ERICSSON Review

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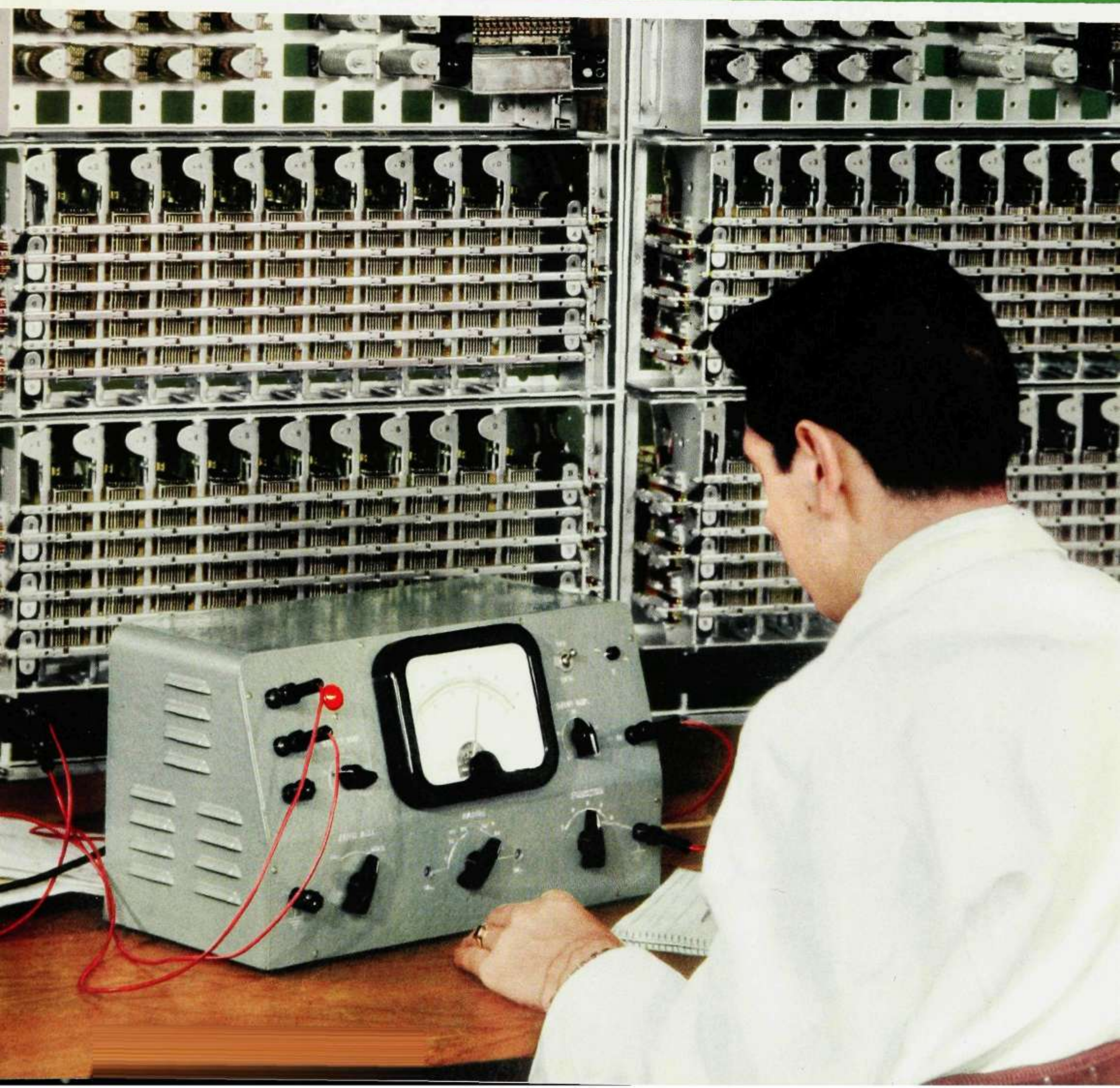
1955



ERICSSON REVIEW

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CONTENTS

On cover: L M Ericsson's electronic time meter LMK 2201 being used for the measurement of lags in relays and selectors

Electronic Identifier for Subscriber's Stage

G SVALA, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

U.D.C. 621.38:621.395.722

During the latter part of 1953 an identifier made up of cold cathode tubes and other electronic components was put into service at the Centrum Exchange in Helsinki. The apparatus was evolved to solve a particular problem and is, therefore, to some extent unique, but at the same time it constitutes an instructive example of the application of electronics to automatic telephony and has already provided valuable experience for future developments in this direction. As it may be considered to be of fairly general interest, an account of its construction and method of operation is given in this article.

The possibility of extending the classical arsenal of electromechanical components used in automatic telephony, consisting of relays and selectors in their varying forms, by the new units that have made their appearance through developments in electronics was appreciated by L M Ericsson at an early stage. Since then a considerable amount of work has been devoted to the development of electronic tubes adapted to automatic telephony purposes, with the main emphasis laid on the cold-cathode gas-filled types, and to circuit designs suited to these and other electronic components. The objective in all this work is, of course, the presentation, when the time is considered ripe, of a completely elaborated and thoroughly tested, advanced automatic system in which the resources of electronics have been utilized in the most favourable manner. This necessitates a careful balance between electromechanical and electronic elements in order to bring out the positive properties of each and combine them into an efficient complex whole.

Viewed in this light, the cold cathode tube identifier described in this article must be regarded as a special piece of apparatus produced to meet a particular need. Nonetheless the work that has gone into its design, entirely carried out at the Head Office Research Laboratory, in cooperation with A Berge and R Cannerström, has brought new inspiration in regard to the prospects outlined above. Moreover, since this is the first occasion in the firm's history on which a piece of automatic telephone equipment, constructed predominantly of electronic components, has served in regular traffic, the operational experience that may be anticipated is, of course, of extreme value.

The Problem

The equipment delivered by L M Ericsson and put into service at the Helsinki Centrum Exchange in 1952 contains a 400-group solely for outgoing traffic, primarily P. B. X. and similar lines. Soon after the commencement of operation, and when only half of the group had been utilized, it was found that the mean duration of calls was unexpectedly short due to the special character of the traffic and, as a result, a marker loading occurred that was nearly twice as great as calculated. In order to ensure satisfactory waiting times, even when the stage is fully utilized, radical measures had to be taken to reduce the occupation time of markers. The crossbar switch system does not employ linefinders, but the selectors are set by the marker direct to the calling line as soon as its identity (number) has been established by a special device, the identifier. An analysis showed that the identification process absorbed a considerable portion of the marker time and that a very great gain would be possible by replacing the existing relay-type identifier by a fast-operating electronic unit. After consultation with the customer, therefore, the Research

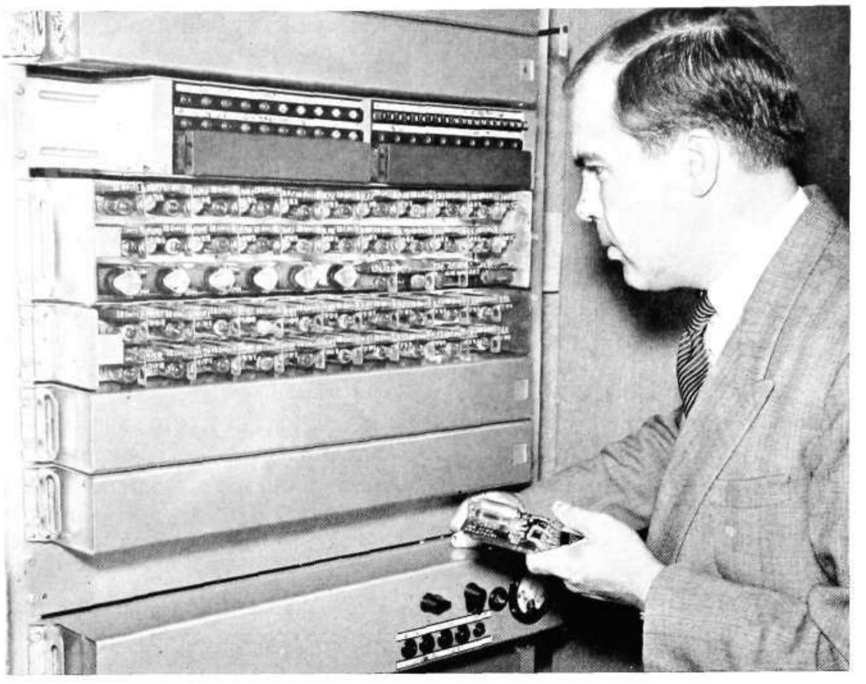


Fig. 1 X 6849

The identifier sets, with covers removed, in their positions in the marker rack

The upper set comprises IDA and IDK, the lower IDB. The power unit is visible at the bottom.

Department of L M Ericsson was ordered to construct and deliver an electronic identifier within the shortest possible time. The requirement was that the electronic identifier, like the existing relay apparatus, should consist of two detachable sets to allow for rapid replacement without rearrangement of circuits, enabling a change-over to take place without interruption of service. No other changes were to be made in the remaining marker equipment. These requirements, of course, added very greatly to the difficulty of the task, since electronic components can often only be used to the best advantage with specially adapted circuits. Here it was obviously impossible to introduce any changes of principle. The result achieved, however, must be regarded as favourable.

Cold Cathode Tubes

The cold cathode tubes used in the identifier are all of the same type, RZC 1021. Contrary to the majority of types of cold cathode tube, which have a large plate functioning as cathode and a small pin as anode, the two main electrodes are in this case similarly constructed and are both activated, so that either can operate as cathode with a low maintaining potential of about 65 V. Since the starter electrode as well, placed beside one of the main electrodes, can function as cathode for striking, the tube can clearly be used with arbitrary polarity in respect to the reference electrode—a unique possiblity which does not exist with, for example, vacuum tubes. In "normal" service the schematic of the tube is as in fig. 2. As long as the tube is not conducting, all electrodes are insulated from one another. The starting potential required between anode and cathode is then > 200 V and the utilizable feed potential is limited to this value. Striking between starter electrode and cathode on the other hand is obtained at a positive potential of 80—105 V (depending on the particular tube). On striking, however, the voltage falls to about 60 V, provided that the current is limited by a suitable series resistance. At the same time, due to the ionization that has built up in the tube, the starting voltage of the main gap falls to a comparatively low level, the value of which is determined by the current in the starter gap. At as low a current as 50 μA the starter potential of the anode is < 100 V. The tube can carry a continuous load of 25 mA in the main anode-to-cathode gap. For short impulses of current the upper limit is 100 mA. The maintaining voltage is largely independent of the current.

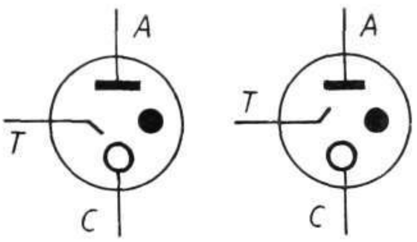


Fig. 2 X 4998

Schematic of cold cathode tube

(left) »normal» operation, (right) »inverted» operation

A anode
T starter electrode
C cathode

The conditions are similar for "inverted" operation as in fig. 2. The starter gap, however, which is here formed between anode and starter electrode, has a rather narrow starting range, 75—90 V (the starter electrode negative to the anode). A greater current is required, moreover, in the starter gap for the same fall in main gap starting voltage.

If a voltage not too much in excess of the starting voltage is applied to a cold cathode tube, striking does not take place immediately, but a certain time passes—striking lag—before ionization arises and discharge occurs. The ionization may derive from different sources. In activated cathodes there is a certain thermal emission even at room temperature—admittedly extremely weak, but not without significance in this connection. Ionization of radioactive origin must likewise be taken into account. Luminous radiation also has an ionizing effect, in fact to so high a degree that the statistical striking lag, which occurs if only the first-mentioned sources of ionization are present, completely disappears even in comparatively weak illumination.

Basic Principle

With an identifier a statistical distribution of the calls must, of course, be taken into account. Consequently, under conditions of heavy traffic, the possibility must be considered that the identifier, after handling one call, finds two or more calls waiting. A selection must thus be made, and in principle the method of statistical striking lag can be adopted. In a greatly simplified identifying device as illustrated in fig. 3, the calls may be represented by the making of the contacts S_1, S_2 and S_3. Assume that S_1 and S_2 are closed when the identifier is switched on by means of S_0. If tubes G_1 and G_2 are blacked out and equivalent, i. e. have the same statistical striking lag, it will obviously be chance that decides which tube strikes first. Since the tubes have a common high-value series resistor R_U—the lock-out resistor for the starter electrodes—as soon as one tube has struck the starter electrodes of all tubes will assume a potential equal to the maintaining potential in the starting gap of that tube, thus about 60 V. Thus if ionization occurs first in G_1, G_1 will manifestly strike and, due to the voltage drop across the common lock-out resistor R_U, G_2 is prevented from striking since it is ionized an instant later. G_3 cannot strike either, of course, if S_3 closes later (corresponding to a call arriving while the identifier is occupied). Selection, or lock-out, has thus taken place.

In the actual switching procedure described below, the feed voltage is not applied instantaneously but rises at a controlled speed after the extinguishing of the tubes that is required between handling of the calls. This circumstance, in combination with the spread in the starting voltages of the tubes, must be the explanation why positive lock-out is obtained even when the tubes are not protected against light.

In most cold cathode tubes, however, another factor that reduces the striking lag occurs, namely the after-effect of the previous discharge. The phenomenon, which has nothing to do with normal de-ionization, has been thoroughly studied in the Research Department. Here it can only be said that this after-effect is so pronounced that it must be taken into account in the design of the circuit. Thus individual tubes must be prevented by external means from striking twice in succession in order that the identifier shall not be blocked by a non-disappearing call or the like.

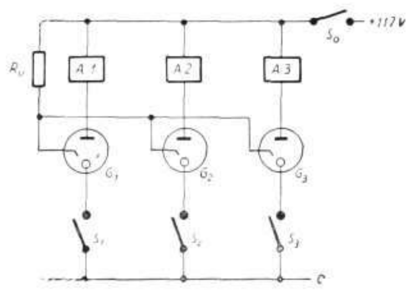


Fig. 3 X 4997

Lock-out circuit with cold cathode tubes

A1—A3 relays
G1—G3 cold cathode tubes
S1—S3 call contacts
S_o starting contact
R_U lock-out contact

Circuit Diagram and Description of Operation

In the simplified circuit diagram in fig. 4 four main sections may be distinguished: the identifier matrix *IDM*, two partly symmetrical sections constituting the identifier proper, *IDA* and *IDB*, and a common auxiliary controlling section *IDK*. The identifier matrix consists of 20 A-wires connected to *IDA* and 20 B-wires connected to *IDB*. At the 400 points of intersection in the matrix the call contacts lie on the line relays *LR* inserted in series with break

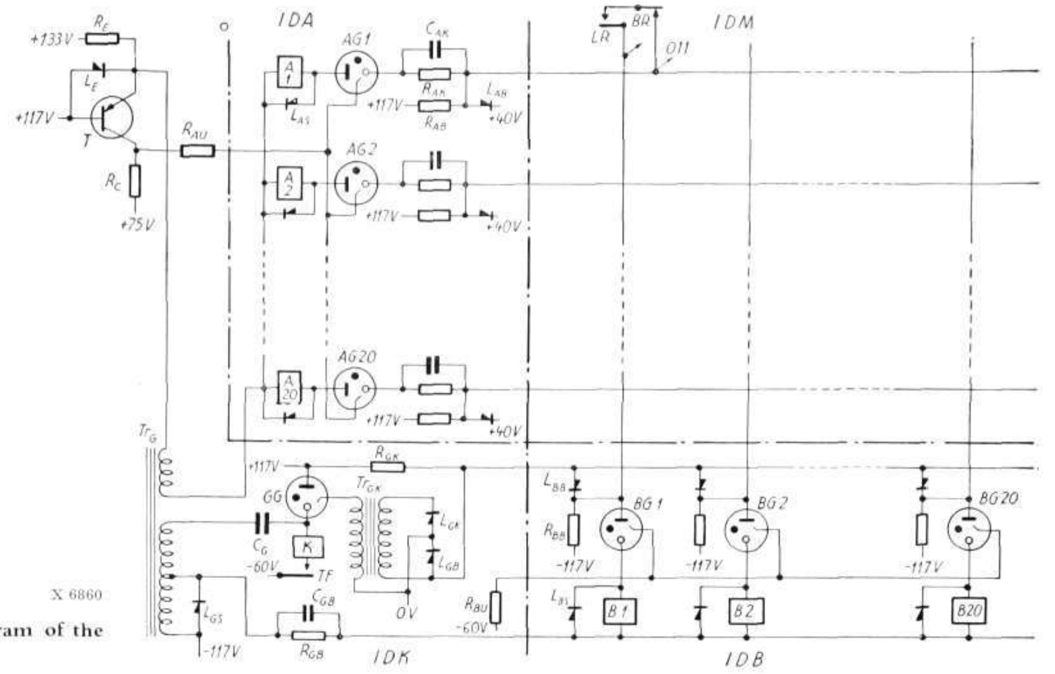


Fig. 4 X 6860
Simplified circuit diagram of the identifier

contacts on the break relays *BR*. Thus on the appearance of a call connection is obtained between the respective A- and B-wires, and the task of the identifier is to indicate to the remainder of the marker which A and B-wires are connected together on each call, of course only for one call at a time. If only one call were in progress at a time, the task would be simple, demanding only one relay in series with every A and B-wire. Thus on a call being received an A and a B-relay operate in series and, through their contacts, signal the identity of the call to the marker equipment. Such relays, *A 1—A 20* and *B 1—B 20*, are in fact shown in the diagram, but in order to achieve the desired lock-out in accordance with the above-described principle, cold cathode tubes *AG 1—AG 20* and *BG 1—BG 20* respectively have been placed in series with the relays. As in the original relay identifier the lock-out takes place in two operations, first in *IDA*, and secondly in *IDB*. To ensure satisfactory lock-out the B-wires should have the same potential during the first operation. This is achieved by connecting them across individual rectifiers L_{BB} to a common supervisory wire, the potential of which is fixed at 0 via the normally active rectifier L_{GB} in *IDK*. When the set is idle, currents of about 2 mA each flow through L_{BB} and the resistors R_{BB} to — 117 V. The feed resistor R_{GK} is designed to allow a certain surplus current to pass L_{GB} in addition to the combined currents through L_{BB}. Thus as long as the current passing through a B-wire does not exceed 2 mA, the wire may be considered to be earthed across a fairly low resistance.

