ruptures in the junction lines or in the winding of the magnet.

X 5159 **Fig. 4. Main fire-alarm box, Type TH 371.**

The *fault-signalling mechanism* is of a type similar to the mechanism of the fire-alarm box and connected in series with this latter to the fire station. It has a special number disc which sends signals to the fire station, these signals being entirely distinct from the alarm signals. When faults occur in the system the fault-signalling mechanism is released automatically and sends out a fault signal to the fire station.

The main fire-alarm box is mounted immediately beside the alarm board, and the fault-signalling mechanism inside the alarm board.

In places where there is no fire telegraph, the alarm and fault signals are transferred to the fire station over junction circuits, *e. g.,* over rented telephone lines, and in this case the fire station is equipped with suitable receiving devices for separate indication of alarm and fault signals respectively.

Current Supply.

As current supply for the operation of the system two storage batteries are used, each of 12 V for alarm boards of up to 10 sections, and of 24 V for larger installations. These batteries are connected for service alternately. The battery which is kept as a reserve is connected to the alarm board and is used as a current supply for a fault-signalling bell and a fault lamp. According to the prescriptions the batteries of the alarm board must not be used for other purposes.

The batteries should have such a capacity that each battery can feed the system for 14 days. The batteries are changed every 7 days and the battery disconnected is charged immediately.

The batteries are charged from the lighting mains. For charging from DC mains series resistances are used, and rectifiers for AC mains.

Operation.

A simple diagram of the Ericsson system for automatic fire alarm with two-wire loops is illustrated in Fig. 5, in which the system is shown in idle position, all circuits carrying closed-circuit current being drawn with heavy lines. In order not to complicate the diagram only two loops with double thermo-contacts are shown, and all equipment for switches and charging and testing has been left out.

Idle Position.

In idle position the conductors of the loops carry closed-circuit current and the following circuits are formed: the negative pole of the working battery *WB*, the ammeter { the inner / the middle } winding of *LFR*, branch *a* of the loop, external winding of the fault relay *LFR*, branch *b* of the { winding of *LFR* / loop } the positive pole of the working battery *WB*.

The alarm relay *LAR* of the loop keeps its armature attracted.

The fault relay *LFR* has three windings: the inner winding has a considerably lower resistance than the middle and external windings. The windings are dimensioned so that inner and the external windings cooperate and compensate the magnetization of the middle counteracting winding, and consequently the relay will not attract in idle position.

The relays *LAR* and *LFR* have in idle position one open and one closed contact each.

All normally closed contacts on the alarm relays *LAR* are connected in series in a supervisory closed-circuit in which an alarm relay *AR1*, common for all loops, is inserted. The normally open contacts on the relays *LAR* are connected to a common alarm relay *AR2*, and on alarm they connect this relay in series with the section lamp of the loop in question.

Two common fault relays, the closed-circuit relay *FR1* and the open-circuit relay *FR2* are connected in a similar manner over contacts on the fault relay *LFR*.

The release magnet of the fire-alarm box *AR* and its supervisory contact are connected in series with the winding of the supervisory relay *ABR* and carry closed-circuit current. On account of the high resistance of the relay the closed-circuit current is limited to a few milliampère, so that the release magnet cannot attract its armature. The fire-alarm-box relay *ABR* however keeps its armature attracted and the contacts of the relay are open.

A similar supervisory circuit and a supervisory relay *FSMR* are provided for the fault-signalling mechanism *FSM*.

Contacts in the fire-alarm box *AB* and the fault-signalling mechanism *FSM* are inserted in the public fire-alarm-box circuit *ABL*.

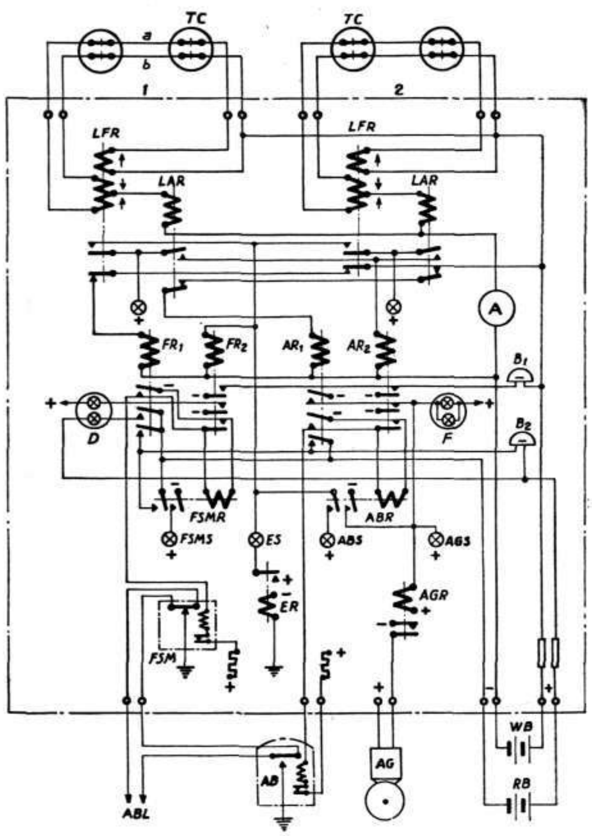
For the signalling of leakage faults in the system there is an earth-fault relay *ER*, which is inserted between the negative pole of the operating battery and earth.

For connecting the big alarm gongs *AG* on alarm signals the alarm board has a separate relay *AGR* with large contacts.

For the local signalling of line faults and alarm there are two signalling bells which ring both for fault and alarm, and in addition two pairs of lamps, two, *D*, for fault signals and two, *F*, for fire-alarm signals. The bell *B2* and one of the lamps are connected to the battery which is in reserve at the time.

Alarm Signalling.

When fire occurs in a room protected by thermo-contacts, these are actuated by the rising temperature, and when a certain limit is exceeded one or more of the thermo-contacts will give *automatic alarm-signals* since their contacts are opened and break the current in the two branches of the loop. The alarm relay *LAR* of the loop will become dead and release its armature. By the switching of the contacts of the relay *LAR* the current



X 1390 Fig. 5. Diagram of automatic fire-alarm system.

A	ammeter	ES	earth-leakage lamp
AB	main fire-alarm box	F	fire-signalling lamp
ABL	alarm-box line	FR 1, FR 2	fault relays
ABR	alarm-box relay	FSM	fault-signalling mechanism
ABS	alarm-box signalling lamp	FSMR	fault-signalling-mechanism relay
AG	alarm gong	FSMS	fault-signalling-mechanism lamp
AGR	alarm-gong relay	LAR	line-alarm relay
AGS	alarm-gong lamp	LFR	line-fault relay
AR 1, AR 2	alarm relay	RB	reserve battery
B 1, B 2	signal-bells	TC	thermo-contact
D	fault-signalling lamp	WB	working battery
ER	earth-leakage relay		

through the relay *AR1* will in its turn be broken and the current is closed through the relay *AR2* in series with the indicator lamp of the section; this lamp will then light up and indicate from which section alarm has been given.

Over contacts on the relays *AR1* and *AR2* the signalling bells *B1* and *B2* are switched on as well as the fire-signalling lamps *F* and the alarm-gong relay *AGR*, and the winding of the fire-alarm-box relay *ABR* is shunted. The alarm gongs *AG* will then be switched on and start ringing.

The release magnet of the fire-alarm box will release the fire-signalling mechanism, thus sending a fire signal to the fire station. After the signalling has ceased the supervisory contact in the signalling mechanism will be opened and consequently the relay *ABR* will be prevented from attracting until the mechanism of the fire-alarm box has been rewound. Over a contact on the relay *ABR* the lamp *ABS* is switched on, and this lamp indicates on the alarm board that fire signal has been sent out to the fire station.

Alarm from an auxiliary fire-alarm box is given by breaking the glass disc and pressing the press button. The current through both branches of the loop in question will then be broken, and in other respects the alarm is given in the same manner as automatic alarm from a thermo-contact.

When *alarm is given from the main fire-alarm box AB* to the fire station, the local acoustic and optic signals of the system are switched on in the following manner: after the signalling mechanism of the fire-alarm box has run down its supervisory contact is broken, the fire-alarm-box relay *ABR* will become dead and over its contacts it connects the lamp for fire-alarm-box signal *ABS* in series with the fault relay $FR2$, which is energized and in its turn connects, among others the signalling bell $B2$, and in addition the fire-signalling lamps *F* and the alarm-gong relay *AGR* which attracts and switches on the alarm gongs *AG*.

Fault Signalling.

On rupture of a line belonging to a thermo-contact loop the balance in the fault relay *LFR* of the loop is disturbed and the relay attracts its armature after which the fault relay $FR1$ is released and the relay $FR2$ energized. This latter is then connected in series with the section lamp which indicates in which loop the fault has occurred.

The signalling bells $B1$ and $B2$, fault lamps *D* over contacts on the relays $FR1$ and $RF2$ are switched on and at the same time the relay of the fault-signalling mechanism *FSMR* is shunted; this latter is released and switches on the lamp *FSMS*. The magnet of the fault-signalling mechanism releases and a fault signal is sent to the fire station.

On *short-circuit* between the two branches of a loop (in two-wire cables without tinfoil tape) the external winding of the fault relay *LFR* is short-circuited and the balance in the relay is disturbed by the current being considerably increased through the external winding, which has a low resistance, and the current through the counteracting middle winding, which has a high resistance, being reduced to a fraction of the normal intensity. The relay attracts its armature and in other respects the fault signalling is carried out in the same manner as on ruptures.

On *short circuit simultaneously with single-wire rupture* in a loop the balance in the fault relay of the loop is disturbed so that the relay will be energized and a fault signal will be sent out as described above.

The *crossing of the wires in a loop* may occur when loops are connected to the alarm board, when thermo-contacts are exchanged or when a faulty loop is repaired. When attempts are made to put such a loop in service a fault signal will be given on the alarm board as described above so that the fault cannot remain unobserved. In regard to all these faults it should be observed that they do not prevent the giving of fire alarm from the loop in question, whether occurring before, during or after the alarm signalling. A faulty loop is not disconnected but is switched over for provisional operation, and alarm signals from this loop will be received in the same reliable manner as from a faultless loop before and after the switching.

In all circuits carrying closed-circuit current, relays with high resistance are connected next to the negative pole of the battery, and consequently on sufficient *leakage to earth* somewhere in the system current will flow through the earth-fault relay *ER*, which is connected between the negative pole of the battery and earth. When this relay is energized the fault relay $FR2$ will be inserted in series with the earth-signalling lamp *ES* which will light up.

Over contacts on the relay $FR2$ the fault-signalling lamp *D* will be switched on as well as the bell $B1$, and the relay *FSMR* will be shunted so that the release magnet of the fault-signalling mechanism receives heavier current and releases the mechanism. The relay *FSMR* releases its armature and connects the bell $B2$ and the indicator lamp *FSMS*.

Rupture in the supervisory circuit through the release magnet of the main fire-alarm box is signalled in the same manner on the alarm board as if manual alarm han been given from the box.

On *breakdown of the current supply* from the working battery all closed-circuit relays release their armatures, and the signalling bell $B2$ and one of the fault lamps, which are fed from the spare battery, indicate the fault.

On *abnormal drop in the operating voltage* a fault signal will be given by the fault relay $FR2$ which is supervised by closed-circuit current and is adjusted so that it will release when the operating voltage sinks below a certain limit. The other equipment of the alarm board will continue to function in a perfect manner at this low voltage.

NAME-CALLS IN TELEPHONE SERVICE

by A. LIGNELL,
former Director of Telephones, Stockholm.

In this article an arrangement is described which up to the present has been used only in the Swedish telephone system, viz., the possibility of calling large subscribers by names instead of numbers. Such name-calls have gained much ground in Sweden on account of the considerable advantages derived by the subscribers having name-calls, by the other subscribers and finally by the telephone service.

In Sweden it has for a long time been possible to call subscribers by name instead of by number. In small exchanges — up to 300 subscribers — name-calls are always permitted, operators being obliged to know the names and numbers of the subscribers in exchanges of this size. Only in exchanges of more than 300 subscribers are number-calls obligatory. In certain cases name-calls may, however, be permitted for large subscribers in these exchanges also.

The greatest advantage derived from name-calls in telephone service lies in the ease and comfort afforded to all subscribers in the system by employing instead of the number the name of a subscriber, in many cases abbreviated to the commonly used form. To keep the long numbers of a large telephone system in mind is difficult and uncertain, and experience has shown that it is often responsible for errors in dialling, causing incovenience not only to the calling party but still more to the subscriber who is troubled by a faulty call. Looking up numbers in the bulky directories of large telephone systems will always involve considerable time and a certain trouble, however well arranged the directories may be and even if they are easily accessible.

In Stockholm there are at present about 360 subscribers with name-calls, and the total traffic *to* these subscribers was 42 316 330 calls during 1932, representing 13.6 % of the total traffic which amounted to 312 051 000 calls. Consequently, about every seventh call in the Stockholm no-charge area was ordered by a name-call without the need of consulting the directory. Consequently each subscriber in the system has nearly the same advantage as if he had a separate telephone by means of which he could come in connection with each of these 360 name-call subscribers by pressing a button, without the necessity of keeping any numbers in mind or using the telephone directory. The subscriber having a name-call will consequently furnish a certain ease to the subscribers calling him, and this ease is of course in its turn an advantage to the name-call subscriber. Name-calls will have a certain advertising value, but as all large subscribers have the possibility of arranging for name-calls, the name-calls will in this respect be of minor importance. What the editor of one of the greatest daily newspapers of Stockholm thinks of the name-call facility may be of interest. He expressed the following opinion:

»My opinion is that a name-call is a necessity for a daily newspaper, and I cannot understand how we should manage if the Board of Telegraphs did not furnish the subscribers with this facility. The name-call has not only a certain advertising value — this is one of the less important advantages — but it gives the public a great comfort in its connection with an enterprise with which it has and must have much to do. It is true that a great many subscribers can keep a certain number in mind with which they have connection very often. But the major part of the persons calling a great daily newspaper consists of persons who have no regular connection with the paper. To these belong occasional correspondents and all persons addressing the paper on advertising matters, particularly for small advertisements concerning things for sale, rooms to let, etc. It would cause no small inconvenience to all these persons to look up a number each time in the directory, and a certain risk of errors in the calling would be inevitable. The use of name-calls contributes to reduce the number of faulty calls and saves time. Consequently, the name-call is of great advantage to the paper, which would certainly not be so well furnished with news nor have so many business opportunities if the public had not this great facility of rapidly and without trouble coming into connection with the paper, thanks to the name-call. The daily papers are now used to a great extent as information offices by the public wanting all kinds of particulars: the results of sport events, the age of a princess, scores in cards, etc. For these persons also it is certainly a great advantage to have the facility of communicating rapidly with the paper and to get an answer without delay. I will not enter into the matter of the advantage of the name-call to the paper in these cases. It is possible that many of our staff wish that the public had more difficulty in obtaining connections so that the enquiries might become fewer and not so disturbing to our work.»

This shows the importance which a great daily newspaper attaches to the name-call from the point of view of the public and consequently also for the paper. The same opinion of the usefulness of the name-calls to the public has been given by chambers of commerce, banks and department stores.

Name-calls are, however, only useful in enterprises with heavy telephone traffic. On account of this a certain size for the subscriber's telephone installation has been prescribed as a condition for being allowed a name-call in Sweden; this size is expressed as a required minimum charge per quarter, and in addition there is a separate name-call charge. The police, the fire brigade and the ambulance service have free name-calls, however.