In the same way the A-wires, when the set is idle, are fixed at + 40 V by means of the rectifiers L_{AB} and the resistors R_{AB}, each R_{AB} having so high a value, however, that the current passing through it to the B-wire on the appearance of a call is only 0.25 mA. It must also be pointed out that the resistance of the cathode resistor R_{AK} is comparatively low and the capacitance of C_{AK} very high. Thus during the locking-out process the voltage drop across the combination is completely negligible. The voltage to the anodes of the A-tubes comes through the respective A-relays, a winding of the transformer Tr_G and the resistor R_E from + 133 V. At the same time, however, a current of barely 2 mA flows through R_E to the emitter of the transistor *T*, so that the anode voltage is practically equal to the voltage of the transistor's base electrode, i. e. 117 V. The transistor is of the p-n-p, junction type, and the collector therefore supplies an almost equally high current to the collector resistor R_C, which is so dimensioned that the collector potential as well approaches 117 V. Since the starter electrodes of the A-tubes are fed from the collector across the common lock-out resistor R_{AU}, they assume the same voltage in the rest condition.

On the arrival of a call, which results in the making of the *LR* contacts in *IDM*, the same situation clearly arises initially in regard to the A-tubes as was described in connection with fig. 3. In the selected tube a current is also obtained in the main anode-cathode gap which rapidly rises at a rate limited by the inductance in the A-relay and Tr_G. When it passes a value of 2 mA, however, the current through R_E no longer suffices; the necessary addition is obtained through L_E and the current to the emitter of the transistor ceases. At the same time the collector current is reduced to a very low value and the feed voltage to the lock-out resistor falls to about 75 V. The remaining A-tubes are thereby prevented from striking, irrespective of the cathode voltage of the already struck tube. Now the cathode voltage also rises rapidly, since there is no current through the rectifier L_{BB} and R_{BB} has a relatively high value (the voltage drop across the A-tube's cathode circuit is still negligible). The voltage at which the B-tube strikes is passed shortly after and the circuit is completed through the B-relay, the common resistor R_{GB} and the lower winding of Tr_G to — 117 V. When $R_{GB} = R_{AK}$ there is clearly full symmetry and the interconnected A and B-wires return to zero potential at the same time as the current rises to the level at which the respective relays operate.

It will be readily realized that lock-out is also obtained on the B-side when several calls are connected to the selected A-wire, since the starter electrodes of the B-tubes as well have a common lock-out resistor R_{BU}.

The marker completes the connection and prepares the disconnection of the identifier by supplying cathode voltage to the extinguisher tube *GG* in *IDK* via a make contact on relay *TF* and relay *K*.

When the operation of the selectors is completed, the connection between associated A and B-wires is broken by the contact *BR*. The current in the B-circuit, which is now up to about 25 mA, immediately seeks another path, namely from 0 through L_{GK}, the primary of the transformer Tr_{GK}, L_{BB}, the B-tube etc. A powerful secondary impulse is thereby sent from Tr_{GK} to *GG* which immediately strikes (the tube is constantly preionized by a weak current from an electrode not shown in the figure). The cathode voltage of *GG* rises momentarily by about 112 V, and a powerful impulse is transmitted via C_G and the transformer Tr_G to the cathodes of the B-tubes, and an opposed polarity impulse to the anodes of the A-tubes. The impulses are of such amplitude and form that the maintaining voltage falls to too low a level for about 1 ms, which is sufficient to ensure that the tubes are definitely extinguished and do not reignite on the return of full voltage a few milliseconds later. The rectifiers L_{AS} and L_{BS} assist in the cut-off by short-circuiting the induced voltages in the relays. L_{GS} prevents overshoot at the end of the extinguishing cycle.

It should be noted that the voltages in *IDA* and *IDB* return to the normal values within a comparatively short time of the order of a few milliseconds, determined by the dimensions of Tr_G and C_G. Consequently a new identification is immediately started if a call is waiting, despite the fact that the remainder of the marker has not yet been disconnected. Due to the rapid operation of the supervisory relay *K*, however, the signal paths from the A and B-relays are broken so as not to disturb the disconnection. Not until *TF* in the marker has released is the circuit to *K* broken and *GG* extinguished.

The circumstance that identification of waiting calls takes place almost immediately after the completion of the previous connection implies two important consequences.

In the first place there is a considerable gain in time when calls accumulate, since identification is already completed by the time the marker has been disconnected. In the second place the possibility is provided of eliminating the harmful after-effect in the tubes, referred to earlier, without employing too large capacitors C_{AK}. A voltage of nearly 25 V is in fact formed across R_{AK} and C_{AK}, and with the chosen time constant of about 10 ms the residual bias voltage will be sufficient to ensure that the same tube does not obtain priority on the next identification.

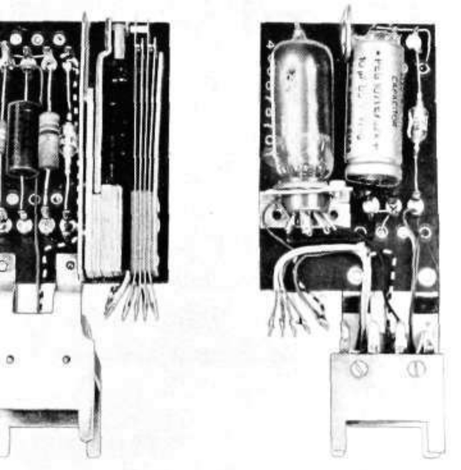


Fig. 5 X 2005

One of the 20 minisets in IDA

The upper side carries the miniature relay, the lower side the cold cathode tube, in addition to other components

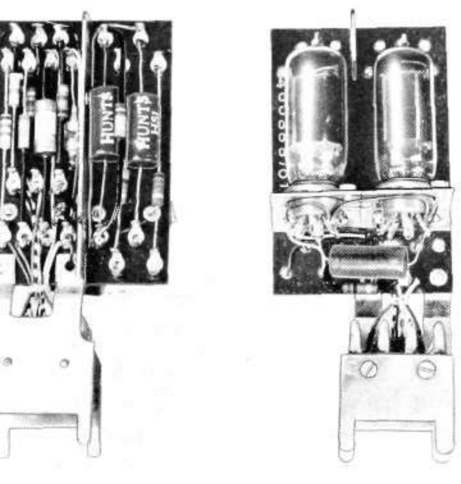


Fig. 6 X 2003

Miniset belonging to the control section IDK

On the upper side are resistors, capacitors and germanium diodes, on the lower side two cold cathode tubes

Finally it may be mentioned that, apart from the circuits described above, there are two supervisory circuits which utilize two further tubes and the relays associated with them.

Power Supply

The electronic identifier is fed from the A. C. mains by a power supply unit with a centre tap and adequate filtration, delivering + 117 V and — 117 V. The same unit, which is mounted on a relay shelf and placed in a vacant space in the rack, also contains a small rectifier delivering 16 V which, added to the main potential of 117 V, provides + 133 V auxiliary supply. Only manual voltage regulation is provided, but has proved fully adequate since the mains voltage fluctuations are very small, and the identifier operates faultlessly at fluctuations of ± 6 ½ per cent. Nor is a spare battery required, since the telephone exchange possesses an automatic starting diesel generator.

Mechanical Construction

A new system of assembly had to be worked out for the electronic components, and it was considered desirable that it should be based on the existing relay shelves. The result was an assembly unit, called miniset, equipped with 20-point plug and designed to fit into a standard relay position. The jack is held in this position by a special bracket; thus the shelf itself contains no other components than are incorporated in a normal relay set. The miniset is built up on a large base plate of insulating material on one side of which tags for resistors, capacitors, germanium diodes etc. can be riveted. Part of this space may be allotted to a miniature relay or the like. On the reverse side one, or alternatively, two tubes with sockets can be mounted. Other alternatives are also possible. Examples of minisets employed in the identifier are shown in figs. 5 and 6. As appears from the circuit diagram, is has been possible to construct *IDA* and *IDB* with only two types of minisets, 20 of each. *IDK*, consisting of five minisets, is accommodated on the same relay shelf as *IDA*. The remaining space is taken up by relays.

Service Results

The reduction in marker occupation time attained by utilization of the electronic identifier was surprising, viz. from 385 to 200 ms for normal traffic through one selector stage, and from 435 to 250 ms in overflow coupling through two selector stages. As regards reliability, no fault has been found in the identifier since is was put into service at the beginning of September 1953.

Series Capacitors in 6—20 kV Overhead Transmission Line Systems

K SCHMIDT, RØNNE, AND N FORCHHAMMER, COPENHAGEN

U.D.C. 621.316.054.42

The improvement of voltage regulation in distribution circuits has become an urgent matter everywhere in the world as a result of the constant growth of electricity consumption. Series capacitors have proved an efficient means of improving the conditions.

During the summer of 1953 Sieverts Cable Works delivered a series capacitor for a 10 kV line belonging to the Bornholm Electricity Works, Rønne. This installation aroused great interest among electrical engineers in Denmark, and the Danish Electricity Works Association placed "Series Capacitors in 6—20 kV Systems" on the agenda of the annual meeting of the Association in Aarhus on September 9, 1953.

The two speakers, K Schmidt, Director of the Bornholm Electricity Works, Rønne, and N Forchhammer, Chief Engineer of L M Ericsson A/S, Copenhagen, presented an account of the installation and its operation. The main points from the two addresses are dealt with in this article.

The only means that were previously available for improving transmission conditions in distribution circuits was the use of shunt capacitors. Their effect is shown in the vector diagrams in fig. 1 a and b. What takes place may be said to be that part of the magnetizing current required for the load, instead of being transmitted through the circuit from the supply to the consumer, is wholly or partly generated at the consumer, so reducing the corresponding voltage drop between power station and consumer.

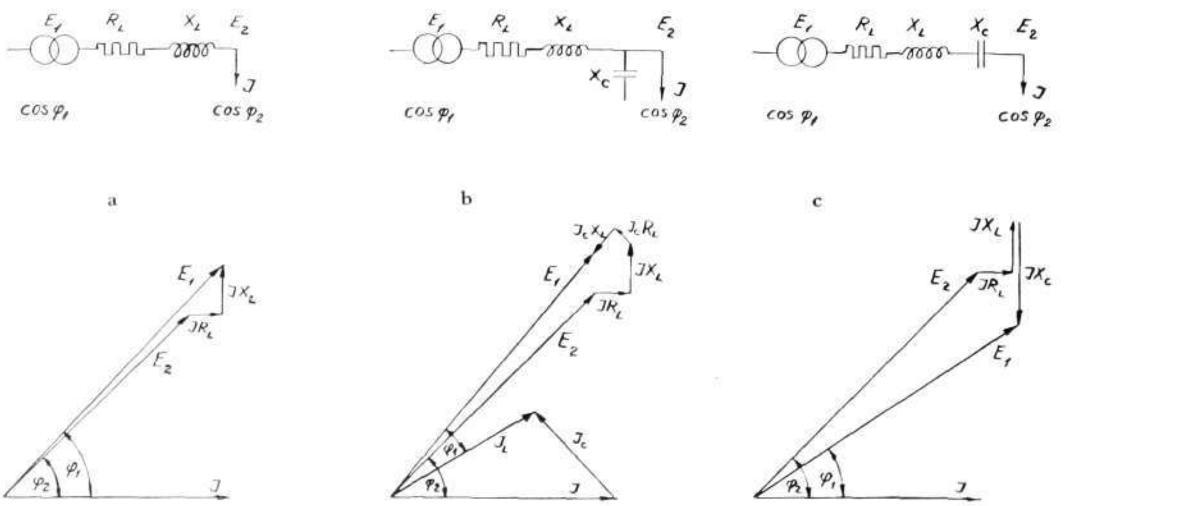
The effect of the series capacitor is shown in the vector diagrams in fig. 1 a and c. In this case no change is effected in the value of the current, but the voltage drop in the circuit is wholly or partly eliminated by introducing a capacitor as capacitive reactance in series with the inductive reactance of the line.

The rise in voltage produced by the series capacitor is proportional to the current load if the phase angle is assumed constant. This is of great value for regulating the voltage of the system in which the series capacitor is placed,

Fig. 1 X 7674

Effect of shunt and series capacitors on voltage drop in distribution circuit

a without capacitor
b with shunt capacitor
c with series capacitor



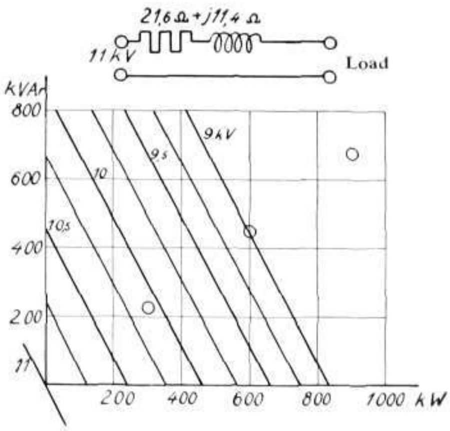


Fig. 2

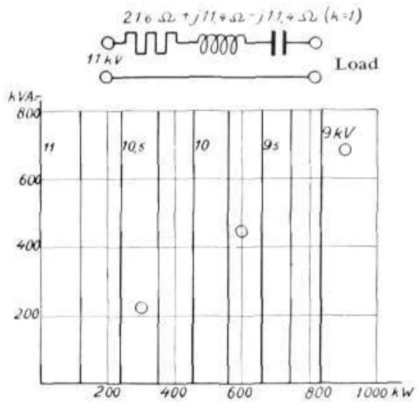


Fig. 3

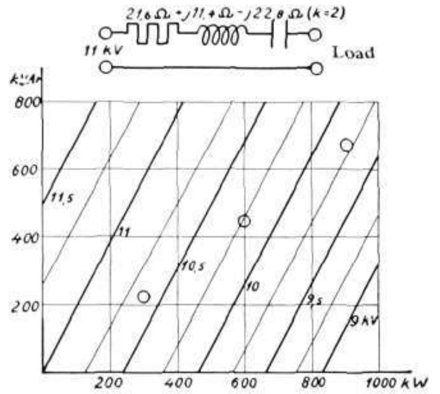


Fig. 4

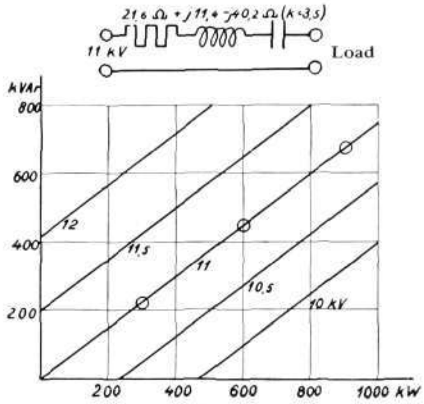


Fig. 5

X 2117
X 2031
X 2118
X 2120

Fig. 2—5

Voltage at end of a 30 km, 25 mm² overhead line

with different sizes of series capacitor (k = 1.2 and 3.5 respectively). The three circles indicate different loads at cos φ = 0.8.

since the greatest rise in voltage is obtained at the time it is needed, viz. at maximum load, while the series capacitor causes no rise in voltage at no load.

The voltage diagrams in figs. 2—5 give an idea of the effect of the series capacitor when the load is concentrated at the end of the line. Fig. 2 shows the line without series capacitor. When the two components of the load, kW and kVAr, are known, a direct reading of the terminal voltage can be made on the sloping curve. The voltage drop, as is known, consists primarily of two components, *resistance × active current + reactance × reactive current*. The transmission capacity of the line is greatest when the reactive current is zero, cos $\varphi = 1$, and decreases with decreasing cos φ. The three points marked in the diagram correspond, to different loads with cos $\varphi = 0.8$. At this value of cos φ, 300 kW can be transmitted with a terminal voltage of 10.1 kV. At 600 kW the terminating voltage is 9 kV, i. e. very poor. The transmission of 900 kW is hardly possible.

Fig. 3 shows the condition of the line when a series capacitor is introduced with capacitive reactance equal to the inductive reactance of the line; degree of compensation k = 1. The line has the state of a purely ohmic resistance, i. e. the terminal voltage is independent of the reactive current. The voltage curves are now perpendicular. The line can transmit 450 kW with a voltage drop of 1 kV, and 900 kW with a voltage drop of 2.1 kV.

There is no objection to enlarging the capacitive reactance. The line will then have a surplus capacitive reactance and the voltage diagram will assume the form shown in fig. 4 (k = 2). An inductive current in the line produces a rise in voltage, and the curves slope to the right. The line may transmit, for example, 900 kW, with a voltage drop of only 1.25 kV. The result, if we proceed even further, is shown in fig. 5 (k = 3.5). If cos $\varphi = 0.8$, the voltage drop across the resistance and reactance of the line is compensated by the rise in voltage across the series capacitor.

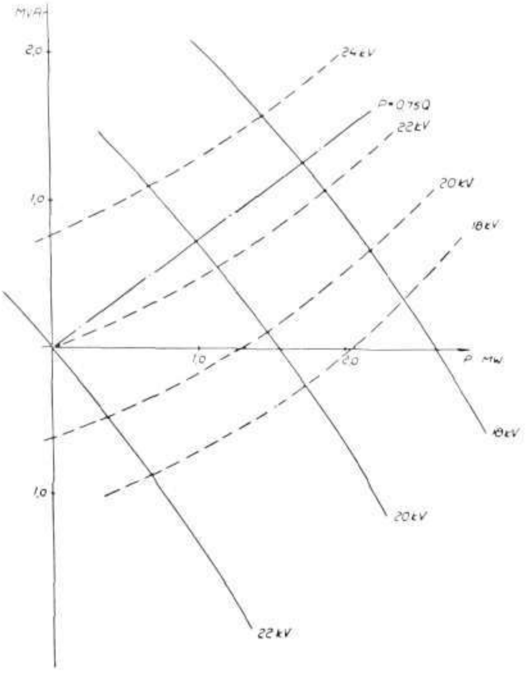


Fig. 6 X 2028

Voltage at end of overhead line

Unbroken voltage curve = uncompensated circuit; dotted voltage curve = compensated circuit: k = 4

Q reactive power
P active power

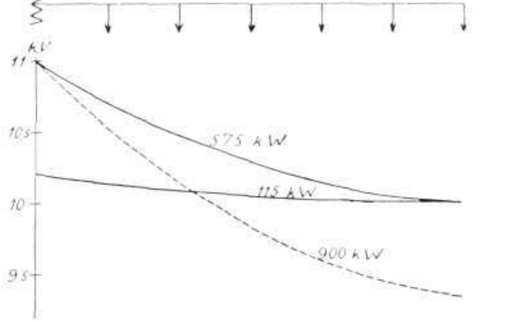


Fig. 7 X 2032

The voltage along a 30 km, 25 mm² overhead line at different, uniformly distributed loads, cos φ = 0.8

without series capacitor

It must be remembered that the linear voltage diagrams in figs. 2—5 are only approximations. In reality the diagrams will be circles with a large radius. An example of an accurately plotted diagram is shown in fig. 6, which refers to a 50-kilometre 22 kV line. The illustration is taken from a paper on series capacitors by G Jancke and S Smedsfelt from the Swedish State Power Board at the 6th Nordic Congress of Electrical Engineers held in Iceland in the summer of 1952.

The Series Capacitor in a 10 kV Line with Distributed Load

To assess the usefulness of the series capacitor in a distribution system, there are various factors to be taken into consideration which have been disregarded in the diagrams in figs. 2—5, viz:

1. It cannot be assumed that the voltage is constant at the feed-in point of the line. The voltage at this point will vary with the load—it can be regulated, for example, by means of an automatic top changer to a definite programme, maximum voltage at maximum load and minimum voltage under night loading conditions.
2. The load is not concentrated at the end of the line, but is fairly uniformly distributed along the line.
3. Consequently it is not only the voltage at the end of the line that is of interest; the main concern is that the voltage regulation during the 24-hourly and yearly fluctuations in load is on an average the best obtainable for the line as a whole.

The curves in figs. 7—10 show the voltage drops in a 10 kV three-phase overhead line, 30 kilometres in length, with 25 mm² copper conductors. The load is distributed along the line with one-sixth at each of the points 5, 10, 15, 20, 25 and 30 kilometres from the supply point. The load has $\cos \varphi = 0.8$. The individual transformers have different tappings on the high tension side so that, if the voltage at a transformer is between 10 and 11 kV at maximum load, a tapping can be selected which produces a reasonably correct voltage on the low tension side. The voltage regulation at the feed-in point is assumed to be such that there is 11 kV at maximum load and 10.2 kV at minimum load.

Fig. 7 shows the voltage conditions along the line without series capacitor at a total load of 575 kW. The terminal voltage is 10 kV, i. e. at a minimum level in consideration of the adjustability of the transformers at that point. Thus it may be said that these 575 kW represent the capacity of the line. The 115 kW curve shows the voltage conditions at minimum load. It is seen that the voltage is not higher at night than during the daytime at any transformer station, the same figure shows the voltage curve at 60 % overload, 900 kW (dotted curve). The terminal voltage of 9.35 kV is inadmissably low. There is inferior voltage regulation on the more distant two-thirds of the line; and the night voltage is considerably higher than the day voltage.

Fig. 8 shows how the voltage conditions can be improved by the use of a series capacitor, 19 ohms per phase, located 10 kilometres from the supply point and immediately after the load at the 10-kilometre point. The capacity of the line is now 1,100 kW, at which load the lowest voltage is 10 kV. The voltage conditions under night loads (180 kW) are shown and, in addition, there is a dotted curve which illustrates the conditions on overloading up to 1,400 kW, at which point the voltage falls to 9.65 kV.

The series capacitor has the same effect as if a regulating transformer producing a rise in voltage of 1 kV at a transmitted power of 1,100 kW had been placed at the 10-kilometre point. An economic comparison between a transformer of this kind with associated automatic regulating equipment and a series capacitor will undoubtedly always be in favour of the series capacitor.

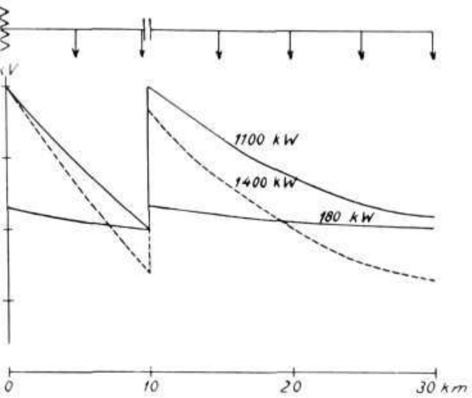


Fig. 8 X 2122

The voltage along a 30 km, 25 mm² overhead line at different, uniformly distributed loads, cos $\varphi = 0.8$

with series capacitor, k = 1.67, 10 km from start of line

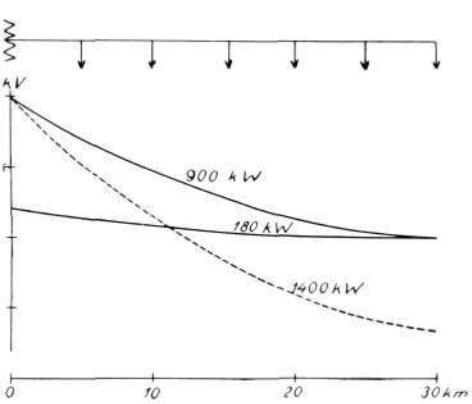


Fig. 9 X 2123

The voltage along a 30 km, 25 mm² overhead line at different, uniformly distributed loads, cos $\varphi = 0.8$

with conductor area increased to 50 mm²

Another calculation which should be made in every particular case is the comparison between installing a series capacitor and increasing the area of the conductors. Here again, in the majority of cases, the result will be in favour of the series capacitor: there will in fact be a very heavy bias in its favour, since it can be installed and connected to the line practically without interruption of service, whereas the change-over to a larger area of conductor involves extremely heavy expenses if it is to be done without interrupting the local power supply.

Fig. 9 demonstrates that the voltage conditions in the line after changing over to 50 mm² conductors are anyhow not quite so good as when a series capacitor is installed. At a load of 900 kW the terminal voltage is down to 10 kV. Thus the capacity of the reinforced line is 900 kW as against 1,100 kW for the series capacitor line.

It should be noted that the losses in the line are naturally reduced if the line is reinforced. A doubling of the area reduces the losses more than 50 %, since the higher voltage along the line gives somewhat lower values of loading current. The installation of a series capacitor also reduces the losses; moreover, the load at the supply point, expressed in kVA, will be rather lower with a series capacitor than with an increased conductor area owing to the fact that the series capacitor introduces a capacitive power into the system, so improving cos φ at the supply point from about 0.8 to 0.85 in the case described.

Fig. 10 is complementary to the diagram in fig. 8. Fig. 8 shows the conditions only at cos $\varphi = 0.8$, whereas fig 10 illustrates the variation in voltage conditions at other values of cos φ. It may be imagined, for example, that the series capacitor is connected to the line at a time when the load is 600 kW, cos $\varphi = 0.8$, and the terminal voltage therefore about 10.4 kV. Thus if the load maintains this value of cos φ as it rises, it is possible to reach 1,100 kW before the voltage drop becomes 1 kV. If cos φ should fall to 0.75, however, the limit of the line's capacity is about 1,190 kW, whereas the limit is about 1,015 kW if cos φ changes in the opposite direction to 0.85.

Protection of a Series Capacitor

The greatest stress that can be imposed on a series capacitor is a short-circuiting of the line immediately behind the series capacitor. Instead of its normal potential of 10—20 % of the phase voltage, it then has a potential in the neighbourhood of the phase voltage—that is a considerable overload which it will only support for a fairly short time. These overloads are carried

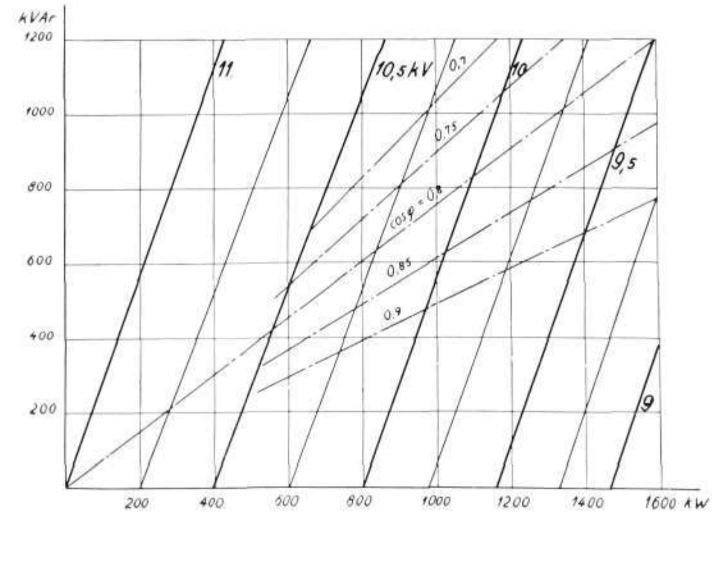


Fig. 10 X 6868

The voltage at the end of a line

with data as in fig. 7 and series capacitor as in fig. 8

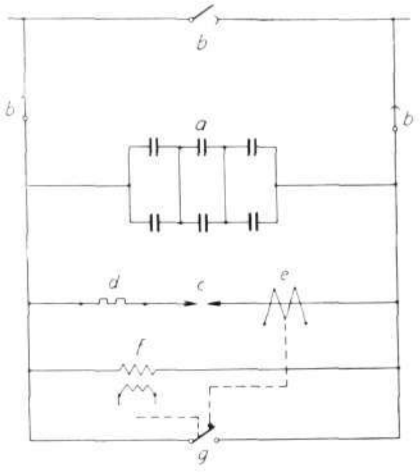


Fig. 11 X 2029

Single-pole connecting diagram of series capacitor plants

- a series capacitor
- b isolator
- c spark gap
- d damping resistor
- e current transformer
- f voltage transformer
- g circuit breaker

off by means of a spark gap connected in parallel with the series capacitor. Other protective devices are needed in addition to the spark gap, and their general arrangement is shown in fig. 11. The spark gap is designed to withstand the short-circuit power until the line's quick break switch comes into action. Moreover the deionizing time of the spark gap is so short that it will not strike again, if the short-circuit does not remain on the line, when the switch automatically reconnects the line after an interval of 0.3—0.5 secs. This circumstance has greatly simplified the automatic action of the series capacitor as compared with earlier methods, with which difficulties were encountered in the reclosing of the line. It might be pointed out that in a plant such as that at Bornholm the current across the spark gap may under unfavourable circumstances be as high as 20,000 amps. In series with the spark gap is a damping resistor which, on short-circuiting of the line, leaves a certain residual voltage across the capacitors and at the same time reduces the stress on capacitors and spark gaps. The series capacitor bank is connected to the line as shown in fig. 11, in which the isolators are resignated *b*. Of the three isolators those to the left and right are three-phase, and that at the top is for by-passing the series capacitor.

In addition to the spark gap, the series capacitor should in the majority of cases have other protecting devices—for example an oil breaker or power switch which is able to short-circuit the series capacitor automatically. Such automatic arrangements are fairly simple and vary according to the character of the plant. They may consist of:

a) a relay in association with the spark gap, e. g. a current relay with delayed action—in the event of the fault being of a lengthy nature or of breakdown in the mains supply the oil breaker will prevent destruction of the spark gap due to the arc being maintained too long.

b) a relay which responds to overloading of the series capacitor bank, e. g. a voltage relay in combination with a time relay—if the load on the line exceeds the rated value of the capacitor, the capacitor is short-circuited and damage is prevented.

c) a relay which responds to a fault in the capacitor, e. g. a balance relay.

A set of equipment of the kind described at the same time protects the capacitor against over-currents in the event of sub-harmonic frequencies occurring. Either the spark gap can enter into operation, or the overloading relay can actuate the oil breaker.

Resonance Phenomena

In the installation of series capacitor plants there is a chance of resonance phenomena being encountered, and an examination of these conditions is therefore made for every individual installation. This paper will only contain a brief account of the problem, which has been dealt with in a large number of press articles including the aforementioned address by G Jancke and S Smedsfelt.

The harmonics of the network present no problem. If, for example, there is a third harmonic in the current passing the series capacitor, the proportion of this current component to the total voltage will be only one-third of what the corresponding current would be at the network frequency. The occurrence of resonance phenomena is bound up with the oscillations that arise at lower frequencies than the network frequency. Oscillations may occur either in the form of ferroresonance or of sub-synchronous resonance.

The ferroresonant frequencies are always an odd fraction of the network frequency, 1/3, 1/5 etc. They may occur in a network incorporating series capacitors when large idle transformers are switched into the circuit under no load conditions. The surge of current thus produced may give rise to a certain instability which generates low frequency oscillations. Calculations and tests show that such oscillations are particularly liable to arise when the degree of compensation is high, i. e. when the total impedance of the line is predominantly capacitive.

Sub-synchronous resonance originates chiefly from the starting up of large asynchronous motors at times when there is a low load on the remainder of the system. Since it appears that these sub-harmonic frequencies are most noticeable on transmission lines from 3 to 20 kV, a short explanation of how they arise may not be out of place.