The charge for name-calls in the Swedish telephone system is:

number of subscribers in the exchange	minimum charge per quarter Sw. Kr.	name-call charge per quarter Sw. Kr.
301— 500	150: —	25: —
501— 1000	200: —	25: —
1001— 1500	200: —	50: —
1501— 2000	250: —	50: —
2001— 3000	250: —	75: —
3001— 4000	400: —	75: —
4001— 5000	400: —	100: —
5001—10000	600: —	100: —
10001 – 20000	800: —	50: —
over 20000	1 000: —	200: —

The number of name-calls and lines for traffic *to* name-call subscribers and the income from the separate name-call charge in Stockholm for the years 1925—1933 is shown in the curves, Fig. 1.

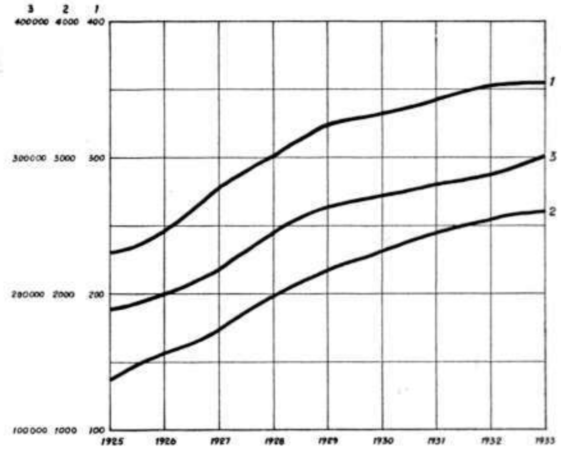
Name-call subscribers in Stockholm are State and municipal institutions, all great daily newspapers, most of the hotels, all banks, great department stores and business enterprises, etc.

A few examples of name-calls in Stockholm are shown below:

Dagens Nyheter: one of the greatest daily newspapers in Stockholm,

Posten: the Post Office with departments,

Handelsbanken: the bank Svenska Handelsbanken,



X 1391 **Fig. 1. Curves showing the development of name-calls in Stockholm 1925–1933.**

1 name-call subscribers
2 lines for traffic to name-call subscribers
3 income from the separate name-call charge.

N. K.: the departement store Nordiska Kompaniet,

L. M. Ericsson: Telefonaktiebolaget L. M. Ericsson,

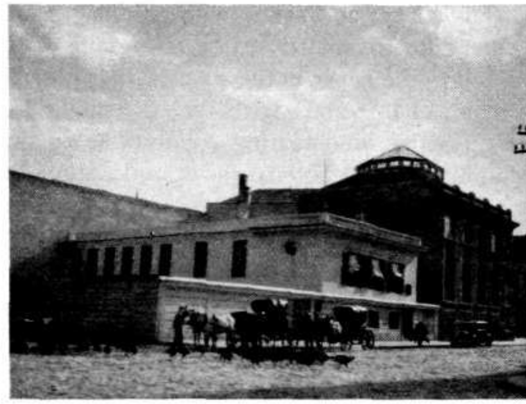
Grand Hôtel, etc.

In small exchanges with manual service the name call service is a matter of memory to the operator, simplified by the name-call subscribers' lines in the multiple being joined to groups of jacks indicated by the name-call in question. As a rule clear lines are selected by means of visible testing. In large systems having manual service and many exchanges, the name-call subscribers' lines for incoming traffic may with advantage be centralized to a separate name-call exchange as has been done in Stockholm. For calls to a name-call subscriber from a subscriber connected to a manual exchange the name-call exchange is a junction exchange, to which the A-operator finds a clear order wire by means of selectors. Subscribers connected to automatic exchanges are connected to the name-call exchange by dialling the digit *0*, and a clear operator and a clear cord circuit in this exchange are automatically selected. On calls to the name-call exchange the reply *0* is given by a photo-electric talking machine as soon as the operator's headset has been connected; the reply can be heard both by the calling party and the operator. The lines to the name-call subscribers are grouped in the multiple in alphabetical order according to wording of the name calls. The jacks of the multiple are collected in groups of 5 lines with visible testing for each

NEW ERICSSON EXCHANGES DURING 1934

In 1934 the following automatic telephone exchanges on the Ericsson system with 500-line selectors have been put into service:

place	exchange	lines
Stockholm, Sweden	Kungsholmen (extension)	6 000
Lidingö, Sweden	Skärsätra	500
Lidingö, Sweden	Brevik	500
Stockholm, Sweden	Esselte, PABX	200
Stockholm, Sweden	Vattenfallsstyrelsen, PABX	200
Stockholm, Sweden	Ericsson, PABX	220
Gothenburg, Sweden	Drätselkammaren, PABX	120
Tampere, Finland		3 500
Tripolis, Libya	main exchange (extension)	500
México D. F., Mexico	Apartado (extension)	500
Tacuba, Mexico	(extension)	500
Christiansand, Norway	(extension)	500
Warsaw, Poland	Zielna (extension)	10 000
Lublin, Poland		2 000
San Sebastián, Spain	(extension)	160
Izmir, Turkey	(extension)	250
Carşiyaka, Turkey	(extension)	60



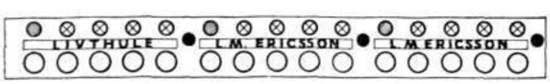
X 1431 **The telephone exchange in Izmir, Turkey.**

Ericsson Telephones Ltd. London—Beeston, have supplied during the year the following exchanges, constructed on the Strowger system:

place	exchange	lines
London	Canonbury	4 300
London	Central	9 200
Dorking		1 100
Peterborough		1 300

group. Each multiple strip, see Fig. 2, contains 15 lamps in the top row serving as testing and supervisory lamps, in the next row a designation strip for the name-calls, and in the bottom row 15 jacks. The lamps and jacks belonging to one line are placed one above the other.

In large automatic telephone systems where the subscribers can come in connection with their own exchange, *e. g.*, by dialling one digit, the provision of a separate exchange for the name-calls is not necessary. This has the advantage that the name-call subscribers' lines with the necessary PBX device can remain in the exchanges to which they have been connected according to the exchange areas. Separate working positions will then be required in each exchange, provided with ordinary key sets, or still better with a device permitting the switch-over to the name-call subscribers by pressing one button. The buttons in these working positions are marked with the name-calls in alphabetical order. An operator in these positions will without difficulty be able to handle 700 to 800 calls an hour. This arrangement will probably be used on the forthcoming modernization of the Stockholm name-call exchange.



X 1392 **Fig. 2.**
Multiple strip for name-call subscribers.

Top, testing and supervisory lamps; middle, designation strip; below, jacks; in the same row as the designation strip, test keys.

Starting and Time-Keeping Apparatus for Race-Courses

Electric starting and time-keeping apparatus has during recent years been introduced on race-courses, and Telefonaktiebolaget L. M. Ericsson has designed a new system for these purposes which is described in this article.

The first installation on this system has been made recently at the trotting track at Sundsvall, Sweden.

Racing has always been very popular and racehorse owners as well as the public have always emphasized the importance of accurate starting and time-keeping apparatus. Large sums are involved in bets on the totalisator and the results depend naturally on the perfection of the start. In addition the chances of runners are mostly estimated from their performances in previous races and for this reason exact time-keeping is required.

Time-keeping may be complicated by the nature of the race. In trotting races, for instance, handicapping is in multiples of 20 m. Consequently the horses do not start from a single line but from several separate lines at a distance of 20 m from each other. Under these conditions it is difficult to ensure that the horses all start at the same moment, if the old method of starting by means of a flag is used. Nor can the time-keeping be accurate when the time check is started manually from the judge's box at the moment the flag is seen to fall.

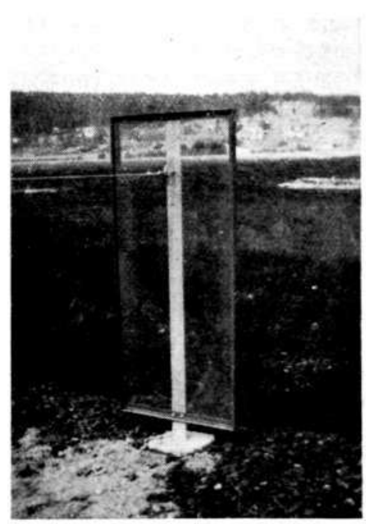
X 5168 **View of the Sundsvall race-course.**

Electric starting and time-keeping apparatus is becoming more and more general, and Ericsson has begun the manufacture of such apparatus on the system employed in the installation recently made at the Sundsvall trotting track in Sweden.

Design.

Around the course, which is one kilometre in length, poles have been erected at each side of the track, at intervals of 20 m. The poles at the outer edge of the course, Fig. 1, have been provided with a protective net and a hook for fastening one end of a rubber cord. The poles at the inner edge of the course have been provided with arrangements for fitting a starting apparatus, which by means of a plug can be connected to a jack at the bottom of a connecting box fitted to the pole; this connecting box is connected to a cable which is laid round the course connecting all the inner poles. The ends of the cable are connected to a starting central. At each of these poles in addition to the jack for connecting the starting apparatus, there is a jack for connecting a portable telephone instrument, which in turn is connected to an automatic private exchange.

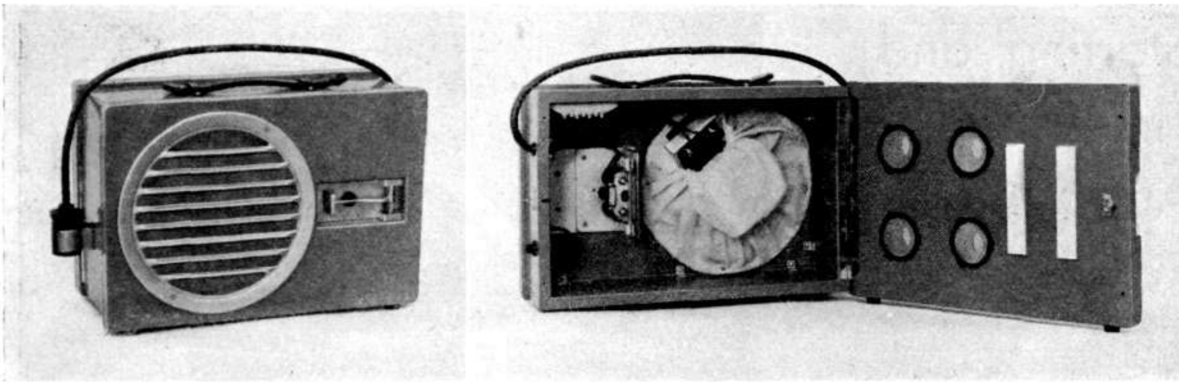
X 3302



X 3301

Fig. 1 and 2. Starting poles.

Left, pole with starting apparatus; right, pole with protective net; between the poles, the starting cord stretched across the track.



X 7066 **Fig. 3. Starting apparatus.**

Left, front view showing loudspeaker orifice and pin for tripping the starting cord; right, back view, open, showing starting relay and loudspeaker.

Each *starting apparatus*, Fig. 3, which is portable, is composed of a starting relay and a loudspeaker, fitted in a case with arrangements for fixing the apparatus on the poles. The starting relay is a powerful two-magnet relay. The armature is fitted with a spring, so sturdy that the relay cannot attract but still keep the armature attracted after it has been pressed down by hand. On the front of the relay there is a pin which can be turned forwards and downwards. When the armature lies attracted this pin, which is for holding the rubber cord, goes through a hole in it and is thus kept locked. The loudspeaker is of Svenska Radiobolaget's manufacture, Type Ed6p. On the bottom of the startig apparatus there is a press button by means of which the relay can be short-circuited.

On the course there are two boxes, one for the judges and one for the course stewards. From the former the starting and time-keeping is controlled and from the latter the competitors are watched during the race.

In the course stewards' box there is fitted a 400 W *amplifier* as supplied by Svenska Radiobolaget for transmitting gramophone music to six Marconi loudspeakers. Instead of a pick-up, a wireless receiver can be connected to the amplifier for distributing sporting news, etc. to the loudspeakers. By means of a switch the apparatus can be switched over to act as an amplifier to a microphone placed near the secretary in the course stewards' box. At the amplifier there is always one man whose duty it is to put on the gramophone or switch over the amplifier, according to orders given by the secretary over the telephone. The full output of the amplifier not being used for the above-mentioned six loudspeakers, the loudspeakers of the starting apparatus could also be connected.

In the lower part of the course stewards' box there has been installed the necessary 24 V, 108 Ah, battery for the operation of the system, as well as a charging plant.

The system is controlled from a *starting central*, Fig. 4, placed in the judge's box. The central is composed of a switchbord in which has been fitted a talking machine for notices of 20 seconds' duration of the type which has been described in detail in the Ericsson Review No 2, 1934. On top of this there is a panel with a main switch for the system, a switch for connecting microphone, talking machine or gramophone to the amplifier, and press buttons for the starting apparatuses and for signalling by means of a bell, Type RA 5 000, which has been mounted on the roof of the course stewards' box. On the top part of the panel there are supervisory lamps indicating the position of the central. For time-keeping there is a chronometer with electric starting and stopping devices, and at the side of the swichboard there are jacks for connecting a microphone and supervisory loudspeaker.

The distance between the starting central and the amplifier of this system being too great (170 m) for direct switching from the starting central of the various facilities of connection to the amplifier, a panel was mounted in the course stewards' box fitted with signalling lamps, a buzzer and a switch. When the switch of the starting central is thrown, *e. g.*, in the position »microphone», the corresponding signalling lamp on the panel in the course stewards' box lights up and the buzzer gives a signal. The man operating the amplifier carries out the necessary switching, and a lamp marked »microphone» lights up in the starting central when the switching has been carried out and the microphone has been connected to the amplifier.

X 3303 **Fig. 4. Starting central.**

Functioning.

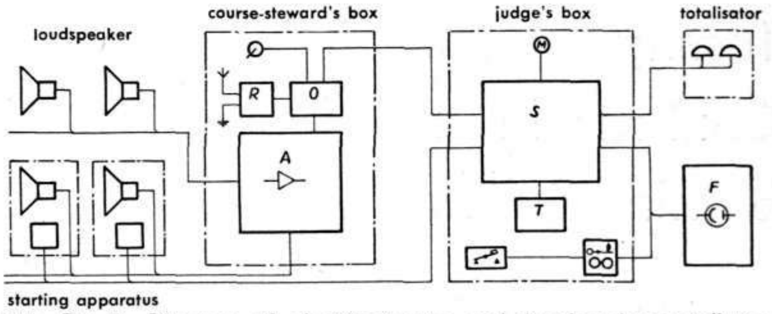
Before the start of the races the main switch at the starting central of the system is turned on. The talking machine is thereby started and runs until the races are over.

At each handicapping place to be used, a starting apparatus is fixed to the pole provided for the purpose. A button marked »starting relays» is pressed at the starting central, whereby a start-preparation relay will be attracted and becomes locked. Over this relay current is switched on to a relay for heavy current, which, when attracting, closes current through the starting relays connected in parallel.

At each starting place a rubber cord is stretched to the starting apparatus from the pole on the opposite side of the track. The rubber cord is laid round the pin of the starting relay, and the armature is pressed so that the pin becomes locked and keeps the rubber cord stretched. The track is 20 m wide and the cord when unstreched is about 7 m long, so that it must be stretched to three times its initial length.

The talking machine is connected to the amplifier by the winning-post umpire throwing the switch of the starting central in the position »talking machine». When everything is ready for the start, a press buttom marked »start» is pressed on the central. A relay will then attract and prepare the connection of the loudspeakers to the amplifier. When next time the talking machine comes in starting position a contact in it is actuated mechanically, and this contact closes current through a connecting relay for the loudspeakers over a contact on the above-mentioned relay. Each starting apparatus and the Marconi loudspeakers then repeat the command of the talking machine, »one — two — go».

Simultaneously with the command »go» the talking machine actuates an adjustable contact which closes current through a relay. This relay breaks the current through the starting relays, closes the current through the starting magnet of the chronometer and through a pendulum relay for bells in the totalisator building which ring to indicate that the race has started and no more bets can be taken.



X 5169 Fig. 5. Diagram of electric starting and time-keeping installation.

A main amplifier
B photo-electric receiver
O switching panel
R wireless receiver and microphone amplifier
S starting central
T photo-electric talking machine

When the starting relays become dead, they release their armatures and the pin around which the rubber cord is fastened is released. The pin is pulled forward by the cord which slips off and flies across the track against the protective net of the pole to which its other end is fixed, leaving the way clear to the competitors.

The starting relays can also be rendered dead by pressing a button marked »false start» at the starting central, or a press button on the bottom of a starting apparatus. This facility of releasing the rubber cords is used, for example should a horse run away before the start.

When the talking machine has run out it actuates a third contact automatically, which breaks the current through the relay connecting the loudspeakers with the amplifier. Consequently the loudspeakers are disconnected until the talking machine is ready to begin anew.

In front of the judge's box there are two projectors with the corresponding photo-electric receivers and amplifiers. All apparatus is mounted on a frame of angle-iron bars with a cover of sheet-iron. On the opposite side of the course there are two mirrors, one above the other, which reflect the rays from the projectors to the receivers. Thus four rays are formed, one on top of the other, and these rays form the winning-post line.

When the race is near its end the judge starts a telegraph apparatus in the judge's box. At the same time the stopping magnet of the chronometer is connected to a contact on the relay of each of the photo-electric amplifiers. When the first horse passes the winning-post and one or more of the four rays is interrupted, current is closed through the stopping magnet of the chronometer which stops. At the same time the magnet of the telegraph apparatus receives a current impulse, and a mark will be obtained on the telegraph tape. As each succeeding competitor passes the winning-post the judge presses a morse key, so that for each competitor a mark is obtained on the telegraph tape. When the last competitor reaches the winning post, the telegraph apparatus is stopped; the tape is then torn off and placed on a special scale on which the difference in time between the winner and the other competitors can be read. The time of the winner is indicated by the chronometer with an accuracy of 0.1 seconds. The telegraph tape moves at a speed of 3 cm per second, which allows of very accurate time readings.

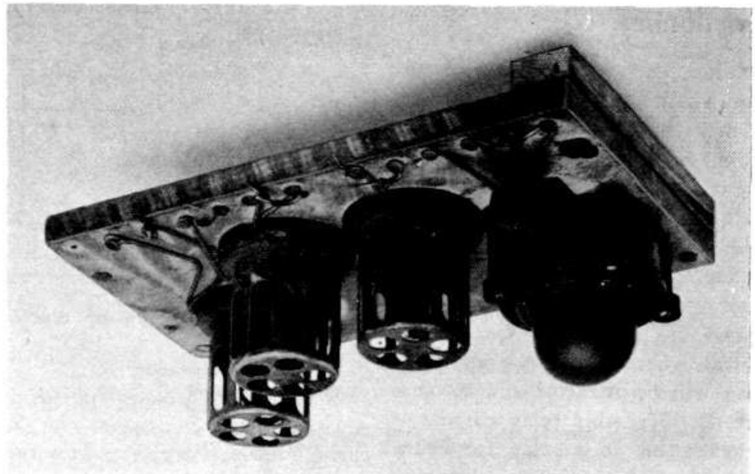
S. Nilsson.

Testing Thermo-Contacts in a Burning Building

In the beginning of this year Telefonaktiebolaget L. M. Ericsson received an invitation to test thermo-contacts in the course of certain fire-technical tests in a burning building, which were to be carried out in connection with the annual meeting of the Swedish Union for Fire Protection.

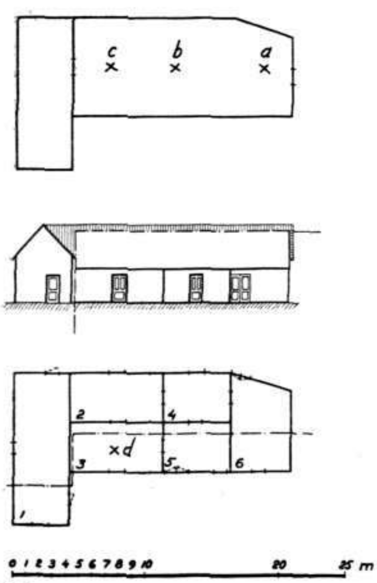
This invitation was gratefully accepted, particularly as it had been desirable for a long time to test thermo-contacts in a fire.

The tests are de scribed in the following, which is reprinted by courtesy of »Brandskydd», July 1934.



X 5163

Fig. 2. Thermo-contacts after the fire.



X 3276

Fig. 1. View of the building used for the tests.

Top, plan of the garret; below, plan of the ground-floor room.

For the tests an old barn was fitted with partition walls, floors and doors, Fig. 1. In order to render the spreading of the fire as natural as possible, the rooms were furnished in the same manner as ordinary living rooms. In the garret bad been placed a lot of rubbish such as wood cases, shaving, boards, old pieces of furniture, etc. such as is usually found in many such places.

Three thermo-contacts were fitted in the garret at the points *a*, *b* and *c*. Various types of thermo-contacts were used. At *a* a bimetallic thermo-contact, Type TH 857/03, was placed, one contact spring of which had been adjusted for 35° C and the other for 70° C. At *b* and *c* melting contacts, Type TH 850, had been placed and these contacts had been adjusted for an alarm temperature of 70° C.

At the point *d* in room *3* on the ground floor four different contacts had been mounted alongside each other on a wooden plate in the ceiling, Fig. 2; there were 1 bimetallic contact, TH 857/03, with one contact group adjusted for 35° C and the other for 70° C, 2 melting contacts, Type TH 850, both adjusted for 70° C, and 1 bimetallic contact of waterproof design, Type TH 859/01, with one contact group adjusted for 35° C and the other for 70° C.

Each of the four melting contacts, Type TH 850, was connected to a press button on a press-button set. The spring groups of the various bimetallic contacts were connected to one button each, and consequently *10* groups in all were connected to the alarm board. The groups were connected to the press-button set in the order in which the alarm was expected.

An alarm board, Type TH 980/01, was used for the testing, the alarm board being altered for the tests so that it would be restored automatically if the interrupted loop was short-circuited. This alteration was made only to simplify the operation of the system.

As soon as a signal was received on the alarm board, indicating that a contact had been actuated, the corresponding button in the press-button set was pressed whereby the actuated contact group was shunted and the alarm board restored to home position, so that the signal could be received when the next contact group was actuated.

The tests were carried out in separate stages, fire being first lit in the garret, and when this fire had been extinguished fire was lit in room *3*, and after this had also been extinguished fire was lit in room *2*.

In *Test 1* fires were lit at three different places in the garret. The fires were set in wood cases filled with saw-dust, pieces of wood and rubbish. The positions of the cases are indicated in Fig. 1. At the moment when the fire was lit a seconds clock was started. As signals were received from the various contacts, these were disconnecetd at the alarm board by means of the press buttons and the time was noted.

In *Test 2*, which was carried out in room 3, the fire was made by flooding part of the floor with petrol. The petrol was poured out in the middle of the floor beneath a large table about 1.5 m square and then set alight. The table prevented the flames reaching the contacts direct. The time check was carried out in the same manner as in the previous test.

From the alarm times of the contacts obtained on the tests, see the table below, it may be seen that in both tests the first signal was received a very short time after the fire had been started, and that there was very small difference in time between the signalling of the contact springs adjusted for 35° C and 70° C. This is of particular interest for the fire that was set in the garret, since the spread of this fire must be considered very similar to what is the case with most garret fires, and since it is shown that the alarm times of the contacts at the temperature in question does not appreciably retard the signal in spite of a difference in adjustment of 35° C.

Of the contacts placed in the garret the one placed at *c* was actuated last, due to the fire being set at a greater distance from this contact than from the others. The difference in time was however only 72 seconds. If the work of extinguishing the fire had been started at this time only, or even 5 minutes later, the spreading of the fire, in spite of the amount of combustibles present, would not have been so great that it could not be rapidly extinguished by means of ordinary bucket squirts.

In *Test 2* it was found that the first contact gave alarm after 14 seconds. The second contact gave alarm after 20 seconds, and the remaining contacts gave alarm so soon after each other that no exact time could be fixed for the separate contacts. The last contact gave alarm after 27 seconds. In this case also we see that a contact adjusted for the lower temperature gave alarm only shortly before the contacts adjusted for the higher temperature, this in respect of thermo-contacts without waterproof cover. Regarding thermo-contacts with waterproof cover, the test gives the same results. The functioning of this contact was somewhat delayed in relation to the others, because of the contact being enclosed.

When reference is made to a temperature at which a thermo-contact is to be actuated, it will seem natural, particularly to persons who are not intimately aquaintetd with the subject, to adjust the contacts for an alarm temperature which is only a few tens of degrees above the ordinary room temperature, so that the contacts may function as soon as possible when fire occurs. If it could be ensured that the temperature in the protected rooms could be kept at a normal level all the year round, there would be no objection to using contacts adjusted in this manner. Only exceptionally does the temperature remain constant and in many places great variations occur. If in such cases thermo-contacts adjusted for a temperature of 10° C above normal were used this would cause false alarm signals from the installation. It is however desirable to avoid this since repeated false alarm signals will reduce confidence in the system with the result that the system may be completely switched off. According to existing prescriptions in Sweden for automatic fire-signalling installations thermo-contacts may be used with an alarm temperature 50° C above normal room temperature of about 20° C. This margin, which may seem rather great, has been fixed with the object of avoiding false alarm signals.

As may be seen from the test figures, compared with the time at the disposal of the fire brigade between the recording of the alarm signal and the latest moment when work to extinguish the fire must begin, the difference in time between the sending out of the alarm from 35° C and 70° C contacts is so small that it can be disregarded. Since melting contacts are far cheaper to manufacture than bimetallic contacts which can be adjusted for various temperatures and also considerably cheaper than differential contacts, it is possible for an installation of a certain cost to have a much larger number of melting contacts than of contacts of other types, and thus a more efficient protection will be ensured.

The tests now carried out show conclusively both the rapidity with which the thermo-contacts are actuated and that the alarm is given at so early a stage that it is possible to extinguish the fire by simple means. This has also been proved in fires which have actually occurred.

G. Bergh.

Testing Thermo-Contacts in a Burning Building.

Test 1. Garret.

Place and Type	a: TH 857/03		b: TH 850	c: TH 850
adjusted for °C	35	70	70	70
alarm after seconds	27	35	48	99

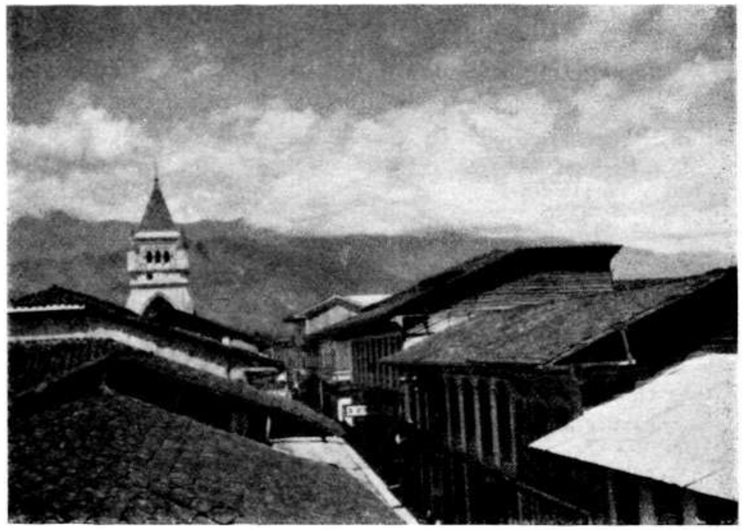
Test 2. Ground floor, room 3.

Type	TH 857/03		TH 850	TH 850	TH 859/01	
adjusted for °C	35	70	70	70	35	70
alarm after seconds	14	20	—[1]	—[1]	—[1]	27

[1] The alarm times of these contacts could not be definitely determined since they were actuated immediately after each other in 20 to 27 seconds.

Fire-Signalling and Police-Telephone Installation in Colombia

The city of Armenia in Colombia placed an order with Telefonaktiebolaget L. M. Ericsson for a combined fire-signalling and police-telephone system which has been delivered recently, in addition to an automatic telephone installation.



X 5153 **View of Armenia.**

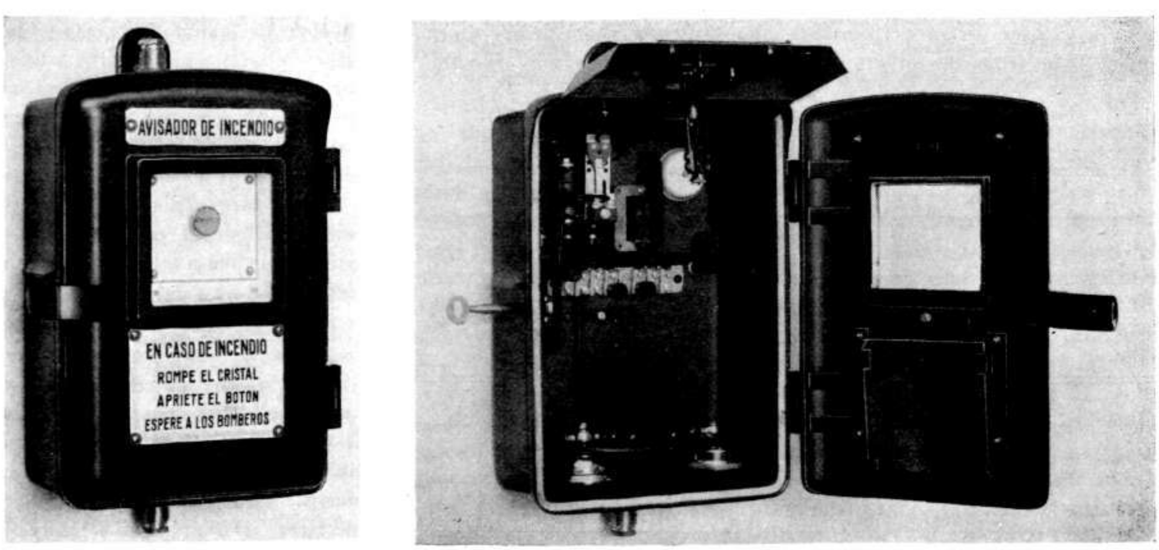
The system comprises 20 street boxes and equipment for the police and fire stations. The public can call the fire brigade from the street boxes and these signals are also received in the police station. By means of flash-light signals from lamps at the street boxes it is possible from the police stations to call policemen patrolling or stationed in the streets, and by means of telephones in the boxes these can put themselves in communication with the police station. The calling lamps at the boxes are also used as night illumination and can be switched on and off from the police station.

Street Boxes.