It is a known fact that if an asynchronous motor is for any reason caused to rotate at a higher speed than the synchronous motor—or "runs over-synchronously" as it is called—it may act as a generator and return energy to the system. While such a motor is starting up, it runs "over-synchronously" in relation to lower frequencies corresponding to its revolutions at each particular moment. A condition of its acting as a generator at these low frequencies is that it can set up a current which produces self-excitation at those frequencies. Normally these circumstances do not exist, but if there is a capacitor in series with the motor, selfexcitation may take place. Accurate calculations have shown that for a given combination of motor and capacitor a zone exists in which self-excitation can occur. Thus within this zone the motor acts as generator and delivers a low frequency current which is distributed among the other loads connected to the system. The sub-harmonic frequency current represents a consumption of energy which brakes the motor; in some cases this extra load on the motor may be of such proportions that the motor fails to attain its fall speed and runs sub-synchronously at a fraction of the normal speed. The two currents are superimposed at the motor terminals and through the series capacitor, and these two superimposed frequencies can be clearly seen on an oscillogram. A voltage corresponding to the two currents is built up across the series capacitor, and since the reactance of the capacitor is greater at sub-harmonic than at fundamental frequencies, there is a large proportion of sub-harmonic frequencies in the voltage which may cause the release of the capacitor's over-voltage protector. The chances of harmful sub-harmonic frequencies developing in a system containing a series capacitor are less, the lower the degree of compensation; sub-synchronous resonance, moreover, is less liable to occur, the lower the current of the motor in proportion to the overall load on the line at the moment of starting. Careful examination of the conditions in series capacitor plants reveals that in the majority of cases no special measures need be taken to avoid resonance phenomena.

10 kV Series Capacitor Installation on Bornholm

The background to this installation was the centralization of the electricity supply on Bornholm in 1945 and the great increase in production during the following years. Deliveries from the steam power station of the Bornholm Electricity Works at Rønne were:

1945/46	4.7	mill.	kWh	at	1,700	kW	max.	load
1950/51	14.9	»	»	»	5,200	»	»	»
1952/53	19.4	»	»	»	5,900	»	»	»

The Board had four alternatives to choose from: 1. reinforcement of the transmission line, 2. autotransformer, 3. series capacitor, 4. 50 kV system for feeding points in the existing 10 kV system. The profitability estimates showed that the series capacitor was preferable to the other alternatives. It was realized that a 50 kV system would inevitably have to be built within a few years. But the saving effected by the installation of a series capacitor even for a few years, instead of a 50 kV system, is so great that the series capacitor pays its way in less than one year.

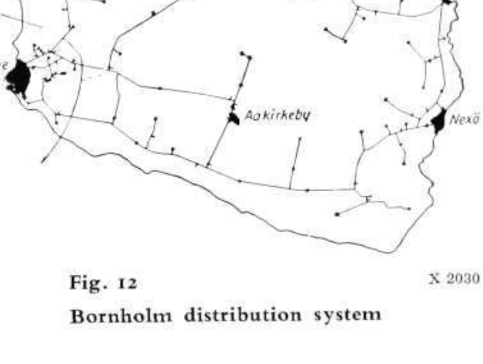


Fig. 12
Bornholm distribution system

X 2030

A map of Bornholm's 10 kV system is shown in fig. 12. The line most in need of improvement was that running north from Rønne to Sandvig. This line is constructed of 1 × 25 mm² copperwire and 20 mm² earth wire and is just over 27 kilometres long.

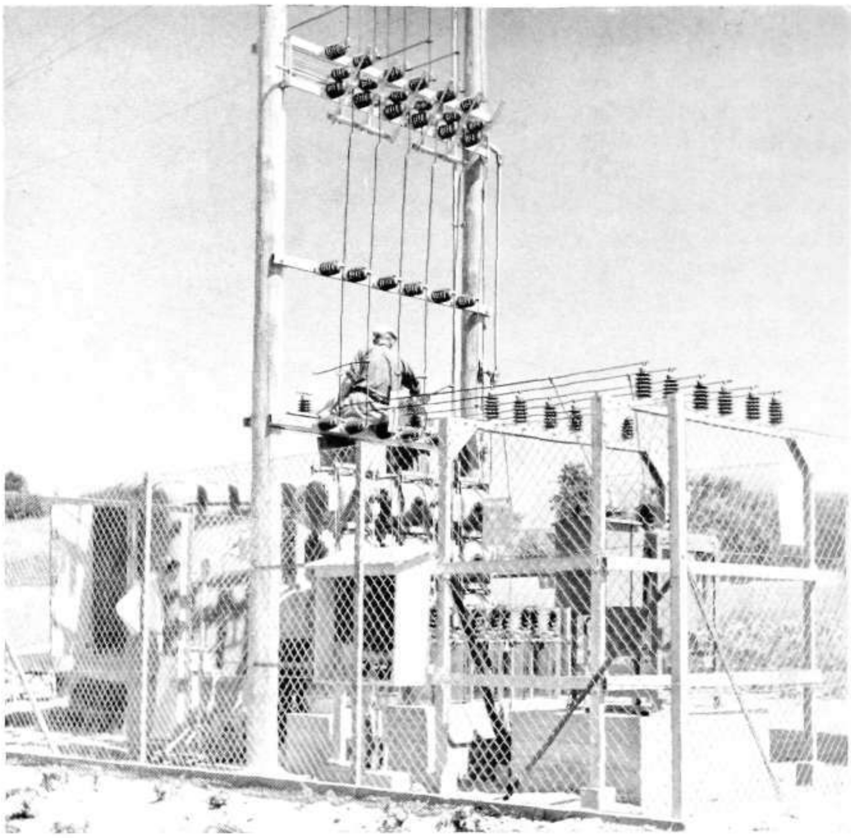


Fig. 13 X 6869

Series capacitor station at Hoglebjerg on Bornholm

Spread along the line and its branches are 30 transformer stations representing a load of max. 1,000 kW, which makes the voltage drop too high, viz. about 1,400 V. The series capacitor is connected at Hoglebjerg, hardly 11 kilometres from the electricity works, and is an open air station. Fig. 13 shows the station, and fig. 14 the voltage conditions along the line before and after installation of the series capacitor. The line suffers from the disadvantage that the maximum total load lies at the end of the line, viz. Hammerens Granite quarry, with 200 kW maximum load and, among other equipment, a 150 h. p. motor. For the servicing of this plant alone a better voltage was necessary, and measurements made before and after the installation of the series capacitor indicated the great difference very clearly—see fig. 15 which is a voltage diagram from this station. In addition to what can be seen in the diagram, the chief mechanic at Hammeren says that the voltage is more stable, it is higher and more even. He also states that the large motors are easier to start.

As the series capacitor is designed for a higher transmitted power than 1,000 kW as provision for the anticipated rise in load, it has been possible to transfer part of the load from the neighbouring areas to the Sandvig line. By 1954—1955, however, the load will have risen to such an extent that the system must be changed back to the original scheme. It was therefore decided to install a further series capacitor on the Neksø line. This plant was put into service in the summer of 1954.

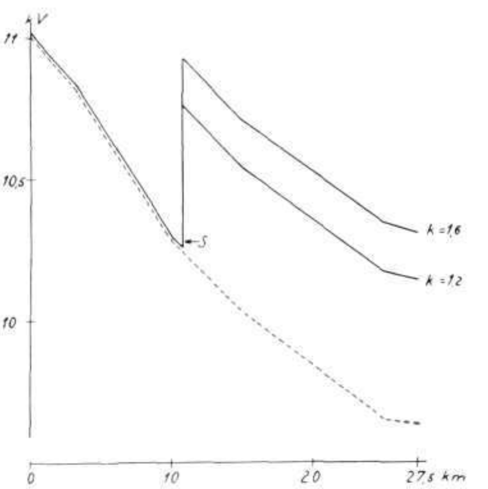


Fig. 14 X 2124

Voltage along the Rønne—Sandvig line

at a total load of 1 000 kW, cos φ = 0.8 and at degrees of compensation k = 1.2 and 1.6

- - - - - - no series capacitor

——— after installation of series capacitor

S series capacitor at Hoglebjerg

Tests on Resonance Phenomena on Bornholm

Some of the measurements made by Mr Boesen of the Electricity Works and engineers of Sieverts Cable Works at the opening of the installation in June 1953 will now be described. The line from Rønne to Hammeren has an overall inductive resistance of about 10 ohms per phase, and the capacitor 16.1 ohms per phase, i. e. k = 1.6. It was anticipated that sub-harmonics might be encountered owing, among other things, to the size of the transformer at

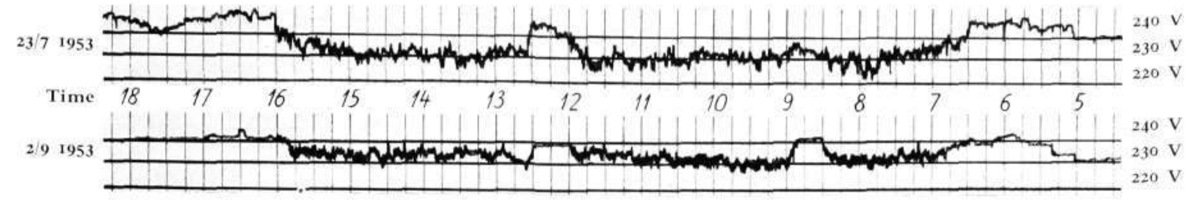


Fig. 15 X 7672

Voltage on Rønne—Sandvig line at Hammerens Granite Quarry near Sandvig

The upper curve shows the voltage without series capacitor and with the transformer ratio of 9 600/400 at Hammeren; the lower shows the voltage with series capacitor, when the transformer ratio was 10 000/400

the end of the line (350 kVA) and to the two large 150 h. p. and 75 h. p. motors stationed there. On the night of the tests the load was about 270 kW. In order to make the testing conditions as unfavourable as possible, this load was further reduced to about 150 kW by disconnecting some side lines. The transformer at Hammeren, 350 kVA, was connected and disconnected some ten times without sub-harmonics becoming apparent. On one occasion, however, there was an indication of sub-harmonics in that a spark gap struck and cut out again immediately afterwards. Thus there does not appear to be any danger of ferroresonance, which is in agreement with earlier tests on Swedish plants where sub-harmonics occurred at a high degree of compensation, but not at values of around 2—3.

On starting the Hammer Works motor nothing unusual was noticed so long as the remainder of the load on the network was at its normal value of about 270 kW. Reduction of the load as referred to above resulted in some indication of sub-synchronous frequencies. Strangely enough they did not come from the 150 h. p. motor, but from the 75 h. p. unit. Thus even under these particularly unfavourable conditons no sub-harmonics were encountered which would interfere with the service, since the increase in current was quite insignificant. Apart from these tests which revealed that no problem need be feared from sub-harmonics, a number of short-circuiting experiments were carried out and showed that spark gaps and relays were functioning satisfactorily.

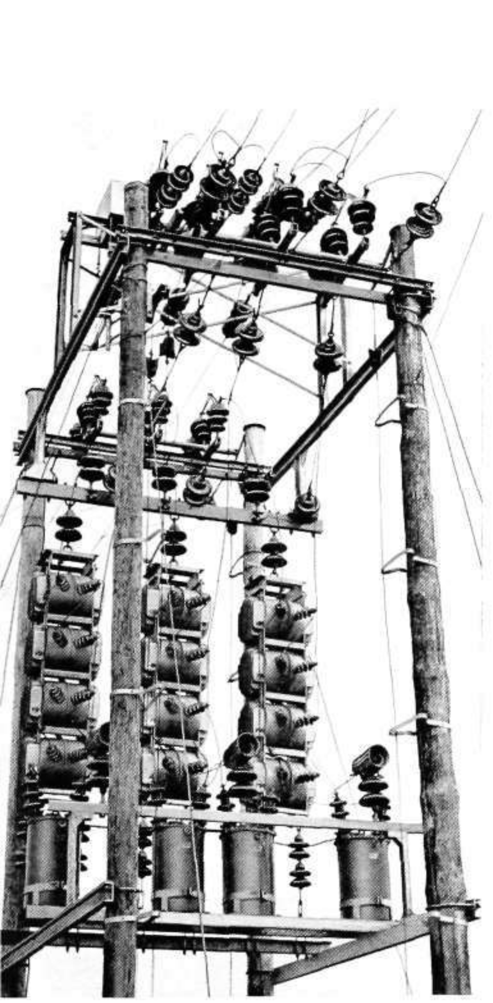


Fig. 16 X 2027

Series capacitor plant

supplied to Himmerland Electricity Works and installed on a 20 kV distribution line

Practical Experience

The experience of the running of the Bornholm plant since it was brought into service in July 1953 has been good. Similar good experience has resulted from the plants installed in Swedish distribution systems during 1951—52.

Among other things, the series capacitor protector was not affected by two thunderstorms when the line was cut out due to short-circuit. Both times the line was automatically reconnected within about 0.3 seconds without disturbance to the series capacitor. On one occasion the excess current relay operated, but only for a fraction of a second.

Applications of the Series Capacitor

A continuous development of distribution systems must be expected in order to keep pace with the constantly rising load. Sooner or later, of course, this development will necessitate new supply points from a higher voltage primary network. If all distribution lines could be divided in the middle in this way, their capacity would be multiplied 4 to 5 times.

If the load on a system rises by 6 % per annum, it will have been doubled in ten years. New supply points therefore imply that transmission is assured for 20 to 25 years, which means that large capital investments are not being fully utilized. The installation of a series capacitor often makes it possible to postpone the construction of new supply points until they can be introduced more economically.

New Electronic Time Meter

Å SVENSSON, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

U.D.C. 621.317.39:531.76

L M Ericsson have designed and recently started to market a new electronic time meter LMK 2201. The wide range of the meter permits measurements from fractions of milliseconds up to 10 seconds which, added to its possibility of direct connection to the test object, gives it a large field of applications. The article describes the operation and construction of the meter and concludes with some examples of the measurements it can perform.

For the testing of switches and relays in automatic telephone exchanges the time meter is an indispensable aid. The recent developments in automatic telephony have created a demand for time meters with a wider range and applicability than those available earlier. The requirements to be met to satisfy the various fields of application were primarily the following:

wide range, from fractions of milliseconds up to a few seconds,

high-impedance inputs with possibility of direct connection to test object, even when in position in a relay set etc.

direct-reading dial with pointer which remains in deflected position for ease of reading.

The time meter LMK 2201 described in this article, was designed to fulfil these conditions.

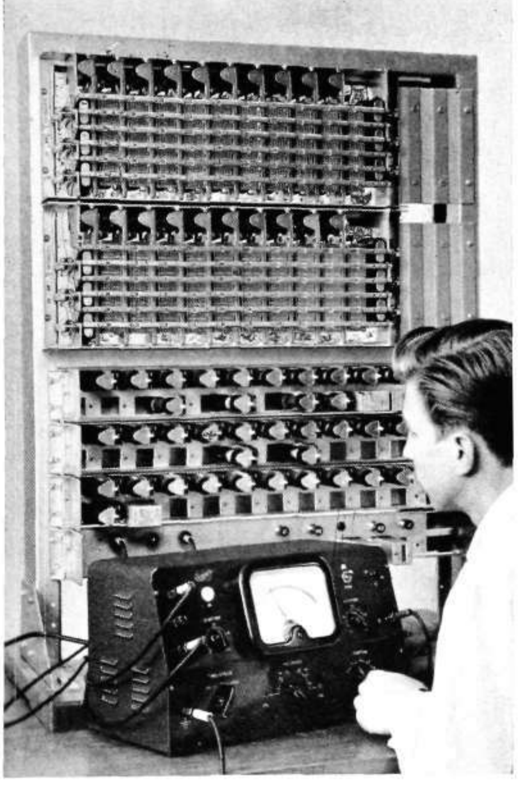


Fig. 1 X 2007

Time meter LMK 2201 in use

Principle

The operation of the time meter is based on the well-known principle of charging a capacitor, whereby the voltage across the capacitor will be a function of charging current and charging time.

The charging current is maintained constant. The voltage across the capacitor will thus be directly proportional to the charging time. The voltage across the capacitor is measured with a tube voltmeter having a linear scale directly graduated in terms of time.

Operation

The charging circuit of the capacitor is shown in fig. 2. Before measurement starts there is zero voltage at point *a*. Current flows from + 85 V through the diode *D2*, resistors *r1* and *r2* to 0. The cathode of tube *V* thereby obtains so high a positive bias that the tube is driven to the point of cut-off. On the start of measurement the voltage in point *a* rises to about + 95 V. The voltage of the control grid is held at + 85 V by means of the diode *D1*. The tube *V* permits the passage of plate current and the capacitor *C* is charged. On the conclusion of measurement the voltage in point *a* falls to about + 15 V, and the current through *V* is again blocked. During the charging of the capacitor voltage is applied to the diode *D2* in the high impedance direction. Thus the connection between + 85 V and *V*'s cathode is broken, resulting in a strong negative feedback in the tube *V*. This gives good stability and, in conjunction with the pentode coupling, produces a straight charging curve.

The capacitor retains its potential until the switch *K* is set to allow discharge to take place through *r3*.

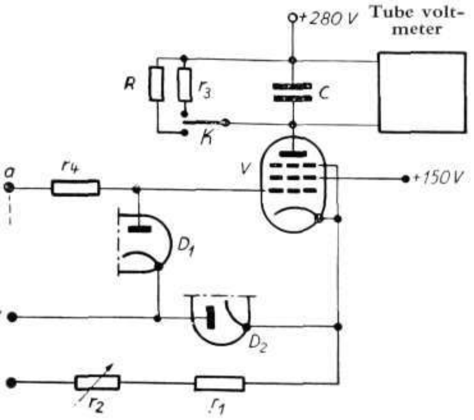


Fig. 2 X 2008
Charging circuit of instrument capacitor

The voltage across the capacitor is determined by its capacitance and by the value of the charging current as well as by the charging time. The capacitor is of the plastic film type with good stability. In calibration, therefore, only the charging current needs to be checked. For this purpose the resistor *R* is connected in parallel with the capacitor. At the same time a voltage is applied to point *a* which causes tube *V* to open. The resistance of *R* is so chosen that a certain deflection of the pointer takes place (to the red line of the dial) at the correct value of the current. Adjustment of the correct value is arranged by means of the variable resistor *r2*. Due to this adjustment an eventual error in the tube voltmeter is also compensated. Thanks to the strong negative feedback the adjustment need seldom be made.

+ 85 V is supplied from a stabilizer tube 85A2. + 150 V is likewise stabilized.

The time meter has six ranges: 0—5—25—100 milliseconds and 0—0.5—2.5—10 seconds. They are obtained by the combination of two cathode resistors (*r1* + *r2* = one cathode resistor) with three capacitors. One resistor is employed for the three lower ranges and one for the three higher. Since the cathode resistors are separately adjusted, no readjustment is necessary when changing over to another range.

The time meter has two separate inputs, one for starting measurement and one for stopping. Each input has its chassis-connected reference terminal.

The start input is in capacitive coupling, fig. 3. If the input terminal *B* is connected to a point at which the voltage instantaneously changes from one value to another, e. g. on opening or closing of a circuit, a short pulse is received on the control grid of the first tube (*V1*). After passing the first tube the pulse is rectified and is taken to the control grid of a thyratron tube which strikes and causes the aforementioned rise of voltage in point *a*, fig. 2, across the cathode resistor. The negative grid bias of the thyratron tube can be regulated with a potentiometer to vary the sensitivity.

The switch *K* can be used to control the test object, e. g. in order to open or close the circuit to a relay. (In the former case the measurement takes place when the button is released.)

The choke is employed when the measuring process is to be started by breaking a circuit, which produces a small instantaneous change of voltage, as in breaking the circuit to a relay coil which is shunted with a large capacitance with small or no series resistance.

The stop input can be switched over for different methods of measurement by means of a five-position switch. When the switch is in position *1*, the stop input is coupled similarly to the start input. An incoming pulse is rectified and taken to the control grid of thyratron tube. The plate of the thyratron tube is connected to point *a* in fig. 2. When the tube strikes, the voltage drop in point *a*, referred to above, takes place at the end of measurement. The method of coupling the thyratron tube means that the tube cannot strike before a start pulse is received, since the tube has no plate voltage at that time.

With the switch in position *2* the coupling is identical, with the exception that the input terminal receives voltage across a resistor. This is necessary for timing unloaded contacts. The required voltage impulse is obtained on opening or closing of the contact.

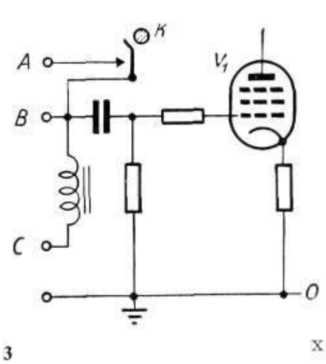


Fig. 3 X 2009
Coupling of start input

A feature common to the stop and start inputs, when the switch is in position *1* or *2*, is that the time meter is not affected by subsequent pulses after a pulse has been received and caused the input thyratron tube to strike. In positions *3—5* a vacuum tube is used in place of the stop input thyratron tube. When a positive potential is applied to the control grid of the vacuum tube, the voltage in point *a* drops (fig. 2) and the charging of the instrument capacitor is interrupted. The input is not cut off, however. If a negative potential is now returned to the control grid, the charging starts afresh.

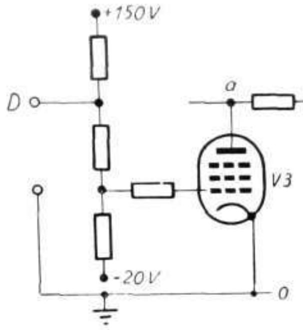


Fig. 4 X 2010

Coupling of stop input

when the »function» selector is set to 3

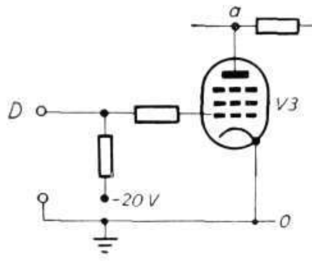


Fig. 5 X 2011

Coupling of stop input

when the »function» selector is set to 4

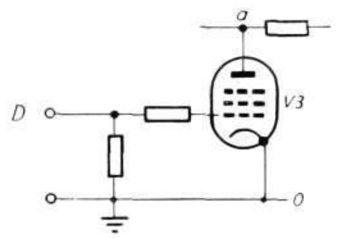


Fig. 6 X 2012

Coupling of stop input

when the »function» selector is set to 5

Fig. 4 shows the coupling of the input when the switch is in position *3*. As long as the input terminal *D* is free, tube *V3* is conducting and there is low voltage in point *a*, so that charging of the instrument capacitor cannot take place. If *D* is connected to earth on the other hand, tube *V3* is cut off and the capacitor can be charged if the thyratron tube on the start side has struck.

In position *4* the case is reversed (fig. 5). Charging of the capacitor is prevented when *D* is connected to earth.

When the switch is in position *5* (fig. 6), the input has no voltage but high resistance. Charging of the capacitor is only possible if a negative potential greater than — 2 V is applied to the stop input.

The sensitivity of the stop input can be regulated by means of its potentiometer when the selector is in positions *1* and *2*. In positions *3* and *4* this potentiometer is disconnected.

Construction

A general view of the time meter is shown in fig. 7.

The front panel is attached to the chassis. For purposes of inspection or change of tubes the front panel screws are loosened and the cover can then be drawn off (fig. 8).

The upper portion of the front panel slopes back at an angle of 30° for convenience of reading the dial. The instrument is of the moving coil type and has a long and easily visible mirror scale. On each side of the dial are knobs for regulating the input sensitivity. The mains switch is placed above the right-hand knob. Above the left-hand knob is a lamp which lights when the switch is on and mains voltage is applied to the meter. The push button *K* at the top right is used for operating relays etc. At the bottom left of the panel is a zeroing and calibrating knob. The range selector is situated immediately below the dial, and on its right is the "function" selector with which the stop input is switched over for different methods of measurement. On each side of the range selector is a potentiometer for adjustment of the charging current during calibration. Since readjustment is seldom required, the potentiometers are only accessible by using a screwdriver, so precluding unintentional alteration of the adjustment.

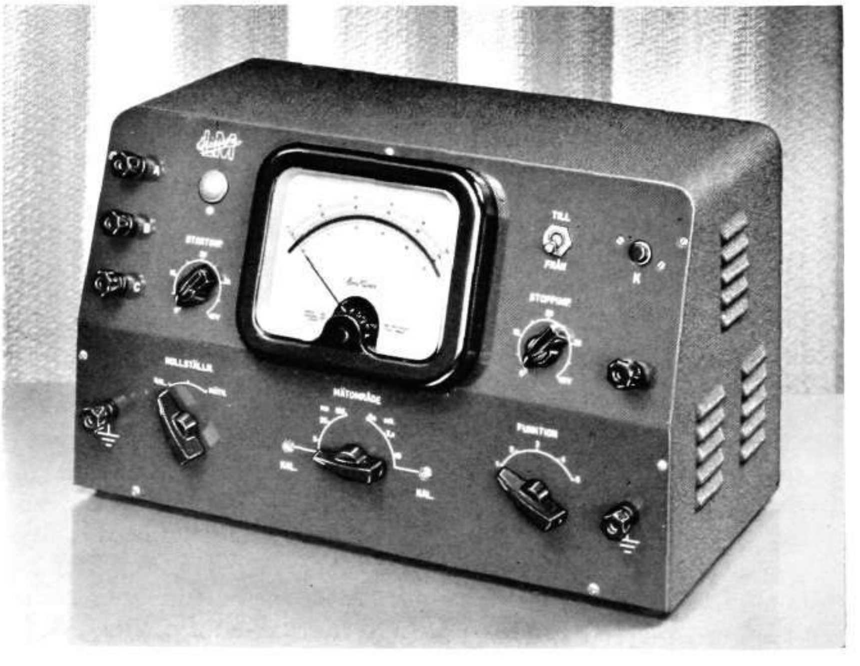


Fig. 7 X 6862

Time meter LMK 2201

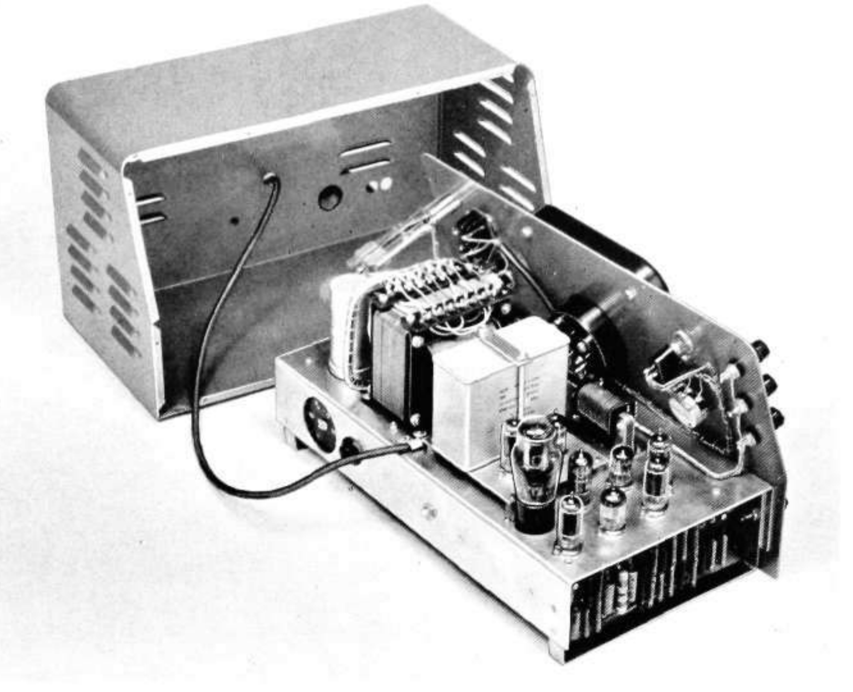


Fig. 8 X 6863

Time meter with cover removed

Applications

The time meter can be employed for many different kinds of measurement. It is a handy and simple instrument to operate. Measurement can be performed without disconnecting the test object from its circuits and is thus carried out under conditions true to practice. The fact that the pointer remains steady after deflection enables an accurate reading to be made, and even small variations in the test object can be observed.

The instrument is effectively protected against overloading. It is not damaged by the pointer coming up against the end of the scale owing to the range being too narrow or to faulty operation.

Some examples of applications are given below. Fig. 9 shows the connection of an individual relay for timing its operate and release lags. In the figure the relay has a make contact, but the case of a break contact is identical. The operate and release lags can be timed in two different ways—including or excluding contact vibrations. The desired method is set on the "function" selector. With vibrations excluded, time t_1 is obtained. If they are included, the result is the sum of $t_1 + t_2 + t_3 + t_4$. For timing "excluding vibrations", the setting of the "function" selector will be the same (position *2*) irrespective of whether the operate or release lag is being timed and whether the contact is a make or break.

Fig. 9 shows the process on operation of the relay. t_2—t_4 represent the vibrations which may arise during the making of a contact.

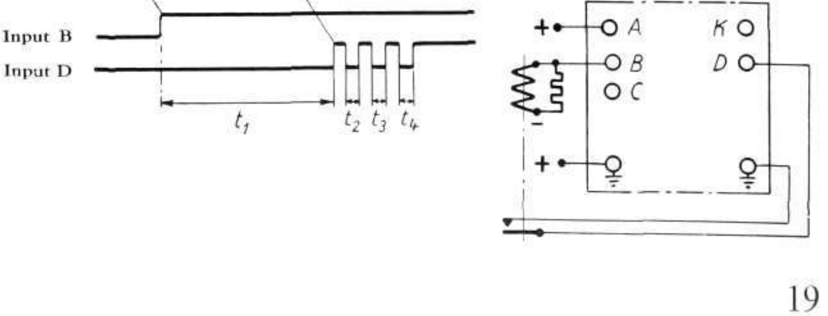


Fig. 9 X 6865

Timing of individual relay

To the right the connection of the test object to the time meter. The left-hand figure shows the sequence of events on operation of the relay. The upper thick line shows the potential variations at input B. The lower line illustrates the contact action. t_1 is the actual operate time; t_2, t_3, and t_4 are vibrations.

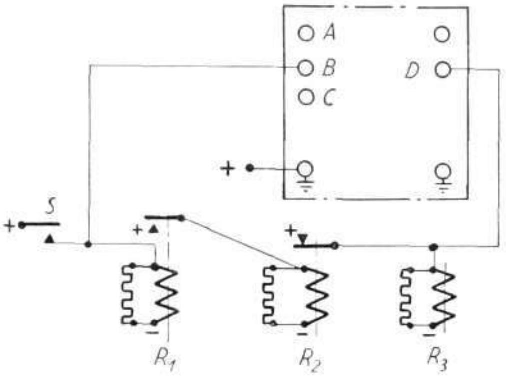


Fig. 10 X 2013

Timing of relays with loaded contacts

It has been found of great value to be able to measure the operating times in these two ways. As a rule it is the longer time (including vibrations) which determines the speed of a relay connection. An increase of the operate power does not always yield a greater switching speed. The result may be the reverse due to increase vibration.

The contact vibrations may also be timed separately. When this is done, a sum of break vibrations is obtained for a make contact ($t_2 + t_3 + t_4$ in fig. 6) and a sum of make vibrations for a break contact.

Fig. 10 shows an instance of timing when the contacts are loaded. When *S* closes, the sum of the operate lags of *R1* and *R2* is obtained. If the meter is zeroed and then reset to measure, the result will be the sum of the release lags of the two relays when *S* opens. The setting of the time meter need not be changed, apart from a possible alteration of the range.

For measuring the duration of a break, make or voltage impulse, only the stop input need be connected. The thyratron tube on the start side is caused to strike by setting its negative bias to zero. Figs. 11 and 12 show two cases in which the meter is set for timing of a voltage impulse.

In fig. 11 the meter is employed to measure the duration of a light signal by means of a photocell.

The time meter can also be used to measure the capacity of condensers, which is extremely valuable when electrolytic condensers are used in D. C. circuits to cause delayed relay action. The value of the capacitance obtained in A. C. bridges may in such case be very misleading.

The method of measuring the capacitance on charging of a condenser is illustrated in fig. 12. If $R \approx 1\ k\Omega$, *P* can be adjusted with the aid of a condenser of known capacitance so as to obtain a direct reading in microfarads instead of milliseconds. The capacitance on discharge can also be measured, but a somewhat different coupling must then be used.