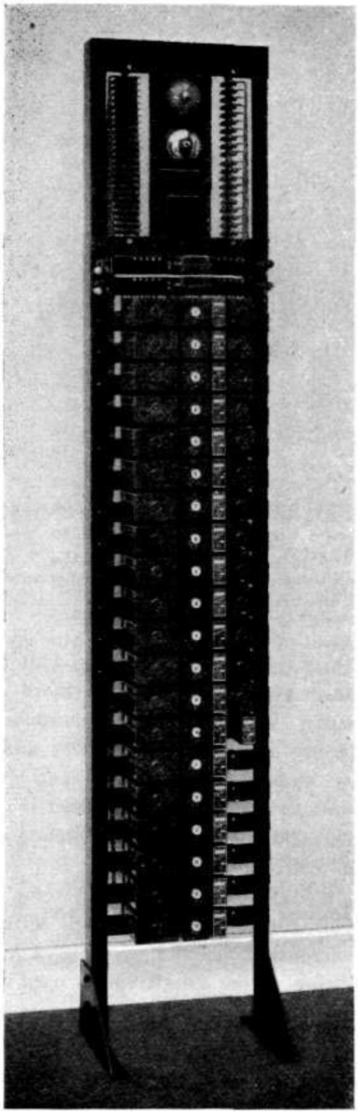
The street boxes are connected with the main distribution frames of the telephone exchange over one pair each in the primary cables of the telephone system, and from there they are connected with a relay bay in the police station over two-wire lines in a separate cable.

The boxes, Fig. 1, are similar to Type TH 351 with a press button behind a glass window for giving alarm signals. Instead of signalling mechanism there is a resistance in the box which is connected between the two conductors of the line so that a loop is formed, this loop being supervised from the police station by a closed-circuit current. A relay is inserted in series with the resistance. The resistance and the relay are connected to a rectifier unit in such a manner that either the relay or the resistance are dead according to the direction of the closed-circuit current. A lamp on top of the box is connected to the mains over the contacts of the relay.

The resistance and the relay are provided with mid-point tappings.



X 3273 **Fig. 1. Street box with microtelephone.** X 5160



X 3274 **Fig. 2. Relay bay in the police station.**

When this tapping is connected to earth, alarm signals are received in the fire and police stations.

Equipment in the Police Station.

As stated above, all incoming lines from the street boxes are connected to a relay bay in the police station, Fig. 2. This bay contains two supervisory relays for each line, one of which is inserted in each branch of the line. The one which is inserted in the positive branch is a closed-circuit relay which is normally energized. The other which is a two-step relay is normally released. The positive pole of the battery is connected to earth, and in addition to the normal position there are four different combinations of these relays to be taken into account.

1. The closed-circuit relay released, the two-step relay released: rupture or leakage in the positive branch;

2. the closed-circuit relay released, the two-step relay energized one step: alarm 5 (earth connection over 1 300 ohm resistance);

3. the closed-circuit relay released, the two-step relay energized two steps: leakage in the negative branch;

4. the closed-circuit relay energized, the two-step relay energized one step: short-circuit or telephone call.

In *Cases 1* and *3* the relay contacts will switch on current to a fault bell and to a fault lamp which is fitted in the supervisory relay corresponding to the line in question.

In *Case 4* a call signal is received in the telephone exchange of the police station.

In *Case 2* an alarm bell is switched on and in addition an alarm relay corresponding to the calling line; this relay starts a selector. This selector moves step by step and when it reaches the position where the energized alarm relay is connected a press button with magnetic release and belonging to the calling line is released in the exchange. The press button is normally in pressed position and when it is released, current is switched on to two alarm lamps connected in parallel in the exchange, these alarm lamps indicate the box from which alarm has been given.

The risk of false alarm has been practically eliminated. The only possibility is that leakage occurs in the negative branch of the line, and this over a resistance of between 500 and 2 000 ohm.

The telephone exchange, Fig. 3, has jacks and calling lamps for 20 alarm lines, 7 local lines, 1 line for direct communication with the fire station and 2 lines for junction traffic with the automatic exchange, dial and 5 cord circuits.

The exchange has in addition one press button for each alarm line for the transmission of flash-light signals to lamps at the boxes. Signals can be sent out over one or several lines at a time. The flash-light signals are produced by a pendulum relay which at regular intervals alters the direction of the closed-circuit current on the lines the press buttons of which have been pressed.

For switching on and off the night illumination of the boxes there is a main switch, by means of which the closed-circuit current over all lines can be shifted.

In addition to the direct line for telephone communication between the police and fire stations there is a two-wire junction line between these places for the transferring of alarm signals. In the relay bay of the police station there is a relay for closed-circuit supervision of this line and in addition relays for the automatic transferring of alarm signals from the police station to the fire station.

Equipment in the Fire Station.

In the fire station there are, in a signalling box, Fig. 4, two relays — closed-circuit relay and indicator relay — inserted in series between the two wires of the junction line. The relays are connected to a rectifier in such a manner that normally

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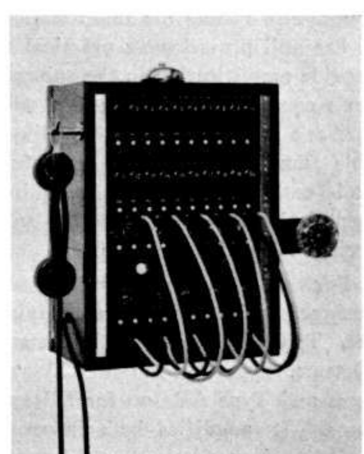

X 3288 **Fig. 3. Telephone exchange in the police station.**

Subscriber's Amplifying Set

Telefonaktiebolaget L M. Ericsson has recently designed a telephone instrument in a bakelite cover of the standard type which contains an amplifier. This instrument, which can be connected to LB, CB and automatic telephone systems, is designed for use in those cases where the subscriber is hard of hearing and, since the outgoing speech can also be amplified, on lines with inferior transmission properties.

X 5172 **Fig. 1. Telephone instrument with built-in amplifier.**
Left, instrument box with microtelephone, dial and volume control; middle, amplifier valve; right, inset with amplifier.

In recent years great interest has been devoted to telephone instruments with amplifying devices. Several designs have been put on the market, but in all types the amplification has been limited to the incoming speech while there has been no amplification of outgoing speech. These instruments have been designed particularly for persons more or less deaf. It may however be assumed, *e. g.*, for lines in out of the way districts, that the transmission needs to be improved also in systems where amplification is otherwise unnecessary. In such cases the amplification of the incoming speech only is not sufficient, the outgoing speech also calling for amplification. It has still proved most practical to provide amplification in the subscriber's equipment proper, and a subscriber's amplifying set with adjustable amplification, both incoming and outgoing, fulfils the requirements also in cases where the subscriber is not hard of hearing.

For this purpose Ericsson has designed a subscriber's amplifying set, Type DP 100 for automatic systems, Type CP 100 for CB systems and Type AP 100 for LB systems. It amplifies both incoming and outgoing speech, as can be seen from the diagram, Fig. 2. The incoming line is switched over when the handset is lifted, from a bell built into the wall fitting in CB and automatic systems or an ordinary magneto telephone in LB systems, to the differential transformer built into the instrument. This transformer serves also as a grid transformer for the valve amplification of the incoming speech, and at the grid of this valve it is terminated by a continuously variable logarithmic potentiometer of 0.5 megohm. The differential transformer is balanced by a stepwise variable resistance connected in parallel with a condenser. The earphone is connected direct to the anode circuit of the valve.

The microphone is fed from the filament battery and is loaded with a resistance over which the microphone transformer is connected. The secondary winding of this transformer is provided with tappings for the regulation of the outgoing amplification, which is carried out by soldering to various tags the grid conductor leading to the amplifier valve for outgoing speech. This valve is connected with the mid point of the differential transformer by means of an anode transformer.

The two valves are of Marconi manufacture, Type L 11.

The voltage for the valves is supplied by dry-cell batteries built into a separate battery case from which a cable leads to the wall fitting. In the battery case there are a 1.5 V battery, for microphone supply and filament current, and a 60 V battery, for anode and grid voltage. When the handset is replaced all tensions are switched off at the common pole.

For CB and automatic systems the wall fitting contains a bell with a condenser. In LB systems a wall fitting of the usual type is used and the bell with its condenser is replaced by an ordinary magneto telephone with bell and magneto for

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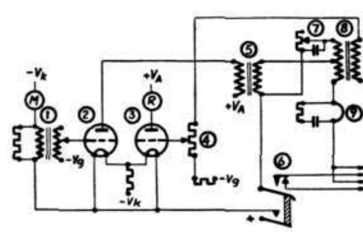


X 3304 **Fig. 2. Diagram of subscriber's amplifying set.**

1 microphone transformer
2 amplifier valve for outgoing speech
3 amplifier valve for incoming speech
4 grid potentiometer
5 anode transformer
6 hook switch
7 line balance
8 differential transformer
9 terminals for connecting a dial
L_1, L_2 line terminals,
A_1, A_2 terminals for connecting a bell or a magneto telephone instrument.

Electric Indicators

Among the few remaining anachronisms in this scientific age, the crude methods employied for the display of numerical information in a readily changeable form must be accorded a prominent place. Stock exchange quotations are still written in more or less illegible figures on dusty blackboards, and train departure times are generally displayed on dials half hidden at intervals by the man who sets them. Hand operated totalisators are common on our racecourses, advertising signs are assembled laboriously from loose letters, and even our cricket scores make their belated appearance upon swinging iron plates.

In telephone exchanges, it has been the practice for many years to display the numbers of certain telephone calls to the operator automatically under the control of readily reset electromechanical devices.

Ericsson Telephones Ltd, London-Beeston, have now designed a new system for numerical indicators, where experience gained in the range of telephony has been applied. The new indicators are suitable for stockbrokers, jobbers, railway companies, totalisator operators, advertisers and all who are interested in the display of variable data to the public.

Ever since the totalisator became popular, numerical indicators consisting of groups of electric lamps lit in selected combinations have been familiar objects to many people. Although such indicators are probably unequalled in their own field, their comparatively heavy current consumption and the fact that they are not readily adaptable to small sizes prevent their universal adoption.

X 5166 **Indicator board mounted in a stockbroker's office.**

Ericsson, London, has developed a new system of numerical indication which avoids these objections and enables figures of almost any size from about one inch upwards to be displayed. Although the new Ericsson indicator can be applied with success to the electric totalisator, the fact that no power is consumed except while the figures are actually being changed renders it suitable for use in a much wider field. Accompanying this article are illustrations of a large installation for indicating current quotations of stocks and shares, but the system is equally applicable to railway platform arrival and departure indicators, and all other cases in which it is required to display variable information to the public at a minimum of cost and effort.

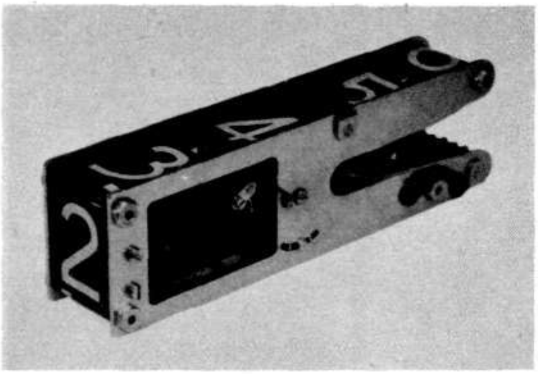
Indicator Unit.

In its simplest form, the indicator is built up from units designed to display at will any one of 10 digits. Other types capable of dealing with 12 different characters, and even with a complete alphabet, will be referred to later.

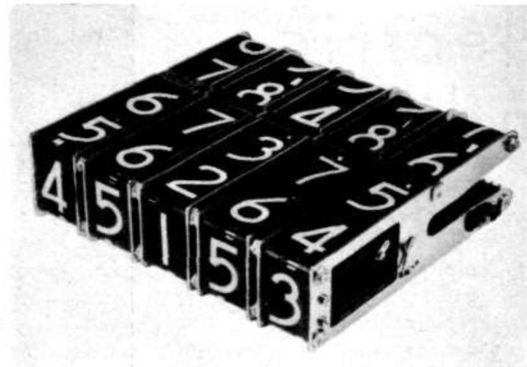
Attempts have been made in the past to accommodate the various figures which it is required to display upon the edge of a circular drum. Obviously, the diameter of such a drum must be large compared with the size of the figures, and is is therefore impossible to display several rows of figures close together. In order to avoid this difficulty, the drum has been discarded in the Ericsson indicator in favour of an endless flexible band upon which the figures are printed in bold type. As the display surface is perfectly flat, the figures on adjacent indicator units do not tend to mask one another, and the angle from which a complete indicator board can be satisfactorily viewed is very wide.

Fig. 1 shows a typical indicator unit. In this example, the band has 12 sections, one for each of the numerals 0 to 9, one blank section, and one section occupied by a special flexible joint in the band. A great deal of care has been devoted to the selection of the best kind of material for the band and the most suitable method of joining it to ensure long life and easy movement.

Tests have proved that the most easily read figures are those in white on a black ground, and this is the standard type. When it is required to distinguish one set of figures from another, the best colour for the second set is a rather yellowish orange. Any other colours, and also black figures on a white ground, can, of course, be supplied if required.



X 1395 **Fig. 1. Indicator unit.**



X 1396 **Fig. 2. Block of indicator units.**

Ericsson indicator units can be assembled into blocks, Fig. 2, of any desired number. For displaying stock exchange quotations, blocks of 4 or 5 are usually required, the particular arrangement of the indicators and the marking of the bands being dependent upon the way in which the stock in question is quoted. For train departure and arrival indicators, 4 units — 2 for the hours and 2 for the minutes — are necessary; for »minutes late» indicators, 2 units, and so on.

A feature of all Ericsson indicators is their interchangeability. Any block of indicator units can be readily removed from the indicator board and replaced by a new block without affecting the operation of other units or interfering with the wiring. To provide this facility, the electrical conductors leading to each indicator unit are terminated at jack contacts of standard telephone pattern, the various connections being made automatically when the unit is placed in position. In the common-drive system, special provision is made to ensure that the mere placing of a block of indicator units in position brings them into proper relationship with the rotating shaft.

Fig. 3 shows a large indicator installed by Ericsson in a stockbroker's office. This indicator displays separate »buy» and »sell» quotations for each of 264 stocks at the same time.

The dimensions of a complete indicator are naturally determined by the number of individual figures and their size. Owing to the features of design already mentioned, the number and size of the figures that can be displayed approaches very closely to the theoretical maximum for the space available.

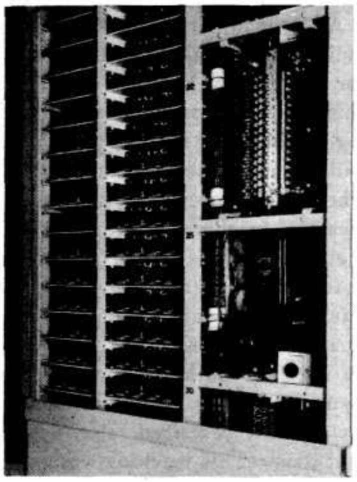
By way of example, the indicator shown in Fig. 3 displays over 2 300 figures each $1^1/_2$ in. high, the area actually occupied by the display surfaces of the blocks of indicator units being about 77 sq.ft. These figures can easily be read at a distance of 40 ft. Although for small numbers of indicator units it is naturally advantageous to make use of a standard size, it may be taken as a general rule that there is no technical difficulty in constructing indicators for figures of any height from one inch to one foot.