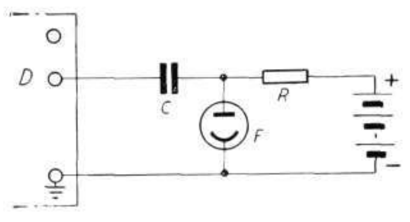


Fig. 11 X 2014

Measurement of duration of light signal by means of a photocell

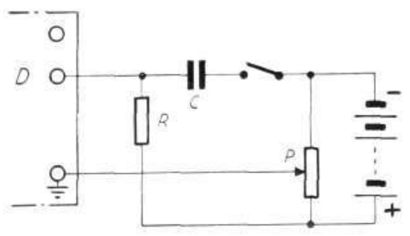


Fig. 12 X 2015

Measurement of a condenser's capacitance

Electrical Data, Tubes and Dimensions

Six ranges: 0—5—25—100 milliseconds and 0—0.5—2.5—10 seconds

Scale: 110 mm

Graduations: 50

Input impedance:

Start input		1 MΩ in series with 2,000 pF
Stop input	"Function" selector to 1	1 MΩ in series with 2,000 pF
	» » » 5	2 MΩ

Accuracy: superior to ± 1.5 % of full deflection

Power consumption: about 36 W

Mains connection: A. C. 50 — 110, 127, 220 or 240 V

Dimensions: 400 × 230 × 240 mm

Weight: about 10 kg

Tubes: 5 6AU6
2 6AL5
2 5696 or 2D21
1 6X4
1 85A2
1 OD3/VR150

Ericsson TV Receiver

B NILSSON & U ENFORS, SVENSKA RADIOAKTIEBOLAGET, STOCKHOLM

U.D.C. 621.397.62

Svenska Radioaktiebolaget, which has manufactured Ericsson radio sets for many years, has now started to produce television sets as well. This article describes the three types of television receivers with generally similar chassis which Svenska Radioaktiebolaget is now marketing.

General

What the general public asks of a TV set is that it shall show good pictures of sufficient size at a reasonable price. The designer's work, which of course must always result in a compromise, is also influenced by other requirements such as reliability of operation, attractive appearance and simplicity of maintenance and service.

Although the fundamental features of the mono-chrome TV receiver have not changed much during the last 10 to 15 years, the developments in tubes and circuit components have now opened up entirely new possibilities of designing efficient and reliable receivers with large pictures. Up to the detector the television set resembles the ordinary radio set. Thus the superheterodyne principle is employed, and generally a high-frequency stage precedes the mixer. The audio signal is separated from the video signal either in the intermediate frequency channel or following the detector, sometimes even at the picture tube. There, too, the sync signal is usually separated from the composite video signal.

The picture tube has magnetic deflection. The deflection yoke requires saw-toothed currents and is usually matched to the output stages by means of transformers. The high peak voltages in the horizontal output stage are transformed and rectified so as to supply high tension to the final anode of the picture tube.

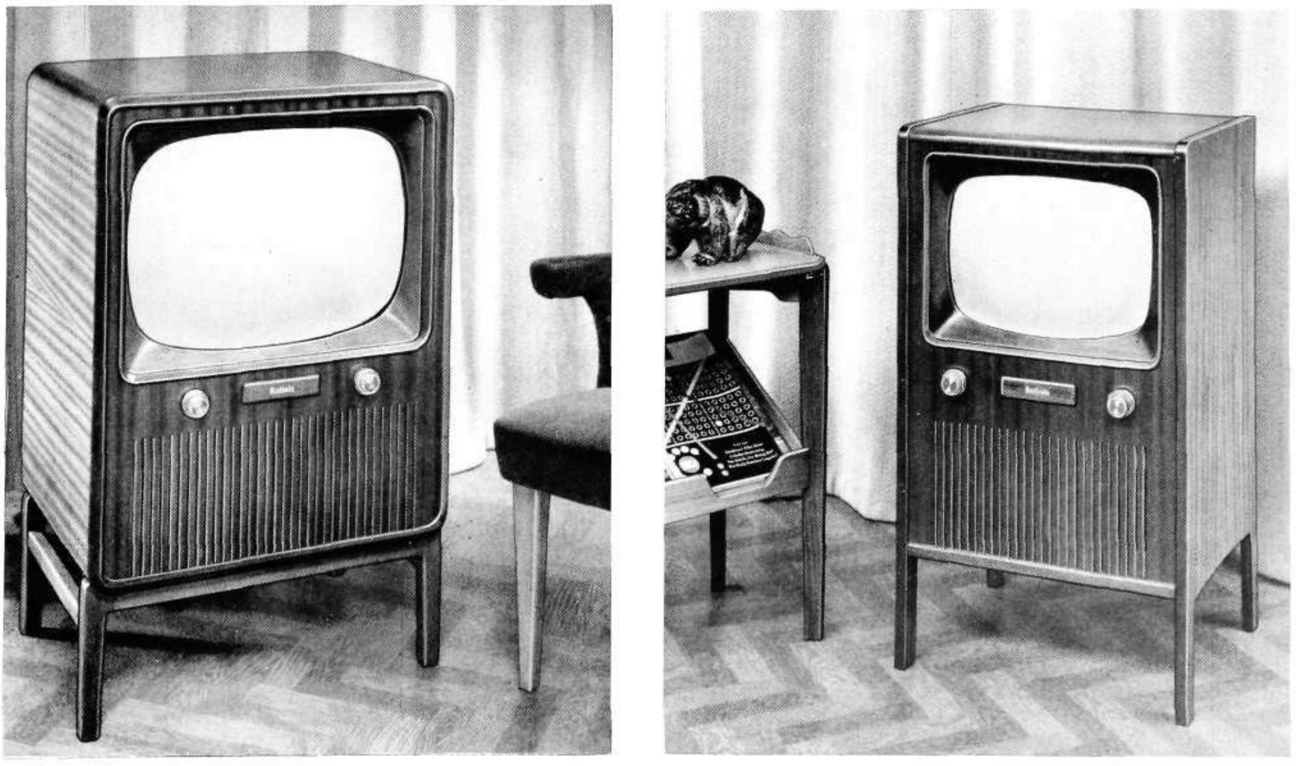


Fig. 1 X 7673
Ericsson TV receiver
TV 547 LV (left) and TV 546 LV (right)

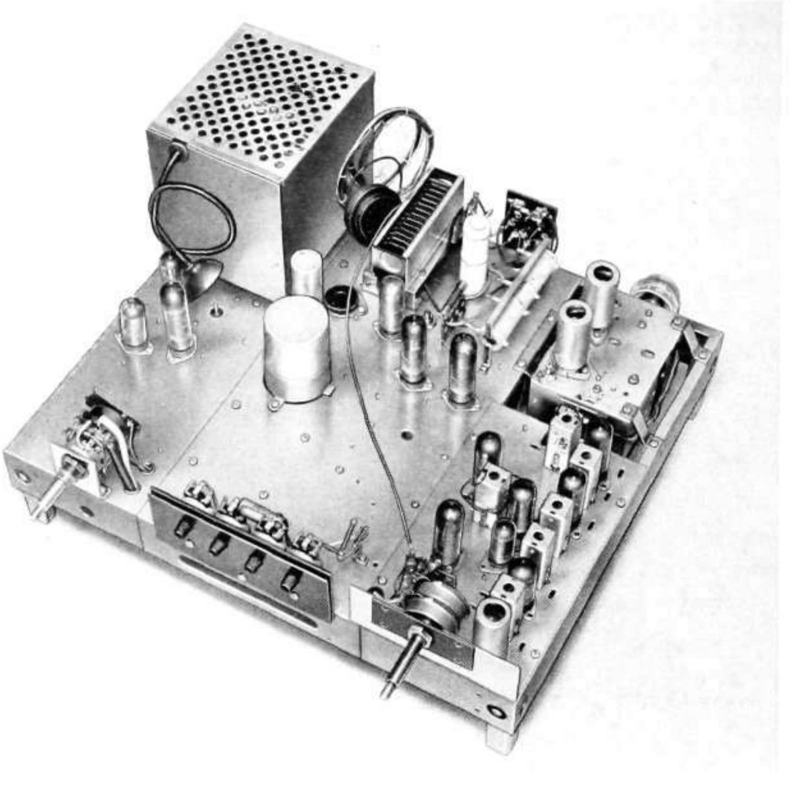


Fig. 2 X 6870

Chassis of Ericsson TV receiver

On the base plate are, from the left, the screened horizontal deflection transformer with the high voltage circuit, thereafter the power unit and the built-in HF and IF units. In the front are the controls.

The total number of tubes in a TV receiver is generally between 15 and 25, but combined radio and television sets, and colour television sets (as yet only used in USA) can have 30 tubes or more. The public has shown little interest in combination sets, one reason being that many homes wish to receive television and radio programmes at the same time.

Since Swedish television is only at an experimental stage, the domestic production of TV sets is still very limited both as regards types and quantities. Ericsson has three models with roughly similar chassis in serial production. All are consoles, which harmonize better in the usual home than the combination of table set and table. A console set, moreover, has generally high sound fidelity due to the large baffle and forward-directed loudspeaker. The fidelity of the Ericsson TV receiver has been further enhanced by a push-pull audio output stage and 21 cm broad band loudspeaker.

The cabinets are made of sapelli mahogany or teak with a dull satin or high lustre finish (fig. 1). The external dimensions are:

TV 545 LV	height 950 mm	width 500 mm	depth 425 mm
TV 546 LV	» 915 »	» 504 »	» 428 »
TV 547 LV	» 995 »	» 615 »	» 470 »

All models have rectangular all-glass picture tubes with maximum 70° angle of deflection. In the TV 545 LV and TV 546 LV receivers the diagonal of the screen is 43 cm (17″), which is a convenient size for five to six persons seated in easy chairs. The third model, TV 547 LV, is more suitable for larger rooms and a larger audience. It has a screen of 53 cm (21″) diagonal, which is aluminiumized to provide good contrast. The 17″ and 21″ screens are both light-absorbing, which gives goood contrast even in daylight. But television pictures, like cinematographic pictures, are naturally more effective in soft light.

A number of the controls of a TV receiver are not often used, and the manipulation is simplified if they are not placed in too accessible positions. The controls for ordinary conditions of reception consist of two conveniently positioned double knobs on the front panel, one for switching on the set and for adjusting sound volume and tone, the second for contrast and light level of the image. Secondary controls—for vertical and horizontal hold, height and vertical linearity—are placed beneath a shutter on the front panel. At the rear of the set are the channel selector with fine timing and the width control.

An adjustable aerial is mounted in the top of the cabinet and is controlled from the rear. With food field strength the aerial can generally be used up to a few miles from a high power transmitter. For several years to come, however, comparatively many TV receivers in Sweden will be in fringe areas with low field strength. Attempts have therefore been made in the design of the sets to obtain good performance at low signal levels.

The receivers can be modified to match different TV systems, but in their present state are mainly designed for the West European continental system with 625 lines, 25 pictures per second. The video modulation of this system is negative and the sound is frequency modulated. The HF channel covers 7 Mc/s within the 47—68 and 174—216 Mc/s bands.

The chassis (fig. 2) consists of a base with HF and IF units (including video amplifier) screwed to it. The remaining electrical equipment, apart from loudspeaker and picture tube (with deflection and focussing unit), is also mounted on the base. The picture tube is fixed in the cabinet, which simplifies the handling of the chassis and reduces the risk of damage in transport.

Including the picture tube the receiver contains 20 tubes with some thirty or so functions. The normal current supply is 220—240 Volts D. C. or A. C., but for lower alternating voltages an autotransformer can be added. The picture frequency of the TV system need not be locked to the mains frequency.

Components

A block diagram of the receivers is shown in fig. 3. The HF stage (240—300 ohms input impedance) is connected in cascode and is followed by a triode-pentode as mixer. The IF component consists of three stagger tuned stages. The IF range is 18—25 Mc/s, and an intercarrier system is employed with audio-IF 5.5 Mc/s taken from the video detector. The video-amplifier consists of a D. C.-connected stage.

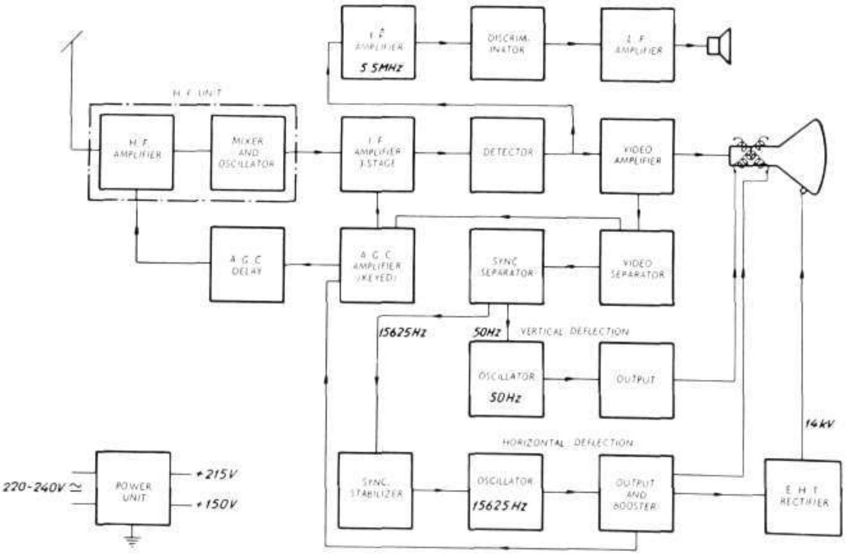


Fig. 3 X 6866

Block diagram of Ericsson TV receiver

The audio-IF amplifier contains two stages and discriminator. The AF amplifier consists of two triode-pentodes, the triodes being used as amplifier and phase inverter. The two pentodes act in combination as push-pull amplifier stage in class AB. The output power is 3 W at 7 % distortion. Full register is obtained when the tone control is centrally adjusted. Anticlockwise rotation lowers the treble, and clockwise the base.

From the anode of the video output stage a signal transmitted to the video separator and automatic gain control (AGC). The latter operates on two IF stages and with delay in HF stage; its time constant is such that even rapid signal fluctuations, for example from passing aeroplanes, are eliminated. The anode voltage of the AGC tube consists of positive retrace pulses from the line transformer. Anode current only flows during the synchronizing pulse period, and the effect of interference pulses between the synchronizing pulses is thus eliminated. Current pulses through the AGC tube produce a negative control voltage. The control voltage to the HF tube is delayed by a positive potential. By this means no adjustment, of the HF stage is obtained until the signal level has risen appreciably. Thus as long as the noise content has any considerable influence on the picture quality, it is determined by the low noise factor of the HF stage.

After the video and sync separation stages the field synchronizing pulses control a blocking oscillator followed by a negative feedback output stage. The horizontal synchronizing pulses synchronize the horizontal oscillator indirectly by means of pulse time control, so attaining high stability against interference. The extra high tension of the picture tube is 14 kV loaded. The booster voltage, about 500 V, is utilized for the vertical oscillator and screen grid of the picture tube. The return traces in the image are suppressed by pulses on the control grid of the picture tube.

The power unit contains a selenium rectifier with π-type filter. The large capacitors (200 + 500 μF) produce a very strong surge of current when the set is switched on, and the anode voltage chain is therefore protected by a thermal fuse. All heaters are series-connected, yet the total heater voltage drop is sufficiently low for the set to operate on under-voltage. The total power consumption of the receiver varies between 150 and 190 W depending on the type and voltage of the mains supply.

Long Life Electron Tubes 18AQ5//6AQ5L and 18C51//2C51L

S. EDSMAN, AB SVENSKA ELEKTRONRÖR, STOCKHOLM

U.D.C. 621.385.1:621.395

In an article in Ericsson Review No 3/1954 mention was made of certain measures that had been taken in the development of S. E. R.'s long life tubes, types 18J6//6J6L, 18AK5//403B and 404A, and the results were given of life tests on these types. The present article deals with the remaining types 18AQ5//6AQ5L and 18C51//2C51L.

18AQ5//6AQ5L

The basic type chosen for the development of a long life power amplifier was the standard tube 6AQ5. This tube, which is of the beam type, normally works with a plate loss that is relatively high in proportion to the dimensions of the tube. Both the plate and bulb temperatures are high, therefore, which might create difficulties in the attainment of long life. A first measure was to lower the maximum permissible plate loss from 12 W to 8 W. This level was in close agreement with normal telephone equipment circuits in which the plate voltages do not as a rule exceed 180 V. At this voltage the plate loss under typical conditions of operation is about 6 W.

In fig. 1, curve A, is shown the change in transconductance obtained from life tests under typical conditions of operations. Several reasons for the decline in transconductance during the test are imaginable:

1. The high plate and bulb temperatures cause a high gas pressure in the tube with consequent decline in cathode activity.
2. The cathode temperature may be too high, so that an abnormal evaporation of the cathode material takes place, accompanied by a decline in the cathode activity.
3. The nickel employed in the cathode contains sufficient silicon for a resistive interface to arise between cathode sleeve and coating, with consequent decline in transconductance.