The number of different indications carried by a single indicator unit is normally ten, or eleven if a blank position is required. Special units for the display of larger numbers of characters can, however, be supplied; thus, a single unit can be supplied for the pence figures in price quotations. Fractions in eighths, sixteenths, or other denominations can also be provided for, and it is even practicable to design a unit carrying all the letters of the alphabet, and thus to erect a remotely controlled sign capable of displaying at will any series of words within its capacity.

X 5164 **g. 3. Stock-quotation indicator board.**

Driving Arrangements.

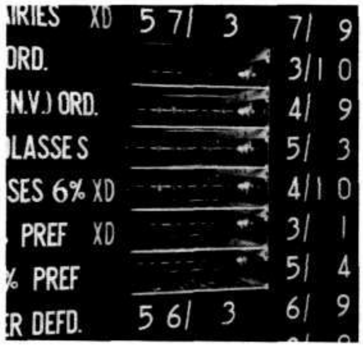
Two methods, based upon the fundamental principles of the two main types of automatic telephone exchange, are employed for driving the indicators. The most suitable type of drive depends upon such factors as the size of the figures, the frequency of operation, the amount



X 3279 **Fig. 4. Reverse of indicator board,**
showing the driving motor and the common drives.

of space available, and the method of control required.

In the first, or *common drive system,* Fig. 5, a rotating shaft is situated behind each row of indicator units, each group of which is accurately positioned with regard to rubber rollers carried by the shaft. These rollers rotate close to the band on each indicator unit without actually touching it. Each unit carries a small roller controlled by an electromagnet, and when the magnet is energised the band is nipped between this roller and one of those on the rotating shaft. In this way the band is driven by the shaft until the required position is reached, when the magnet is de-energised and the band brought to rest immediately. The shaft can be arranged to rotate either continuously or only when it is required to change the reading of an indicator, the choice

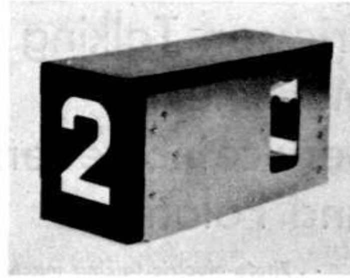


X 3278 **Fig. 5. Detail of indicator board,**
showing the rotating driving shafts.

being dependent upon the frequency with which changes are likely to be made.

In the other system, or *individual drive system,* Fig. 6, the rotating shafts are dispensed with and each indicator unit is driven by a self-contained impulse-driven motor of special design. These motors, which have only one moving part and are extremely simple and robust, drive the bands by means of small sprocket wheels engaging with perforations similar to those employed in cinematograph film.

Each indicator unit carries electrical contacts capable of positively determining the position of the band at any time, so that when the appropriate control circuit is closed the band moves forward automatically until the required indication is reached and then stops practically instantaneously. Owing to the very small mechanical inertia of the band, only a few thousandths of a second are required to bring it completely to rest.

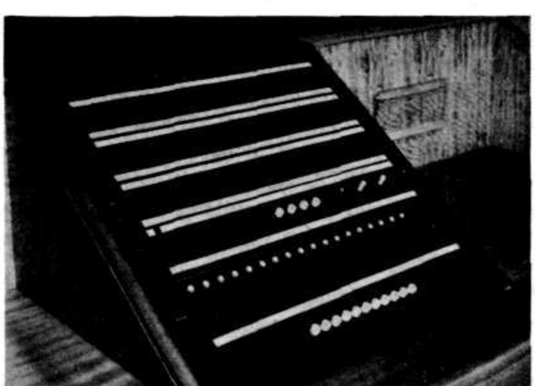


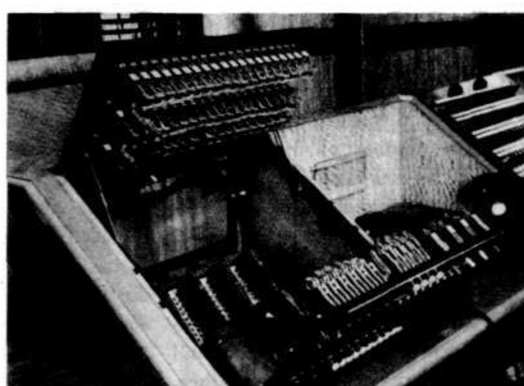
X 3281 **Fig. 6. Indicator unit for individual drive.**

Controlling Arrangements.

The form taken by the electrical control circuits depends entirely upon the use to which the indicator is to be put, and circuits can be designed to fulfil any possible conditions required in practice. Ericsson's long experience in the design of automatic telephone circuits and, more recently, of electric totalisator circuits, guarantees in any given case the cheapest and most efficient solution. In particular, novel methods of using electrical conductors in combinations instead of individually allow us to reduce the amount of wiring and the number of contacts required to a minimum, thereby achieving a considerable saving in first cost and reducing maintenance charges to an almost nominal figure.

Fig. 7 and 8 show a typical control panel. The group of indicators which it is desired to control is selected by throwing a key in one of the horizontal rows, the new indication then being set up by pressing the white buttons at the foot of the panel according to the digits





X 1398 **Fig. 7—8. Control panel.** X 1397
The figure to the right shows how the panel is lifted up for inspection.

Ericsson Talking Machines in Service in Sweden and Poland

Photo-electric talking machines as described in the Ericsson Review No 2, 1934, have now been installed and put in service at several places.

Eight talking machines have been supplied to the Swedish Telegraph Administration, the first of which was put in service last May in the Stockholm name-call exchange, where it gives the call number »zero» of the exchange twice in a second; the new talking machine has replaced a machine of an old type which had been in service on trial in this exchange since November 1932. Six other machines have been installed in Stockholm, Gothenburg and Malmö where they repeat the words »eight», »nine», »zero», »who is speaking», »Gothenburg» and »Malmö». This eighth machine is used for time indication, giving the hour, the minute and every ten seconds. A time indication sounds, *e. g.*, »thirteen, twenty-eight and thirty». This machine was put in service at the beginning of October, so that the statistics available at present cover only about one week. The number calls answered by the »time» machine during the week averaged about 23 000 per day.

In Poland also Ericsson has supplied time-indication machines: one to Warsaw and one to Lodz. The Warsaw machine was put in service on July 1st this year; as with the Lodz machine, which was put in service in October, it indicates only hours and minutes. Statistics from Warsaw show a remarkably high number of time inquiries per telephone. On the day of opening there were no fewer than 36 800 calls to the machine, and after 3 months' service the daily average is still as high as 26 000.

These figures prove that automatic time-indication machines supply an actual need, while at the same time they can be good sources of income to the administrations.

At present Ericsson has a time-indication machine in manufacture for Bergen in Norway. This machine is to be combined with a talking machine for short notices, which will be put in service automatically when faults occur in the time-indication machine, informing callers that the latter is out of action.

In addition to the twelve machines referred to above Ericsson has manufactured a machine for notices of 20 seconds' duration for the race-course starting and time-keeping installation described elsewhere in this issue. This machine was put in service in August this year on the Bergsåker trotting course near Sundsvall, Sweden. The machine utters the following words which are repeated by loudspeakers at the various starting points: »take your places», 10 seconds later »one», 5 seconds later »two» and after another 5 seconds »go». As the word »go» is uttered, the machine closes a contact which starts the time-keeping clocks and releases the cords stretched across the course at the starting points leaving the course open to the competitors.

C. Ahlberg.

X 3280 **Fig. 9. Rotary switch for control of indicator units.**

required. The four white buttons in the centre of the fourth row of keys enable any number of the indicator units in the selected group to be left unchanged without retransmitting their readings on the numerical buttons.

Control panels of this type are employed for the stock quotation indicator, Fig. 3, the indicator and control desk may be seen together. Each operator is provided with a telephone over which the quotations to be set up on the indicator are received, and on each key panel one row of keys is devoted to the control of the telephone circuits. In this installation the control desk is situated directly in front of the indicator, but there is actually no limit to the distance between them, the only connection required being an electric cable having the necessary number of conductors. Any number of indicators can further be controlled in parallel, thereby allowing the indications to be repeated in as many places, widely separated or otherwise, as may be desired.

The whole of the wiring and associated electrical apparatus conforms to the severe standards set by the British Post Office for automatic telephone exchanges.

The miniature *switch* shown in Fig. 9 offers an alternative method of control. When it is rotated to any number, as indicated either by an arrow on the mounting panel or in a small window through which only one character is visible at a time, the indicator at once takes up a corresponding position. As the setting can be ascertained at any time by an inspection of the switch, this method of control is particularly convenient in cases in which the indicator is not visible from the controlling point. Sixty-four of these small switches can be mounted on a panel only 1 sq. ft in area.

The control circuits are normally designed to operate with 50 or 100 V DC and a small secondary battery provides a suitable source of current. Alternatively, current may be obtained from any alternating current supply by means of a suitable transformer and rectifier. Alternating current supply mains are also suitable for the motors driving the rotating shafts in the common drive system.

C. W. Wilman.

New Measuring Instruments

Insulation and Fault Localizer, Type ZA 149.

The set is designed for measurements of resistance and insulation and for locating contacts between the conductors or leakage to earth on telephone lines.

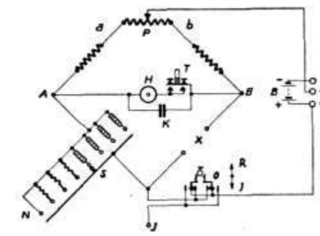
The diagram is shown in Fig. 1.

The ratio $\frac{b}{a}$ is read direct on the potentiometer P which is graduated from 0.3 to 3.5. The resistance R can be varied by means of the switch S and may be 0, 10, 10^2, 10^3, 10^4, 10^5, 10^6 och 10^7 ohm. The resistance to be measured is connected at X. The receiver circuit contains a condenser K and a switch T in addition to the receiver H. By this arrangement it is possible to use a receiver in spite of the set being fed with DC. As long as any difference of potential remains between A and B the condenser K will be charged. The condenser is short-circuited over the receiver H by means of the switch T. A click will then be heard in the receiver. By opening and closing the switch T and at the same time turning the potentiometer P, a position of the potentiometer will be obtained where no click is heard in the receiver. The bridge is then balanced, and consequently

$$X = \frac{b}{a} N$$

When measuring resistances and insulation this formula may be used. The measuring range is 3 ohm to 35 megohm.

For locating a contact between one conductor and earth or a contact between the conductors, a ratio measurement is carried out, and in certain cases also a calibrating measurement.



X 5167 **Fig. 1. Diagram of insulation and fault localizer,**

connected for measurement of resistance and insulation.

a, b	ratio resistances
B	battery
H	receiver
J	earth terminal
K	charging condenser
N	decade resistance

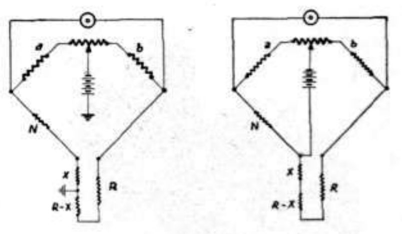


Fig. 2 and 3. Diagram of insulation and fault localizer,

connected for locating contacts between the conductors and between a conductor and earth.

P	potentiometer
O	switch with two positions, R and J
S	decade switch
T	charging switch
X	unknown resistance

When locating a contact between one conductor and earth the bridge is connected according to Fig. 2. This connection is obtained by throwing the switch O, Fig. 1, into position J, which will connect the battery to earth over the earth terminal J.

If

$2R$ = the length of the line up and down,

X = the distance to the fault,

m_1 = the measured ratio $\frac{b}{a}$

$n = \frac{X}{R}$ = the ratio between the distance to the fault and the length of the double line,

we get

$$m_1 = \frac{2R - X}{X}$$

and consequently

$$n = \frac{2}{1 + m_1}$$

In this measurement the resistance N, Fig. 2, must be = 0. Should m_1 be greater then 3.5 the branches should be shifted.

In order to facilitate the determination of n the set is supplied with a curve, Fig. 4. The corresponding values of m_1 and n are obtained from the curve a.

As may be seen, n can in this measurement vary only between 0.45 and 1.54. If n is less than 0.45 the resistance N, Fig. 2, must be inserted and adjusted so that the receiver is dead. Then

$$m_1 = \frac{2R - X}{N + X}$$

and consequently

$$m_1 (N + X) = 2R - X$$

After that a measurement is carried out according to Fig. 3 with the resistance N in the same position. This bridge connection is obtained with the switch O, Fig. 1, in the position R.

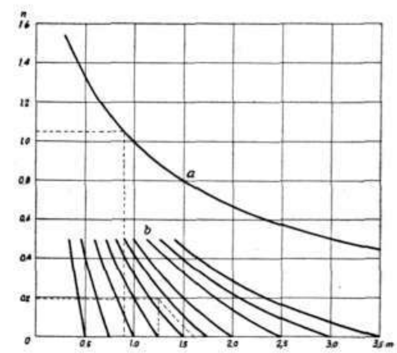
If m_2 is the measured ratio $\frac{b}{a}$ we get

$$m_2 = \frac{2R}{N}$$

and consequently

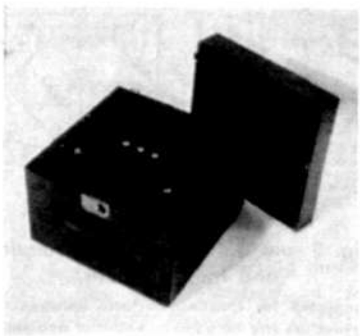
$$N = \frac{2R}{m_2}$$

If this value of the resistance N is introduced in the preceding for-



X 3289 **Fig. 4. Calibrating curve for Type ZA 149.**

The corresponding values of m_1 and n are obtained from curve a (i. e., if $m_1 = 0.9$, $n = 1.05$). n is obtained from the curves b when m_1 and m_2 are known (i. e., if $m_2 = 1.60$ and $m_1 = 1.25$, the curve $m = 1.60$ is followed until it intersects with the ordinate through $m = 1.25$; the n—coordinate at this point is the value searched for, in this case $n = 0.195$).



X 3290 **Fig. 5. Gain tester, Type ZB 151.**

mula, we get

$$X(1+m_1) = 2R\left(1-\frac{m_1}{m_2}\right)$$

and consequently

$$n = 2\,\frac{m_2 - m_1}{m_2\,(1+m_1)}$$

In order to determine n by means of the curve, when m_1 and m_2 are known, the curves *b*, Fig. 4, are used.

For locating a contact between the conductors the same measurement is carried out. Consequently, if n lies between 1.54 and 0.45, only m_1 is measured, and when n is less than 0.45 both m_1 and m_2 are measured. The set is connected between one conductor and an auxiliary conductor, these two conductors being joined at the far end. The other conductor is connected to the earth terminal *J* of the set.

A detailed description of the method of fault locating is to be found in the Ericsson Review No 4 —6, 1930.

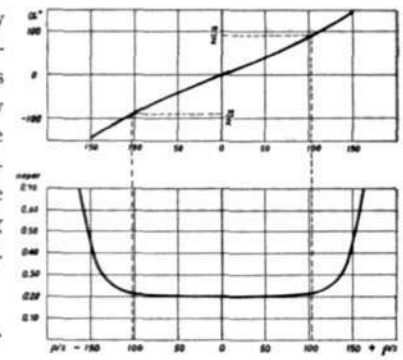
The set is supplied in a case of oak, measuring 260×125×190 mm. The case is provided with a leather strap so that it can be carried over the shoulder or on the back. At one end of the case there is a room for the receiver. The built-in battery has a tension of 9 V, but when measuring high insulation resistances this should be replaced by a battery of say, 100 V. This battery can be connected outside the set after a connecting tag has been removed. The weight of the complete set including the receiver and battery is 3.5 kg.

Gain Tester, Type ZB 151.

For measuring the gain of a repeater with in and output impedances of 800 ohm, *e. g.*, two and four-wire repeaters, the gain tester, Fig. 5, has been designed, allowing gain measurements at three different frequencies, 500, 1 000 and 2 000 c/s, without the use of an audio-frequency generator. The design is based on the principle that when a repeater is fed back over a quadripole of a certain attenuation, the repeater will start singing when the attenuation of the quadripole is as high as the gain of the repeater, provided that the tension fed back to the grid is of the right phase angle.[1]

The quadripole over which the repeater is fed back consists of a frequency-controlling band filter and an attenuation network composed of resistances, Fig. 6. The filter is a band filter with the effective band width about 200 c/s, and by means of a switch it is possible to place the band at 500, 1 000 or 2 000 c/s. The gain measured will consequently refer to 500, 1 000 or 2 000 c/s with an accuracy of ± 100 c/s. The effective phase shift within the band is 180°, and by shifting the branches an additional phase shift of 180° is obtained; it is thus sure that at least one frequency within the band can always come in the right phase for the return feed. The bottom attenuation is 0.2 neper for the three frequency ranges due to a suitable arrangement of an additional attenuation network.

[1] Swedish Patent 73 433.



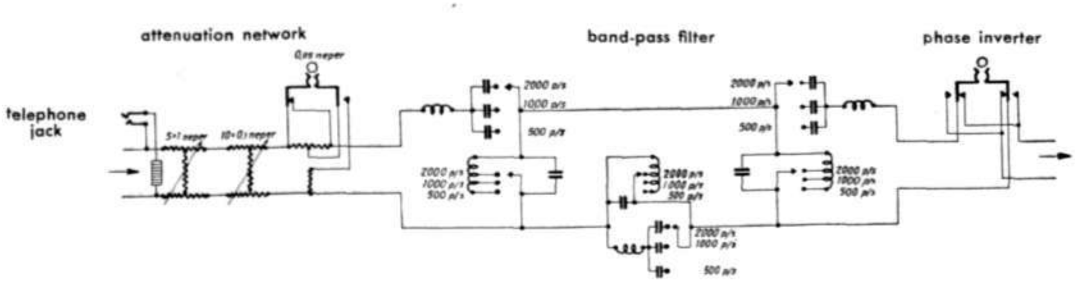
X 3291 **Fig. 7. Effective phase-shift and attenuation**

of frequency-controlling band-pass filter with band width 200 c/s.

The attenuation network can be regulated in 5 steps of 1, 10 steps of 0.1 and 1 step of 0.05 neper.

The attenuation of the complete quadripole can thus be regulated from 0.2 to 6.25 neper in steps of 0.05 neper, and consequently there is the possibility of measuring gain between 0.2 and 6.25 neper with an accuracy of 0.05 neper.

The diagram of the gain tester is illustrated in Fig. 6. The »in» side of the quadripole is connected to the output side of the repeater to be measured, and by then connecting the »out» side of the quadripole to the input side of the repeater this will be fed back over the filter and the attenuation network. The switch is set for the frequency wanted, and the attenution network is varied until the singing from the repeater can be heard in the receiver. The highest



X 7065 **Fig. 6. Diagram of gain tester.**

attenuation which can be in circuit without the repeater ceasing to sing indicates the gain.

Fig. 7 shows the effective attenuation and the effective phase-shift of the filter. The part of the effective-attenuation curve that corresponds to the phase shift 180° (—90° to 90°) is very straight as may be seen.

Capacity Measuring Set, Type ZA 155.

This measuring set is designed for measuring the capacity and loss angle of condensers within the range 1 $\mu\mu F$ to 10 μF, and is suitable for manufacturers of condensers and wireless equipment, test rooms, laboratories and research institutions. In principle the measuring set is designed as a simple Wheastone bridge with four branches, Fig. 8. The objects to be measured, the condensers C_x, r_x are compared in the bridge with a fix standard condenser C_1, which is connected in parallel with a small adjustment condenser C_2, with the ratio resistance R_5, and the resistance set R_2, R_3 and R_4. As the variable elements of the bridge are only pure resistances, an extremely high stability is obtained both electrically and mechanically, since resistances are the impedance elements which are simplest to manufacture and adjust and least liable to change with time.

The measurement is carried out by varying the resistance set R_2, R_3 and R_4 and R_1 until the receiver circuit of the bridge becomes dead. We then have

$$C_x = (C_1 + C_2)\frac{R_2 + R_3 + R_4}{R_5}$$

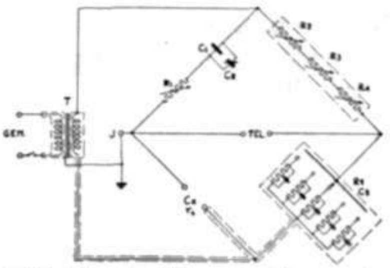
$$\text{tg}\delta_x = \omega\, C_x r_x =$$

$$= \omega[(C_1 + C_2)R_1 + C_5 R_5]$$

By R_5 being dimensioned so that its five resistances have a very small inductance, this branch of the bridge is compensated by the corresponding value of C_5, so that it becomes purely ohmic; the factor C_5R_5 will then vanish, and consequently

$$\text{tg}\delta_x = \omega\, C_x\, r_x = \omega\,(C_1 + C_2)R_1$$

When $C_1 + C_2$ is constant and the frequency is given, the set can consequently be calibrated direct in capacity values from $R_2 + R_3 + R_4$ with the exception of a multiplying factor, and in loss angle δ_x, which is obtained from R_1.



X 3292 Fig. 8. Diagram of capacity measuring set.

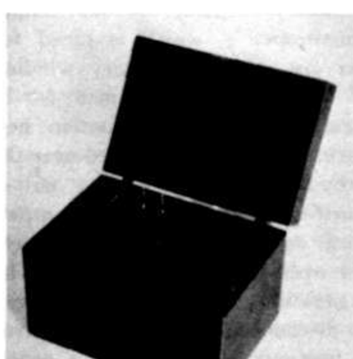
C_1, C_2 standard condenser with adjustment condenser
C_x–r_x unknown capacity with loss resistance
J earth terminal
R_1 variable resistance
R_2, R_3, R_4 resistance set
R_5, C_5 ratio resistance with compensating condenser
T feeding transformer

This bridge has thus two adjustments which with the above assumptions are independent of each other, the result being that the adjustment until the receiver circuit is dead is carried out under heavy convergency so that both C_x and δ_x can be adjusted rapidly.

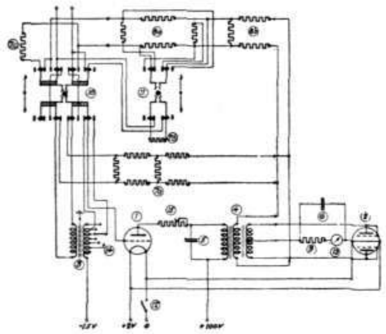
The resistance set R_2, R_3 and R_4 is manufactured with extremely small inductances and capacities so that its phase angle is practically zero and does not influence the adjustment of the loss angle δ_x. By careful electrostatic screening both of every separate element of the bridge and of the complete bridge system, it has been possible to give the set a compact design, without in any way taking from its accuracy. The current is supplied over the special transformer *T*, Type ZF 640, which has its primary and secondary windings enclosed in metal screens. The secondary winding is connected with its screen. The screen is in addition insulated with quartz rods so that its capacity both to the screen of the primary winding, which is connected to earth, and direct to the earth connected cover of the transformer is practically free from losses and is added as a constant amount to the capacities C_1 and C_2. By this arrangement the current supply to the bridge can be ensured quite independent of capacities to earth or the direct earth connection of the generator side. The screen of the secondary side has been extended to cover the lower part of one of the terminals of the condenser C_x and the ratio resistance R_5, whereby the zero capacity of the bridge, *i. e.*, between the terminals of the condenser C_x, is only 1.0 $\mu\mu F$. This value is also read on the resistance R_4 when no capacity is connected and thus it is always possible to correct for the actual zero capacity.

The resistances R_2 and R_3 are made as decade resistances in 10 steps, while the resistance R_4 can be varied continuously. The resistance R_5 has 5 steps which for the reading of the capacity C_x gives multiplying factors of 1, 10, 100, 1 000 and 10 000.

The measuring range is from about 1 $\mu\mu F$ to 11.1 μF. The smallest capacity values may however be read with a far greater accuracy than 1 $\mu\mu F$, the resistance R_4 at the multiplying factor 1 covering 10 $\mu\mu F$ as a total and being divided in 50 graduations. The absolute accuracy is for capacities up to 1 μF $\pm$ 1 unit of the scale value of the third resistance R_4, and, for capacities between 1 and 10 μF, $\pm$ 2 units. Loss angles can be measured up to 4 % at 1 000 c/s with an absolute accuracy of $\pm$ 0.05 %. As a standard the set is manufactured with tgδ_x calibrated at 1 000 c/s, but on request it can also be supplied for other frequencies. When



X 3293 Fig. 9. Capacity measuring set, Type ZA 155.



X 3294 **Fig. 10. Diagram of direct-reading transmission set.**

1	generator and amplifier valve
2	valve voltmeter
3	input transformer
4	output transformer
5, 6	condensers
7, 8	attenuation networks
9	compensating resistance
10	switch for transmission (top), calibrating (middle) and reception (below).
11	switch for adjustment of the outgoing level to +1 neper (top) or 0 neper (middle) on transmission, or for switching to terminal level (middle) or through level (below) on reception.
12	battery switch
13	micro-ammeter
14	switch for adjusting the measuring range
15	calibrating potentiometer

required for measuring very high capacities or within limited ranges, special varieties of this bridge can be supplied.

For the measurement, an audio-frequency generator with an output of a few hundred milliwatt and an output impedance of about 800 ohm is required, *e. g.*, Type ZD 150, as well as a laboratory amplifier, *e. g.*, Type ZF 550 or ZF 555.

The capacity measuring set, Fig. 9, has the dimensions 385×265×255 mm, and it weighs complete about 16 kg.

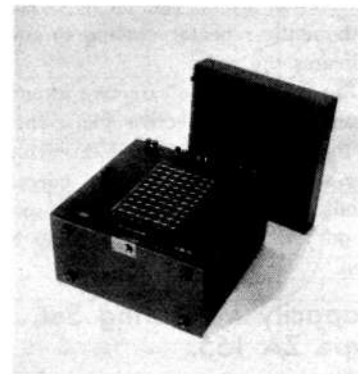
X 3295 **Fig. 11.** ***Direct-reading transmission measuring set, Type ZB 455.***

Direct-Reading Transmission Measuring Set, Type ZB 455.

The need of a simple and inexpensive portable instrument for the rapid checking of overall attenuation and level conditions on a line has become apparent during recent years, particularly in countries with a small number of long-distance overhead lines for which a complicated measuring instrument is not necessary. To meet this requirement Telefonaktiebolaget L. M. Ericsson has designed a direct-reading transmission measuring set, Type ZB 455. This instrument can either serve as a generator for transmitting zero level at 800 c/s on a line or as a level indicator at 800 c/s for through level or incoming level at terminal stations. It thus replaces the transmission measuring set, Type ZB 450, and the audio-frequency generator in cases where measurements at one frequency only are sufficient. For attenuation measurements on a line two sets, Type ZB 455, are required.

The set, of which a diagram is shown in Fig. 10, contains two Marconi valves, Type LP2 and B21. The former, *1*, operates as a generator when zero level is transmitted and as an amplifier on level indication. The latter, *2*, operates as a valve voltmeter with direct reading of the level.

When the set serves as a generator for zero level, the first valve is fed back over a suitable attenuation network, *7a*, between the secondary winding of the output transformer *4*, which is tuned for 800 c/s, and the primary winding of the input transformer *3*. In parallel with this attenuation network, *7a*, there is connected over the secondary winding of the output transformer another attenuation network, *8a* and *8b*, of suitable design, and over this the line is fed. The attenuation of *8a* is 1 neper and can be disconnected when it is desired to transmit a level of + 1 neper. The amplitude of the oscillation is adjusted by means of the potentiometer *15* in the anode circuit of the first valve, and when the switch *10* is in calibration position the line is replaced by a resistance of 600 ohm. When the measuring instrument of the set indicates zero level, the switch is thrown into transmitting position, and the line is then connected and fed with zero level of 800 c/s.

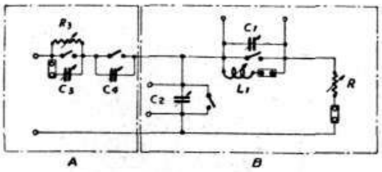


X 3296 **Fig. 12. Balance simulator, Type ZB 211.**

The grid transformer *3* has tappings arranged so that the set after being calibrated in the above described manner, indicates direct the incoming level. The attenuation network *8a* and *8b* should then be terminated with 600 ohm and the line to be measured be provided with a termination of 600 ohm by throwing the switch into receiving position, that is if the line has not been terminated outside the set or if through level is measured at a point in the line.

The indicator is fed with an insignificant amount of power over another secondary winding in the output transformer *4*, and in principle it is a push-pull connected diode rectifier. The Marconi valve, Type B21, contains two triode systems with a common filament, which allows the push-pull connection selected to avoid the occurrence of harmonics in the generator. The characteristic curve of the diode has been straightened out as far as possible by the insertion of a high resistance *9* in series with the sensitive DC instrument *13*.

The switch *10* serves, as stated, for switching the set for »calibration», »transmission» and »reception». The switch *11* serves for adjusting the outgoing level to »0



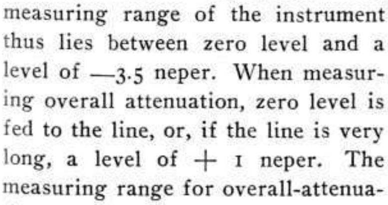
X 3297 **Fig. 13. Diagram of balance simulator, Type ZB 211.**

neper» or »+ 1 neper» on transmission, and for switching between »terminal level» and »through level» on reception.

The indicator instrument *13* is graduated in neper, from zero level at full deflection to —1.0 neper at about $^1/_3$ of full deflection. Seeing that the scale is very crowded for small deflections it is better to operate with great deflections as far as possible, and for this reason the ratio of the grid transformer can be increased in steps of 0.5 neper so that the reading can always be kept between half and full deflection. The secondary tappings of the grid transformer are connected by means of a dial switch *14* with six positions between 0 and —2.5 neper. The measuring range of the instrument thus lies between zero level and a level of —3.5 neper. When measuring overall attenuation, zero level is fed to the line, or, if the line is very long, a level of + 1 neper. The measuring range for overall-attenuation measurement is consequently 0 to + 3.5 neper when zero level is transmitted, and to + 4.5 neper when a level of + 1 neper is transmitted.

The measuring accuracy is greater than 0.1 neper. On transmission the accuracy is 1 % in respect of the frequency and 2 % in respect of power.

The set is fitted on an iron panel which is placed in a wooden case, Fig. 11, measuring with the lid 324×204×250 mm.



X 3298 **Fig. 14. Balance simulator, Type ZB 211,**
connected for reproduction of overhead lines.
a C_3 and C_1 short-circuited, $C_2 = 0$
b C_4 and C_1 short-circuited, $C_2 = 0$
c C_1 short-circuited, $C_2 = 0$; C_3 connected between the branches

Balance Simulator, Type ZB 211 and ZB 205.