In the attempt to discover which one or more of these causes of error had been most responsible for the falling curve in fig. 1 A, two new tests were carried out—one at the same cathode temperature as in the earlier test, but

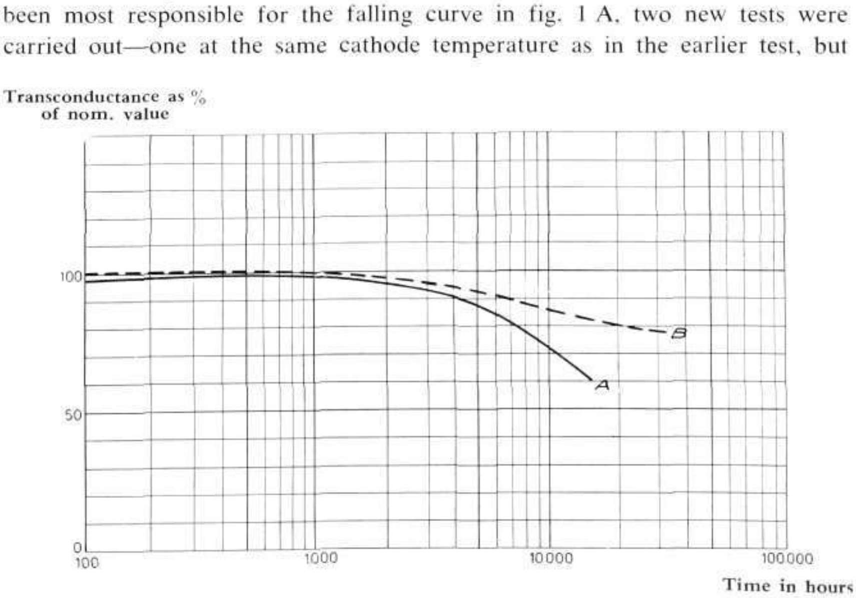


Fig. 1 X 6854

Life test on 18AQ5

A Heater power 2.83 W, plate power 5.5 W, mean of 13 tubes (tests with plate power of 11 W showed the same result)

B Heater power 2.11 W, plate power 5.5 W, mean of 6 tubes

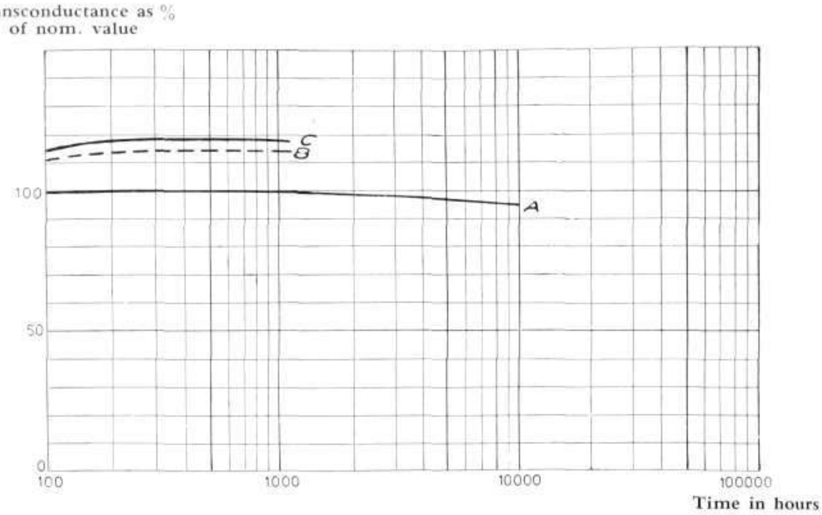
Fig. 2 X 6855

Life test on 18AQ5

A Heater power 2.83 W, plate power 5.5 W, mean of 24 tubes

B Redesigned tube, heater power 2.35 W, plate power 5.5 W (as the cathode area had been increased by about 10 %, this heater power corresponds to about 2.11 W in the earlier design), mean of 7 tubes

C Same tube as in curve 2 B, but with heater power 2.65 W (this power corresponds to about 2.35 W in the earlier design), mean of 24 tubes



with the plate power raised to about 11 W. Since the life curve was practically the same as in fig. 1 A, the first of the listed causes of error may be considered as being of little consequence. In the second test, shown in fig. 1 B, the plate loss was maintained at about 5.5 W, but the cathode temperature was reduced (about 25 % lower heater power). This shows that the second cause of error was to a large degree responsible for the fall in transconductance. Measurements of the interface resistance revealed that point 3 had also been a contributory factor, but to a lesser degree. The low cathode temperature employed in tests 1 B produces a satisfactory life. Unfortunately, however, it is practically impossible to obtain a sufficient cathode activity in regular production, for which reason there is too great a spread in output and transconductance. The margin for satisfactory operation at 5 % under-voltage, moreover, is too small. A compromise was made in respect to heater power and, with all the improvements that were successively brought about at different stages of manufacture, the result shown in fig. 2 A was obtained.

Practical experience of power amplifier tubes has shown that a considerable fall in cathode activity may take place after a certain period of service. The reason often is that the plate has been overloaded as a result of grid-current of some kind (grid emission, faulty insulation, gas), which has given rise to an increased plate power and the liberation of gas. The attempt to eliminate the occurrence of grid current must therefore be made when designing power amplifier tubes.

To avoid grid current due to faulty insulation, the magnesium content in the cathode sleeve should be kept as low as possible. This was one of the reasons for the redesign of 18AQ5 despite the fact that life tests had shown good results —also in respect to grid current phenomena—up to 10,000 and even 30,000 hours.

Cross-sections of the old and new tube systems are shown in fig. 3. An account is given below of the more important changes and the reasons why they were made.

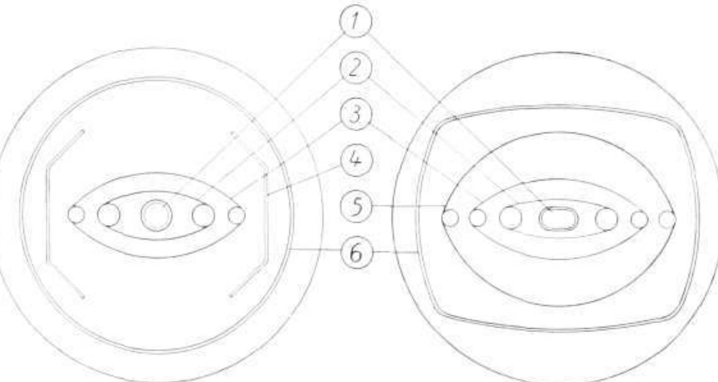


Fig. 3 X 6856

To the left is shown a cross-section of the original tube system, to the right the corresponding cross-section of the new system

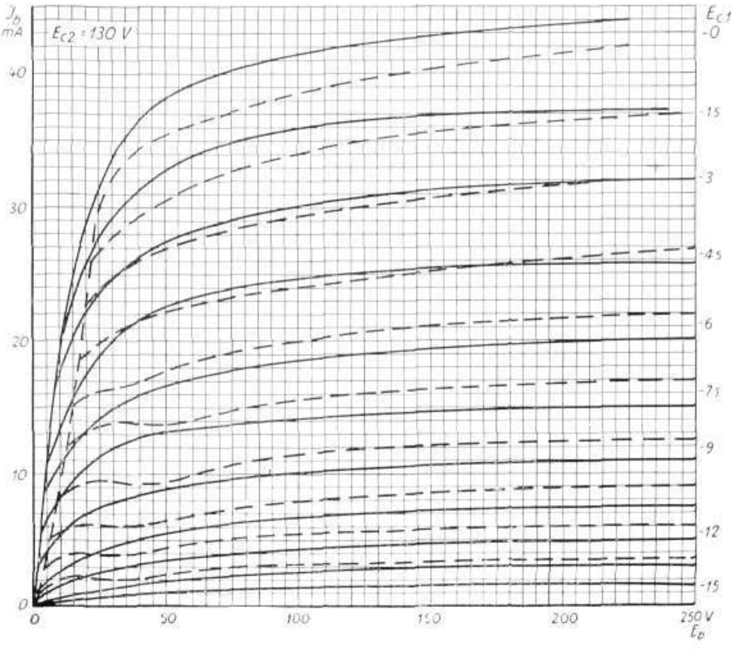
1 cathode
2 control grid
3 screen grid
4 beam plates
5 suppressor grid
6 plate

Fig. 4 X 6861

Plate voltage and plate current curves with grid bias as parameter

The dotted curves represent the old design (»beam tetrode»), the continuous curves the new design (the pentode)

Note the difference in the initial rise of the curves at low plate voltages and the depressions in the dotted curves at low plate currents and voltages



1. The cathode material was changed from Inco 220 with max. 0.1 % magnesium and 0.5 % silicon to DH 499 in which magnesium and silicon each amounted to max. 0.01 %. We knew from earlier experience that the latter material showed the smallest tendency to insulation faults (through metal coating on micas and stems), especially if the service temperature was kept permanently below 800° C. The reduced silicon content also renders the tube proof against the phenomenon of interface over a long period.

   The cross-section of the cathode was changed from circular to oval. Its area was thereby increased by about 10 % which, for the same heater power, gives the same temperature as in the batch in fig. 1 B.

2. The control grid was made with a gilded lateral wire, which has less tendency to grid emission. The changed form of the cathode provides a more constant grid-cathode distance. Moreover, since the diameter of the lateral wire was reduced from 0.08 to 0.05 mm, the cathode current will be more uniform over the whole surface. A higher transconductance is also obtained for the same minimum grid-cathode distance.

3. The tube was changed to a pentode with suppressor grid instead of the "beam plates" used in a beam tetrode. The change in the plate current-voltage curves is shown in fig. 4. At the same time the shape of the plate was altered in such a way that its area remained the same, but the plate-cathode distance was diminished. This change produces a steeper initial rise in the plate curves with, in consequence, a rather higher output.

In fig. 2 B and C are shown the life curves of the new design during the first 1,000 hours of the present tests. The difference lies in the different heater powers. In consequence of the larger and better utilized area of the cathode, the mean transconductance has risen by a good 10 %. In spite of the low cathode temperature (as low as in batch 1 B) it has been possible to limit the spread in transconductance and output, even with a 10 % undervoltage on the heater, which affords a safe operating margin.

18C51//2C51L

From the circuit point of view the double triode 18J6 had certain drawbacks due to the fact that the two systems have a common cathode. It was desirable, therefore, to produce a double triode with ratings similar to 18J6 but with separate cathode tappings for the two triode systems. Since 18AK5, triode-connected, has practically the same data as one system in 18J6, it was possible to build such a tube on the same primary system (cathode, control grid) as 18AK5. It was in this way that 18C51 was constructed, as shown in fig. 5.

The heaters of the two systems were connected in parallel, since experience has shown that it is very much more difficult to obtain a reliable construction when they are in series. This is due, among other things, to the uneven distribution of power which may arise as a result of different heating times in heaters and cathodes.

The cathode material is of the passive type (DH 499), as in the other long life tubes. The sleeves are made with two embossings which prevent axial movement during heating and cooling. The grids are wound with a gilded tungsten wire 0.0018 mm in diameter, and the side rod legs without notches which fit into the mica holes. The plates must be located at the same distance from the cathode as the screen grid in 18AK5. The cross-section of the plates will therefore be comparatively small and, purely theoretically, a tendency to impaired life may be expected due to the higher gas pressure in the system. The getter has greater difficulty in operating efficiently since the channels connecting the space below the getter mirror, where the gas is absorbed, with the space in the system in which the gas is liberated, are comparatively narrow. In a triode, moreover, in which the only heat screen between cathode and plate is the control grid, the plate temperature reacts very much more strongly on the cathode temperature than it does in a pentode having three grids. In 18C51 it is not unusual that a normal plate power (1.2 W) produces an increase in temperature of about 30° C, corresponding to about 10 % over-voltage in the heater. This is an advantage in a way, since a higher cathode temperature makes the cathode less sensitive to poisoning by liberated gas. A disadvantage on the other hand is the high temperature due to the higher rate of sublimation of magnesium and other metals on the micas and button stem, which forms leakage paths between the electrodes. This factor, in conjunction with the small gaps in the tube and the very high standard of insulation needed, places very high requirements on the micas.

Fig. 6 shows the results of life tests on 18C51 taken from different batches in the process of manufacture. It is seen that in this case the life tests show better results without any change being made in the design. This is probably due to progressive improvements in the various production processes and to the achievement of greater continuity in production.

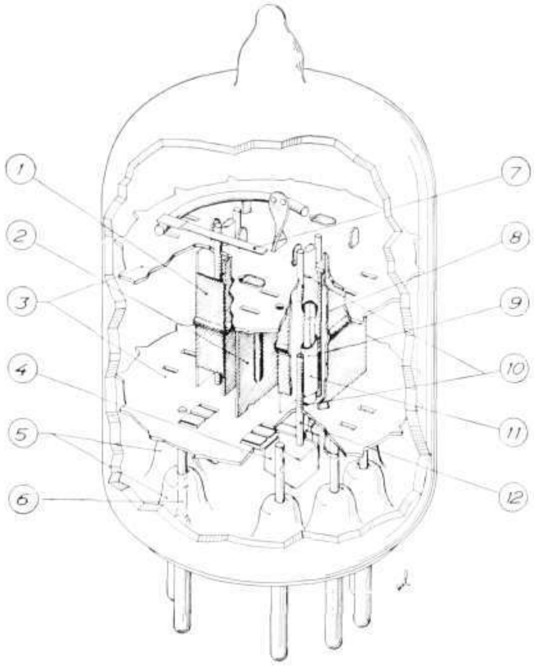


Fig. 5 X 2032

Long life tube 18C51

1 plate
2 screen between systems
3 micas
4 heater connectors clamped to bottom mica
5 glass fillet formed around the lead-in wire
6 vacuum-tight glass-metal seal
7 getter ribbon coated with getter material. When the getter is flashed the material forms a »getter mirror» on the inside of the glass bulb
8 heater with insulation coating
9 coated cathode sleeve
10 embossings which fix the vertical position of the cathode sleeve
11 control grid consisting of two side rods with swedged lateral wire
12 the control grid has side rod legs without notches which can be inserted in the holes of the mica without tearing it

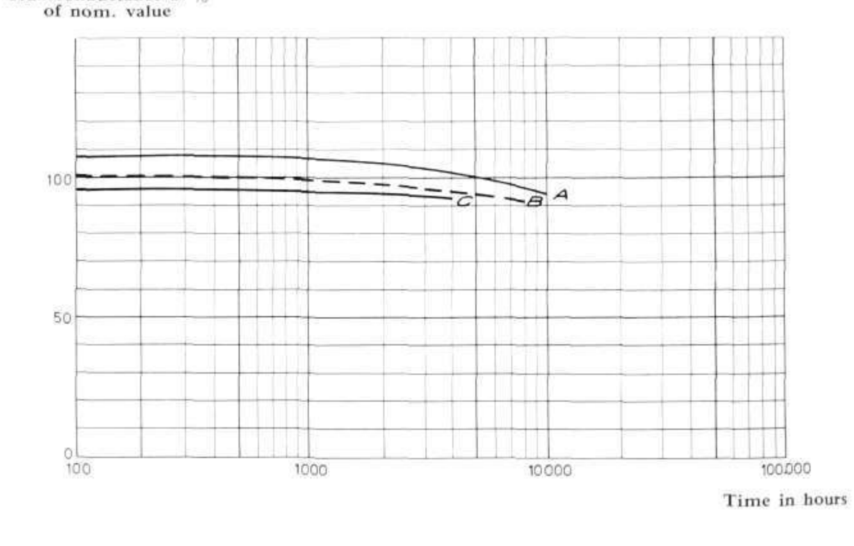


Fig. 6 X 6859

Life test on 18C51

L M Ericsson Exchanges Cut into Service 1954

Exchanges with 500-line selectors

Town	Exchange		Number of lines
Brazil			
Belém	Centro	(extension)	500
Belém	Souza	(extension)	500
Diamantina			300
Fortaleza		(extension)	2000
Juiz de Fóra		(extension)	1000
Limeira			1000
Patos de Minas			500
São José de Rio Preto			2000
Vitória	Central	(extension)	2000
Vitória	Vila Velha		200
Chile			
Santiago	1 PABX		280
Colombia			
Bogotá	Centro	(extension)	4000
Bogotá	Chapinero	(extension)	1500
Bogotá	Teusaquillo	(extension)	1500
Manizales		(extension)	1000
Medellín	America	(extension)	1000
Popayán			1000
Denmark			
Copenhagen	1 PABX		200
Copenhagen	1 PABX	(extension)	60
Finland			
Harjavalta		(extension)	140
Helsinki/Helsingfors	1 PABX	(extension)	100
Kankaanpää			600
Karjasilta			500
Kouvala	1 PABX		200
Pori		(extension)	500
Italy			
Barletta		(extension)	300
Caltagirone		(extension)	300
Castellammare			1000
Catania		(extension)	1000
Catanzaro		(extension)	700
Cosenza		(extension)	700
Cremona		(extension)	1000
Enna		(extension)	300
Este		(extension)	300
Foggia		(extension)	700
Gela			300
Iesolo			500
Marsala		(extension)	300
Messina		(extension)	2000
Mogliano		(extension)	100
Napoli	Amedeo	(extension)	2500
Napoli	Centro	(extension)	3000
Napoli	Fuorigrotta		1000
Napoli	Museo	(extension)	1500