For the accurate balancing of cable circuits, *e. g.*, for echo-attenuation measurements on delivery tests, a variable line balance, Type ZB 211, Fig. 12, has been designed, which with satisfactory accuracy covers all existing types of loaded cables and overhead lines.

For a loaded cable circuit we have, if the leakance is disregarded,

$$Z = \sqrt{\frac{L}{C}} \sqrt{1 + \frac{R}{j\omega L}} \cdot \frac{1}{\sqrt{1 - \left(\frac{\omega}{\omega_0}\right)^2}}$$

where

L = the inductance per loading-coil section,

C = the capacity per loading-coil section,

R = the ohmic resistance per loading-coil section,

ω_0 = the cut-off frequency of the cable.

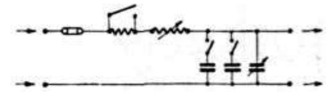
For high values of ω we get

$$Z = \sqrt{\frac{L}{C}} \cdot \frac{1}{\sqrt{1 - \left(\frac{\omega}{\omega_0}\right)^2}} = Z_0 \cdot \frac{1}{\sqrt{1 - \left(\frac{\omega}{\omega_0}\right)^2}}$$

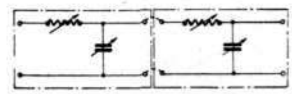
and this value is reproduced by the usual Hoyt section *B*, Fig. 13, which has the *Π* image impedance

$$= Z_0 \frac{1}{\sqrt{1 - \left(\frac{\omega}{\omega_0}\right)^2}}$$

and the *T* image impedance real and independent $= Z_0$ within the greatest part of the frequency range 0 to ω_0; in view of this the section can be terminated by $R = Z_0$. The values of L_1, C_1 and C_2 are obtained as multiples of known values of the inductance and capacity of cable. The section *A*, Fig. 13, corrects the balance within the frequency range where $\frac{R}{\omega L}$ cannot be disregarded and the values of R_3, C_3 and C_4, which are obtained from known values of Z_0, ω_0 and R.



X 3299 **Fig. 15. Diagram of balance simulator, Type ZB 205.**



X 3300 **Fig. 16. Two balance simulators, Type ZB 205,**
connected in series for better reproduction of a line at low frequencies.

The various elements of R_1, C_1, L_1, etc. are divided into 10 elements which can be connected and disconnected by means of press buttons. It is possible to extend C_2, C_1, L_1, and R by the addition of units, so as to increase the measuring range or improve the reproducing accuracy of the simulator in certain cases.

For the reproduction of overhead lines three different types of balances, Fig. 14, can be obtained by means of the balance simulator. The instrument is fitted in a wooden case, measuring, with lid, 384×384××250 mm.

In addition to the above described balance simulator, a smaller set has been designed, Type ZB 205, especially intended for the balancing of overhead lines.

The balance simulator, Fig. 15, is composed of a resistance and a condenser connected in series. The resistance is composed of two decade resistances 10×10 ohm and 10×100 ohm one resistance of 1 000 ohm, *i. e.*, in all 2 100 ohm. The capacity is made up in a similar manner by two decade condensers of 10×0.01 μF and 10×0.1 μF and one condenser of 1 μF and one of 2 μF, *i. e.*, in all 4.1 μF. It is possible to extend resistances and condensers by the addition of units.

If a very accurate reproduction of a line is wanted two balance simulators can be connected one behind the other as shown in Fig. 16.

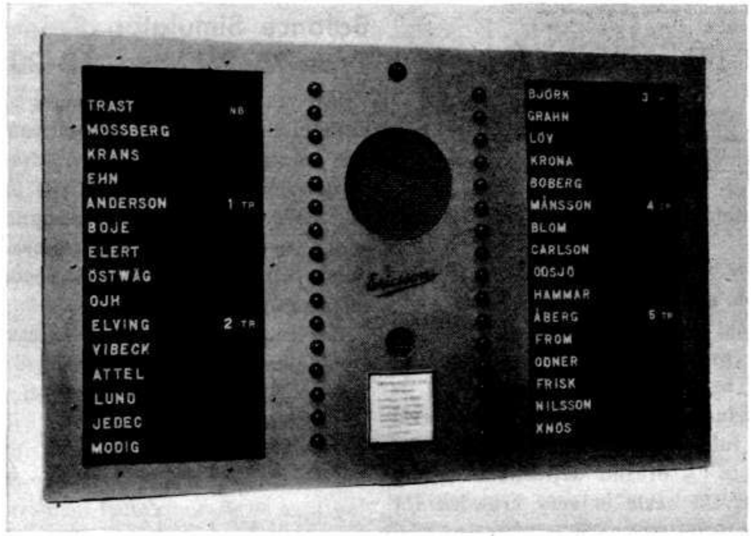
The balance simulator is fitted in a wooden case with an iron panel. The dimensions, with lid, are 384××264×250 mm.

J. Ljungberg, G. Styrén,
S. Överby & C. Anjou.

Hallway Telephone

The principal reason telephones have not up to now been more used as hallway telephones has been the difficulty of designing a suitable apparatus. The apparatus previously used for this purpose consisted chiefly of ordinary telephone instruments, by means of which visitors called from the entrance hall to occupants of a building. It is obvious that it was unhygienic to employ such an apparatus of which the microtelephone was used by all kinds of people, and moreover it was often exposed to damage.

Telefonaktiebolaget L. M. Ericsson have now designed a modern hallway-telephone instrument, which has two main advantages: protection against the entry of hawkers and canvassers to a building and protection of the apartments of the tenants.

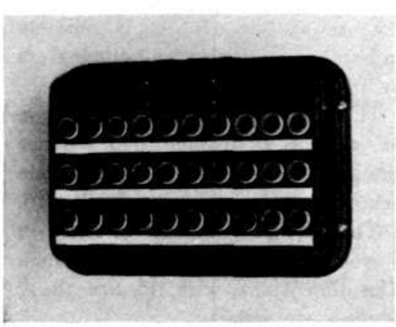


X 5161 **Fig. 1. Hallway-telephone panel.**
Opposite the names in the register, press buttons for calling the tenants; in the middle: top, press button for calling the porter, below, loudspeaker and microphone.

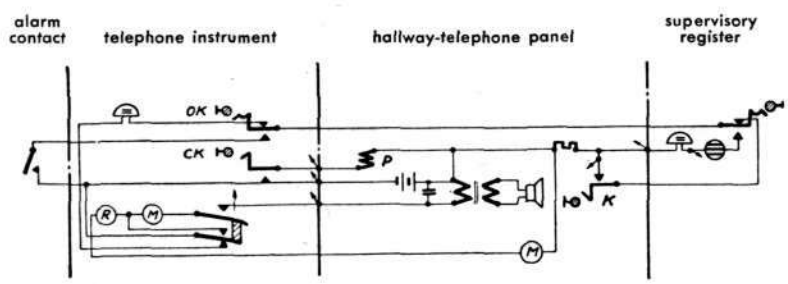
In a building where a hallway telephone is installed a visitor, after passing the street door, presses the button beside the name of the wanted tenant on the name board. A signal is then sent out to a telephone instrument mounted in the apartment of the tenant. The reply of the tenant comes clearly and distinctly through a loudspeaker fitted on the panel. The visitor can then ask to be let in, his speech being picked up by a sensitive microphone also fitted on the panel. The tenant, if satisfied about the visitor, presses a button on the telephone instrument by means of which the inner door is opened allowing admittance to the building.

The hallway-telephone panel, Fig. 1, is as a standard, designed for flush mounting. It is composed of a chromium-plated front plate, on which the microphone and the loudspeaker are fitted. The loudspeaker is of the the same type as that used for the moving-coil type with a permanent field magnet. The microphone, which requires to be very sensitive in order to pick up a fairly low speech at a comparatively great distance, is of the same type as that used for the Ericsson loudspeaking intercom. telephone system. The loudspeaker and the microphone are protected against touching by a chromium-plated grid.

On both sides — in small installations only on the left side — of the front plate of the panel there is a name register which is covered by a protective glass screen fitted in the front plate. The front plate has hinges at the bottom and a Yale lock at the top, so that it is possible to turn down the whole front plate thus allowing access to the name register when changes are to be made. Alongside each name there is a press



X 3286 **Fig. 2.**
Supervisory register for burglar alarm.



X 5162 **Fig. 3. Diagram of hallway-telephone installation,**
with burglar alarm.

CK button for opening the door lock
OK burglar-alarm switch
K button for calling the tenant
P door lock

button for calling the tenant in question.

Should the called tenant not answer, the button of the porter may be pressed and information can be given or received.

When the tenant intends to be away from his flat for a long time he can by throwing a switch on the telephone instrument in his flat make his absence known to the porter, who then throws a switch corresponding to the tenant on a supervisory register, Fig. 2. If attempts are made to break into the flat, a contact built into the door panel, Type TL 650, is actuated, which causes a bell in the porter's room to ring, and at the same time a drop indicator on an annunciator, Type RP 130 w, indicates the flat from which the alarm has been given. A diagram of the installation is given in Fig. 3.

The telephone instrument in the tenant's flat, Fig. 4, has a microtelephone of bakelite and a built-in bell. At the front of the telephone there is a press button for actuating the door lock down below. The burglar-alarmswitch is at the bottom of the instrument so as not to be conspicuous.

The electric door lock is of standard type.

For the operation of the system a 4 V storage battery is suitable. The wiring can consist of 1 mm² cable of the type used for electric bell systems, and in new buildings these cables are usually drawn in piping under the finishing coat.

The hallway telephone is particularly suitable for large apartment buildings, where it may be difficult for a porter to keep watch on callers, which may at times cause irritation. In buildings under construction it will be particularly advantageous to install hallway telephones as in such case the hallway telephone system can be put in instead of the wiring and bells for an ordinary electric bell system that would otherwise be necessary.

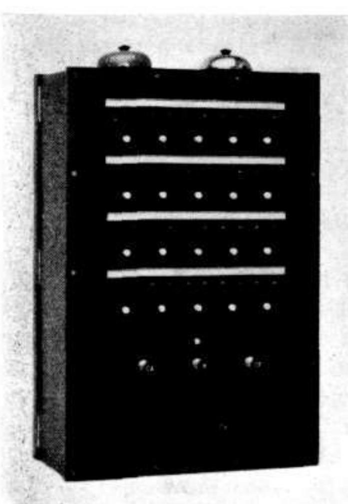
O. Arntyr.

X 3275 **Fig. 4.**
Tenant's telephone instrument.

(continued from page 171)

the closed-circuit relay is energized; if the direction of the closed-circuit current is altered the indicator relay is energized instead.

On alarm signals from a box the junction line is interrupted and closed at the police station each time the above-mentioned selector in the relay bay moves one step. In the signalling box in the fire station there is also a selector which is controlled over contacts on the closed-circuit relay. On alarm these two selectors will thus move synchronously.



X 3287 **Fig. 4. Signalling box in the fire station.**

When the selectors have reached the position corresponding to the calling box, a current impulse will be sent out from the police station over the junction line in the opposite direction to that of the closed-circuit current. The indicator relay at the fire station will then be energized and close the current through the alarm relay of the calling box through contacts on the selector.

The magnets of a printing device, Type UD 510, are connected in parallel with the alarm relays so that the number of the calling box and the time at which the alarm was received are recorded.

The alarm relays have mechanical locking devices and press-button release, and over their contacts current is closed to an alarm bell and to indicator lamps, which indicate the box from which alarm has been given.

Any number of alarm signals can be given simultaneously, and each of them in its turn will be indicated and recorded as the selectors move on.

When all alarm signals given have been indicated the selectors stop in home position. Should the synchronism have been disturbed so that the selector at the fire station stops in another position than the home position this will be indicated by a lamp in the signalling box. By pressing a button which closes the current over the self-moving contact of the selector, the selector will move on to home position. If this is carried out after an alarm signal there will be no risk of a faulty box number being indicated. It will then be necessary to call up the police station by the telephone from the fire station and ask which box has been indicated.

All apparatus has been made for an operating tension of 24. The batteries are composed of 4 Ford batteries, 2×12 V. Two of these batteries are for the police station, one for the fire station, and the fourth is on charge in the automatic exchange for replacing successively the batteries discharged.

S. Nilsson.

Electric Hot-Water-Supply Apparatus

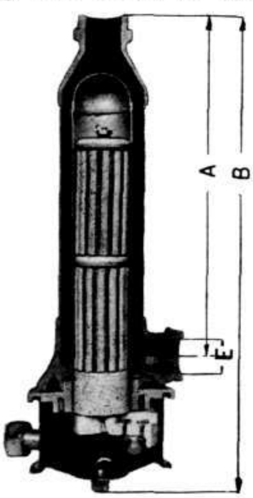
A/S Elektrisk Bureau, who has been manufacturing electro-thermal apparatus for 15 years, has during this period put on the market a number of electric cooking and heating apparatus. The Ericsson Review has in previous issues, No 1 and 2, 1933, described the ALO-REX disc stove and new types of domestic ranges. The present article is chiefly devoted to the REX apparatus as used for electric hot-water supply.

The REX apparatus for electric hot-water supply is made in following three types:

outside circulating waterheaters,
immersion-type waterheaters,
hot-water storage tanks.

Outside circulating waterheaters.

The apparatus, Fig. 1, is composed of an internal and an external tube. The internal metal tube has space for a non-hygroscopic steatite heating unit which is introduced from below and connected to the mains through a watertight connection box. The external metal tube is nickelplated on the outside so as to prevent losses of heat by radiation. The top and bottom consist of brass fittings.



X 3282 **Fig. 1.**
Outside-circulating waterheater.

When the apparatus is connected to the hot-water tank as illustrated in Fig. 2 the space between the internal and external tubes is filled with water which starts circulating as soon as the heat from the heating unit reaches the water.

There is consequently continuous circulation, the hot water being forced into the top part of the tank and the cold water being drawn in from below into the bottom of the circulating tube.

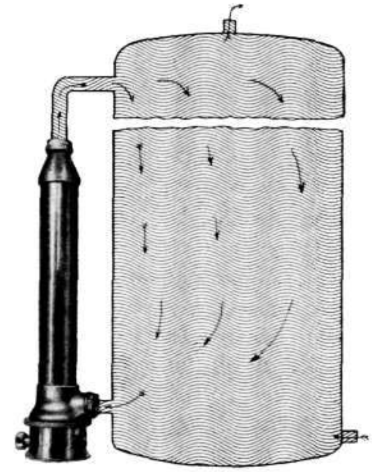
The power consumption can be regulated in 3 heats according to requirements. Thus a heating unit for 1 000 W can be regulated down to 500 W or 250 W respectively.

These circulating tubes are particularly suitable for hot-water tanks for more than 100 l, where it is not possible to fit heating units at the bottom elements.

The apparatus, of which thousands have been placed in Norway alone, is extensively used for hot-water supply in factories, laundries, large kitchens and bathhouses.

The circulating tubes are supplied in various lengths and for various power consumptions as indicated in the table below, in which the dimensions A, B and E refer to Fig. 1.

power consumption W	B mm	A mm	design	diameter of water tube E
500 600 750	480	410		
1 000 1 500	480 630	410 560	single tube	3/4"
2 000 2 500	795	725		
3 000	935	865		
4 000 5 000	805	720	double tube	5/4"
6 000	960	875		
7 500 9 000	975	890	triple tube	



X 3583 **Fig. 2.**
Outside-circulating waterheater,
connected to water tank.

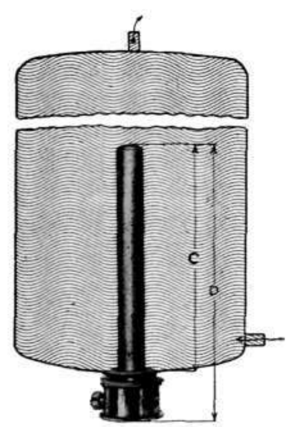
Immersion-Type Waterheaters.

The apparatus, Fig. 3, is fitted with the same type of heating units and connection boxes as the circulating tubes described above.

The immersion heaters can be fitted either in the bottom of a receptacle or on its sides, and are used both for heating water and for melting solid matters such as paraffin, asphalt, compound, etc.

The apparatus is fitted with special brackets for mounting on walls of wood or of iron.

The tube is made of metal and is heavily tinned on the outside which gives adequate protection against corrosion.



X 3284 **Fig. 3.**
Immersion-type waterheater,
mounted in water tank.

The immersion heaters, the power consumption of which can be regulated in two heats, are manufactured in various sizes as indicated in the table below, in which the dimensions *C* and *D* refer to Fig. 3.

power consump-tion W	D mm	C mm	design
500 600 750	435	340	single tube
1 000 1 500	435 585	340 490	
2 000 2 500	735	640	
3 000	890	795	
4 000 5 000	735	640	double tube
6 000	890	795	
7 500 9 000	910	815	triple tube

Hot-Water Storage Tanks.

Fig. 4 shows an automatically refilled REX storage tank of the standard type. The interior receptacle is made of strong tinned sheet-copper and tested for a water pressure of 4 atmospheres. The external cover is white enamelled on the outside and is treated with anti-rust preparation on the inside.

The receptacles are carefully heat-insulated and have a very high efficiency allowing hot water to be tapped as long as 10 hours after the current has been switched off.

For cleaning the receptacles there is an easily removable drain plug at the bottom, so that the inside tank can be flushed by opening the tap and removing the plug.

The heating units are of non-hygroscopic steatite and are fitted from the bottom through the watertight connection box.

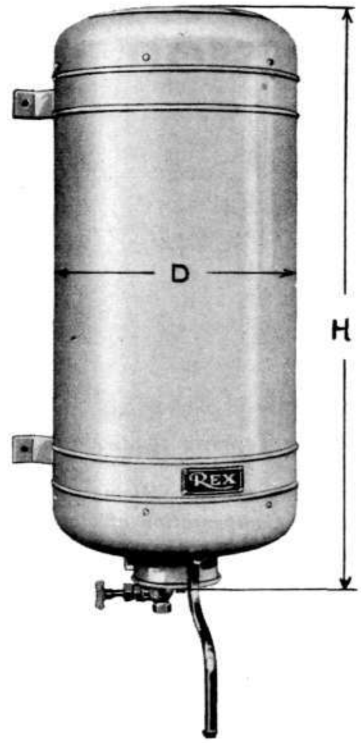
By means of a double pole regulating snap-switch supplied with the tank the power consumption can be regulated in 2 heats: $^1/_1$ — $^1/_2$ and $^1/_4$ of normal consumption.

In order to limit the power consumption to an absolute minimum the apparatus is fitted with a mercury thermostat, which automatically switches off the current when the water reaches the temperature of 85° C and switches on the current anew when the water temperature drops to 75° C.

Experience has shown that the above-mentioned is the most suitable temperature for switching off, but the thermostat can of course also be adjusted for other temperatures if desired.

The tanks are supplied in three sizes as indicated in the table below in which *D* and *H* refer to Fig. 4.

size	power consumption W	D mm	H mm
20	250—600	280	735
30	300—900	330	780
50	500—1 200	330	1 160



X 3285

Fig. 4.
Hot-water storage tank.

It is difficult to give an exact figure for the power required to heat a certain amount of water as this is governed by several factors, *e. g.*, the insulation of the tank, the first temperature of the water, etc. The following may however be taken as applicable in most cases, when dealing with insulated tanks: 100 W and 10 hours are required for heating 10 l water from 10° C to 90° C.

A. Kvam.

(continued from page 172)

signalling. The magneto telephone can then be used when amplification of the speech is not required.

The maximum amplification for incoming speech is about 2.3 neper, *i. e.*, the output is increased 100 times. The characteristic impedance of the receiver circuit being about 18 times that of the line, this represents a tension amplification of about 3.5 neper. On account of the grid space given by the tensions of the valve, this amplification can be utilized free from distortion only at an incoming level of —1.3 neper or less. However, as the incoming level at the subscriber's instrument lies between —1 neper and —3 neper, full amplification free from distortion can always be relied upon. For outgoing speech the level can be adjusted between 0 neper and + 0.8 neper in steps of 0.2 neper by means of the tappings of the transformer's secondary winding.

The appearance and design of the set is illustrated in Fig. 1, which also shows one of the valves. The exterior view of the set differs from the standard bakelite set only in the potentiometer knob below and to the right of the dial. The interior of the set is characterized by a compact construction and good utilization of the space. *C. Anjou.*

Ericsson Technics

Ericsson Technics 1934, No 3.

H. Sterky and R. Stålemark: Automatic Compensation of Variations in the Overall Attenuation of Carrier-Telephone Systems.

When a conversation is transmitted over long lines by means of carrier telephone equipment, the volume of the signals received varies considerably on account of the fact that the attenuation of the line is not constant but is dependent on climatic conditions. This variation may be compared with fading in radio reception; in the same way as a remedy against fading has been found in the form of automatic volume control, the variations arising in the overall attenuation of carrier-frequency systems may be successfully counterbalanced and equalized by automatic means. Thus, in systems where the carrier frequency is transmitted, the carrier may be used for purposes of control.

In this article it is shown how Ericsson has, both in theory and in practice, solved the problem of automatic compensation of variations in the overall attenuation of carrier-telephone systems. Ericsson has been manufacturing carrier-frequency systems with such apparatus for two years now, and these have in all cases given excellent results in actual service.

Ericsson Technics 1934, No 4.

H. Spanne: Câbles pour la transmission à grande distance de l'énergie électrique sous haute tension.

For this reason the capacitive of electric power over great distances is usually carried out at high tension.

For this reason the capacitive currents of AC cables become rather heavy, and it is necessary to compensate for them by means of inductances inserted in parallel at several points along the cables. Consequently the energy losses depend to a great extent on the electro-static capacity of the plant and on the frequency used. A certain tension gives a minimum of losses for which a certain distance between the compensation points is the most favourable.

AC cables are provided with oil channels which are connected with oil receptacles placed along the cable. The distance between these oil-supply points is calculated in proportion to the amount of oil which may be absorbed by the cable when temperature falls and the amount which may be forced out when temperature rises at a sufficient speed.

Comparative calculations have been carried out regarding the transmission properties of cables for DC. These cables require no oil supply and their electro-static capacity is of no importance.

Ericsson Technics 1934, No 5.

T. Laurent: Théorie et application pratique des demi-cellules à trois branches pour filtres électriques.

This article deals with electric filter circuits composed and dimensioned in a new manner. These new circuits have been called »three-branch half-sections» because of their design and the electric properties of the filters which are made up of them.

The properties of the three-branch half-sections are similar to those of two-branch half-sections which are well known, but these properties are combined in a different manner; for this reason the image properties of the three-branch half-sections are compared with those of the two-branch half-sections.

When the problem is to make up a filter of half-sections and at the same time to avoid reflexion, the three-branch half-sections are most useful. These half-sections can also be used as separate filters and in certain cases they provide considerable advantages as compared with known types of filters. These new filters in addition allow for several new technical facilities, which render them useful also in other spheres than the filtering of frequencies.

The first part of this article has for its purpose to simplify the problem by introducing a new mathematical treatment, common for various types of filters. In the following parts the chief interest is devoted to the properties of the three-branch half-sections with a view to the uses to which they are most likely to be put. Finally some actual applications of the three-branch half-sections are indicated and explained by examples from the work of the author, perfectly illustrating the wide range over which this new filter device is useful.

ERICSSON REVIEW 1934

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Imprimé en Suède

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FOR VERY HIGH VOLTAGES

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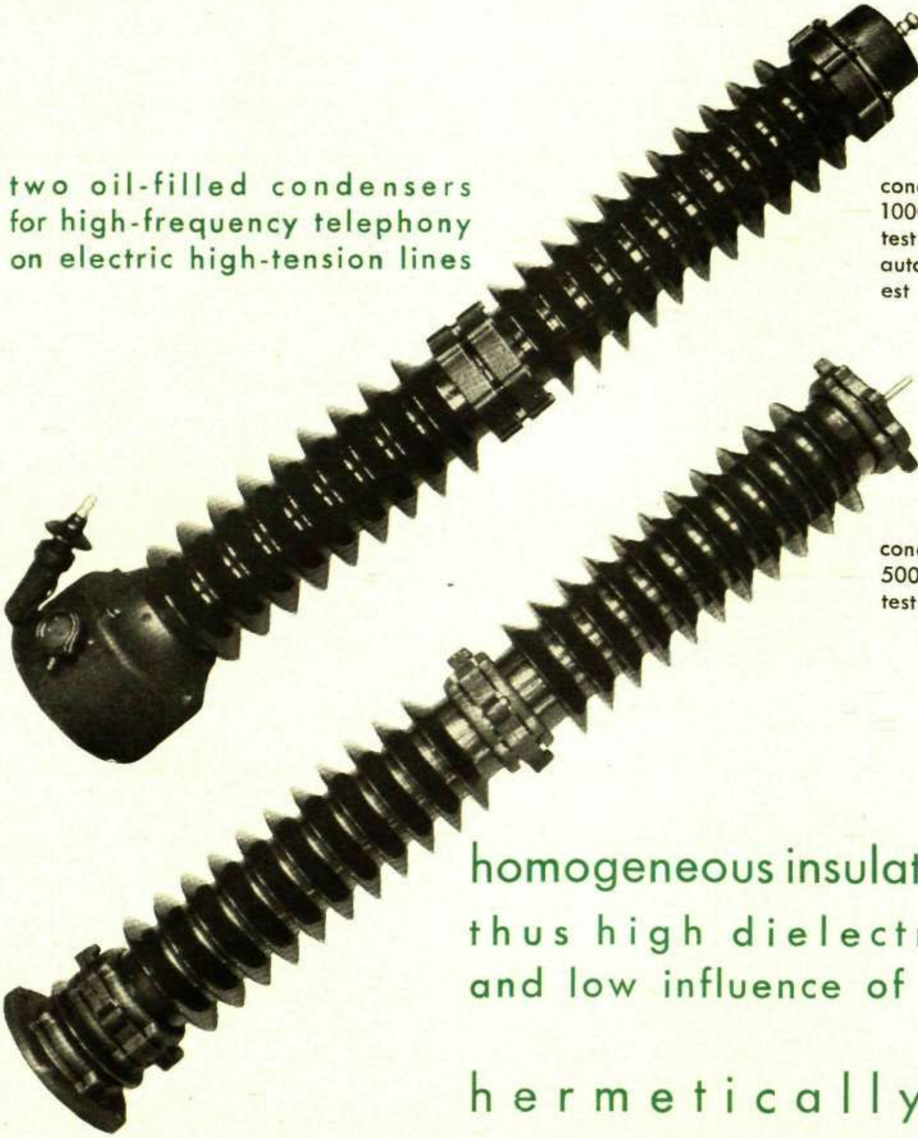
on electric high-tension lines



condenser with manometer
1000 cm, 170 kV, 50 p/s
test voltage in rain 450 kV
automatic signalling at highest permissible oil pressure

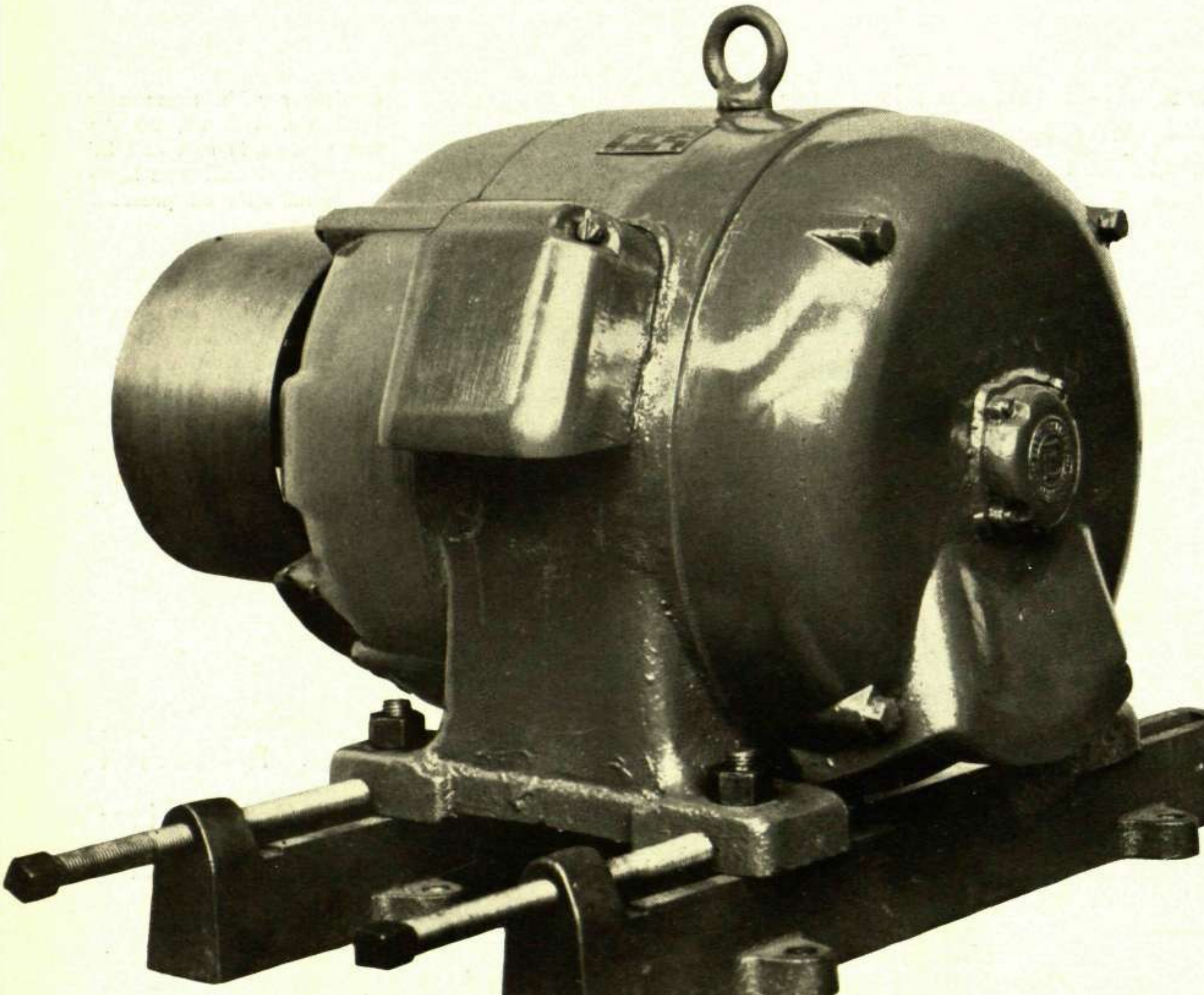
condenser of standard type
500 cm, 220 kV, 50 p/s
test voltage in rain 500 kV

homogeneous insulating material
thus high dielectric rigidity
and low influence of temperature

hermetically sealed
thus protected against humidity
and highly reliable in service

SIEVERTS KABELVERK

squirrel-cage three-phase motors



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ELEKTROMEKANO