Town	Exchange		Number of lines
Napoli	Nolana	(extension)	500
Napoli	Vomero II	(extension)	6000
Novara		(extension)	2000
Padova		(extension)	2500
Palermo	Ferrovia	(extension)	2000
Palermo	Libertà	(extension)	2000
Reggio Calabria		(extension)	500
Rovigo		(extension)	200
Salo			800
S. Donà di Piave		(extension)	100
Schio		(extension)	100
Thiene		(extension)	200
Trapani		(extension)	500
Treviso		(extension)	500
Valdagno		(extension)	100
Venezia	Centro	(extension)	2500
Venezia	Lido	(extension)	600
Venezia	Mestre	(extension)	1700
Venezia	Murano	(extension)	80
Verona		(extension)	3500
Libanon			
Beirut			15000
Beirut	1 PABX		180
Mexico			
Campeche		(extension)	500
México D.F.	Apartado	(extension)	1000
México D.F.	Atzcapotzalco		1000
México D.F.	Piedad	(extension)	1000
México D.F.	Portales	(extension)	1000
México D.F.	Roma	(extension)	4000
México D.F.	San Angel	(extension)	500
México D.F.	Tacuba	(extension)	500
México D.F.	Valle	(extension)	3000
México D.F.	Victoria	(extension)	1400
México D.F.	Zócalo	(extension)	3000
Villahermosa			500
Netherlands			
Rotterdam	Noord II	(extension)	3000
Rotterdam	West II	(extension)	4000
Rotterdam	1 PABX		400
Rotterdam	2 PABX	(extension)	40
Netherlands West Indies			
Hato			200
Norway			
Egersund		(extension)	140
Eidanger	1 PABX	(extension)	40
Fredrikstad		(extension)	1000
Hamar		(extension)	1500
Sandnes		(extension)	500
Selbak		(extension)	80
Skien		(extension)	1000

Town	Exchange		Number of lines
Poland			
Katowice	2 PABX	(extension)	250
Spain			
San Sebastián		(extension)	2000
Sweden			
Borås		(extension)	2000
Eskilstuna		(extension)	2000
Göteborg	Hisingen	(extension)	2500
Göteborg	Kortedala		6000
Göteborg	Mölndal	(extension)	1000
Göteborg	5 PABX		1120
Göteborg	1 PABX	(extension)	60
Hälsingborg		(extension)	3000
Kalmar		(extension)	2000
Karlstad		(extension)	3000
Katrineholm		(extension)	1000
Kinna		(extension)	500
Kristinehamn		(extension)	1000
~~Krylbo~~		~~(extension)~~	500
Linköping		(extension)	3000
Lund		(extension)	2500
Nässjö			4000
Skara		(extension)	500
Stockholm	Högalid	(extension)	5000

Town	Exchange		Number of lines
Stockholm	Östermalm	(extension)	3000
Stockholm	Norrviken	(extension)	500
Stockholm	Roslags-Näsby	(extension)	1000
Stockholm	Storängen	(extension)	1000
Stockholm	Ängby	(extension)	3000
Stockholm	10 PABX		1660
Stockholm	2 PABX	(extension)	240
Trollhättan		(extension)	1000
Uddevalla		(extension)	1000
Västerås		(extension)	3000
Örebro		(extension)	1000
Various places	11 PABX		1890
Various places	1 PABX	(extension)	20
Turkey			
Ankara	Merkez Santral	(extension)	2000
Ankara	Yenişehir	(extension)	2000
Antakya			500
Ceyhan			500
Trabzon			1000
Venezuela			
San Felipe			300
Trujillo			300
		Total	178780

Exchanges with crossbar switches

Town	Exchange		Number of lines
Denmark			
Horsens			1000
Copenhagen	Kastrup		6000
Copenhagen	Vestskel		2000
Copenhagen	Virum		2000
Finland			
Helsinki Helsingfors	Sörnäs	(extension)	2200
Sweden			
Visby			5500
		Total	18700

Exchanges with crossbar switches and with 100-, 25- and 12-line selectors. (Extension to existing plants are not included in the figures.)

	Number	Number of lines
Exchanges with crossbar switches, system ARK	10	3270
Switchboards with 100-line selectors, system AHD	152	14005
Switchboards with 25- and 12-line selectors, system OL	459	12390
Total	621	29665

NEWS *from* *All Quarters of the World*

L M Ericsson Exchanges Spread Through All Turkey

L M Ericsson's comparatively recent offshoot in Turkey—Ericsson Türk Ltd—has had a successful run of business from its start. Shortly after the firm was established, two contracts were signed with the Turkish Telephone Administration. One was for the installation of automatic exchanges in eleven towns, now already nearing completion. The second contract covered the expansion of the automatic telephone exchanges at Ankara and Izmir (Smyrna) by altogether 12,700 lines. This work is under progress, as also are alterations to the Eskişehir and Sivas automatic exchanges.

A new large order was recently placed with Ericsson Türk by the Telephone Administration, covering the installation of 13,700 automatic lines spread over 30 towns; further, for thirty 200-line manual exchanges and the installation of complete external plants including telephone instruments in 24 towns throughout the country.

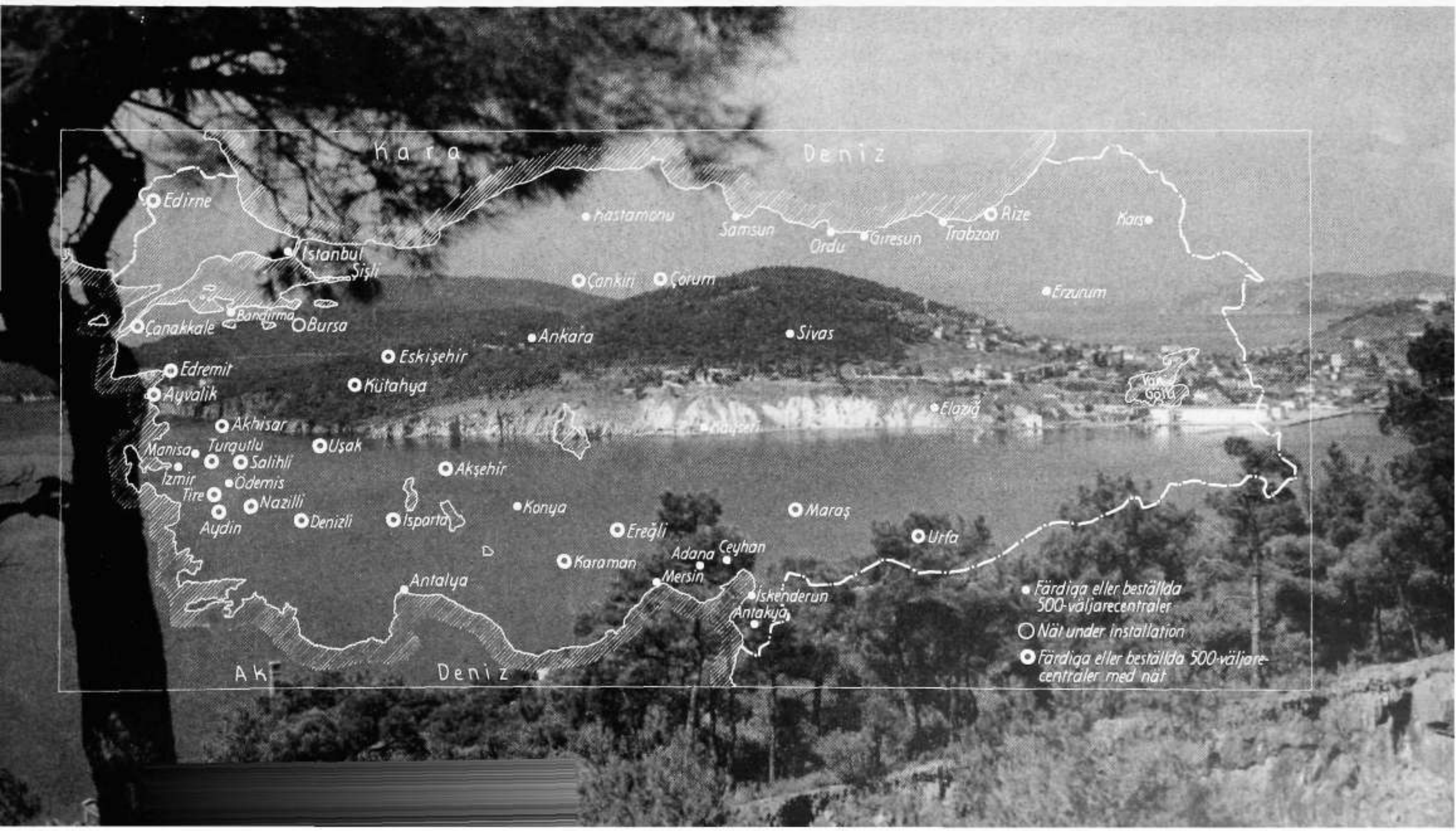
The total capacity of L M Ericsson exchanges in Turkey, once the present contracts have been completed, will be 75,000 lines. 43,680 secondary cable pairs will have been installed.

These extensive projects, which are to be completed within three years, will require a force of about 300 men—principally Turkish labour under Swedish leadership. Preparations for the work are under way and, pending the arrival of the materials from Sweden, the native staff are undergoing a course of training to bring them up to scratch in readiness for their coming tasks. A cable splicing school has been started in Ankara, and instruction is also being given in the construction of cement conduits.

(Above.) A view of Istanbul with the famous Galata Bridge in the foregrund.

(Below.) One of the Prince Islands off Istanbul and, inset, a map of L M Ericsson exchanges in Turkey.

- ● 500-selector exchanges, completed or on order
- ○ Network installation in progress
- **O** 500-selector exchanges including network, completed or on order



Signalbolaget Delivers Control Equipment for Lighthouses

The need has been manifested for a simple and reliable, non-electronic equipment for the control of lighthouses at places where a line exists, or can easily be installed, between the lighthouse and the control position. Signalbolaget was excellently equipped to meet this need by the combination of units long used in railway signalling practice.

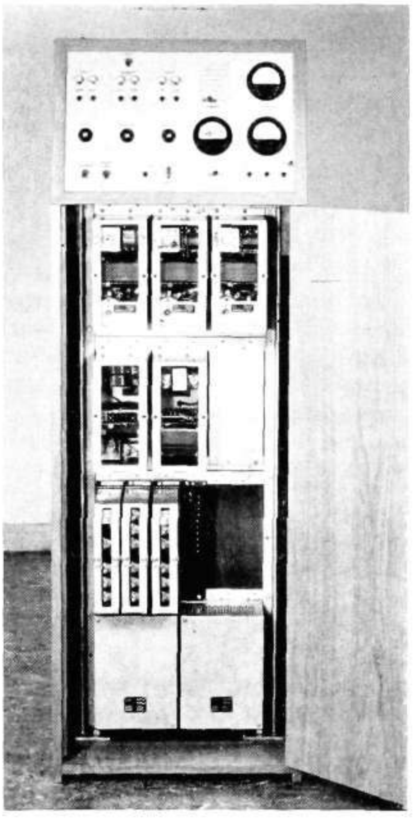
In Signalbolaget's system both the remote control of the light and the remote indication of its condition is arranged over a single pair of wires, which is also used for telephone communication between lighthouse and control room.

Supervision of the line is by means of d. c., and an open or short on the line sends an alarm to the control room. Intermittent interruptions of the d. c. circuit are used for other fault indications. The controls consist of short impulses at one or more of the frequencies 15, 38 and 60 c/s. The frequencies are generated by means of oscillating polarized telephone relays which form part of a unit that is used in Signalbolaget's manual block system for railway signalling. Indications are transmitted on the frequencies 25 and 100 c/s according to the character of the lighthouse signal. These frequencies are obtained from 50-cycle mains by means of static converters designed for the feeding of track circuits in railway signalling systems.

The local telephone instruments for communication between control room and lighthouse are automatically connected to the line by the raising of one of the handsets. The other equipment is thereby disconnected.

An equipment for Djursten lighthouse is ready to be put in service, and Signalbolaget has a further order for the Engelska Grundet lighthouse.

Left Djursten lighthouse, below remote control for the lighthouse. Control cabinet with operating and indicating panel at the top contains all the equipment required in the control room at Öregrund.



Three Signalling Companies in Practical Nordicism

While representatives of the Scandinavian governments have been meeting for the discussion of increased cooperation in regard to trade and industry, and committees appointed by their governments have long been working for the same end, three Nordic signalling companies have given an example of practical Nordicism by their joint delivery of a signalling installation to the Norwegian State Railways.

The installation consists of Signalbolaget's manual block system serving the single track line Skien—Eidanger with three intermediate stations. Dansk Signal Industri A/S has supplied the necessary relays, which were forwarded to Signalbolaget in Sweden for assembling in racks in conjunction with the latter company's transmitters and receivers operating on three different frequencies. The ready-assembled relay racks were installed by A/S Elektrisk Bureau, Oslo, which also supplied the remaining signalling material.

(Below.) Testing the relay racks for the Norwegian State Railways in Signalbolaget's laboratory.

From the Visitors' Book

During his tour of Europe the Governor of the Brazilian town of São Paulo, Sr. Jânio Quadros, visited the L M Ericsson plants at Midsommarkransen in the company of Sr. Olavo Fontoura, head of the largest penicillin factory in Brazil. The two visitors (the Governor in the foreground) are seen watching the operation of planing coined parts.

(Below.) The Chinese Ambassador to Sweden, General Keng Piao, has been caught by the camera in the act of signing his name in the Visitors' Book during a tour of the head factory. The Ambassador was accompanied by the Chinese Commercial Attaché, Mr. Cheng Yün-Hsiao.

(Above.) The speaker of the Syrian Parliament, F Nehlaoui, and the two newspaper publishers, F Tellaoui and F Amine, become acquainted with the different types of telephone instruments on display in the Show Room at L M Ericsson's Head Office.

Norwegian Telecommunications Administration Celebrates 100th Anniversary

The Norwegian Telecommunications Administration recently celebrated its 100th anniversary. The event was commemorated at a festival gathering in the Aula of Oslo University, attended by King Haakon, Crown Prince Olav and Princess Astrid at the head of a numerous assemblage of Norwegian and foreign guests. Among the gifts received by the Director General Mr. Rynning-Jönnesen, on behalf of the Administration, was a bronze statue by the Swedish sculptor Axel Wallenberg—a part of his Arild group in Hälsingborg. The statue was presented on behalf of L M Ericsson by the President, Mr. Sven T Åberg.

L M Ericsson Order for Burma

The telephone installations in Burma's capital city of Rangoon were razed to the ground during the war. The city authorities have since been compelled to solve the telephone problems of Rangoon by means of military type exchanges and a rather makeshift external line plant. The number of telephones in Rangoon is at present about 3,000.

Experts have spent several years in studying the suitability of various automatic systems to the needs of Rangoon; the choice finally fell to L M Ericsson's system, which will also be the first automatic telephone system to be used in Burma. The contract will cover three automatic exchanges with a total of 8,300 lines, further a widespread underground cable system, private manual branch exchanges for 3,000 lines and about 7,000 telephone instruments. The work is to start in the summer and is expected to be completed by the beginning of 1958.

(Top right.) Withdrawal of the break plugs from the main distribution frame. (Below.) The Halmstad exchange.

Automatic Telephones in Halmstad after Year's Work by L M E

A few minutes past 5 a.m. on Sunday, January 16, the first dialled telephone call took place over the new Halmstad exchange, which caters both for local and toll traffic. The exchange, on which work was started by L M Ericsson on February 1, 1954, has an ultimate capacity of 25,000 lines.

The conversion to automatic operation in the Halmstad area, with its present capacity of 13,700 lines, represents a new milestone on the road to total conversion of the Swedish telephone system. The plan, which started in the early 1920s, has now progressed so far that about 70 per cent of the telephones in the country are served automatically.

The local exchange—500-selector system of so-called Åmål type—with 9,600 lines in service out of its ultimate capacity of 13,000, and the toll exchange with roughly similar quantities of equipment, were both constructed by L M Ericsson.

The Halmstad area also comprises 13 terminal exchanges, directly connected to the Halmstad group centre, and a junction centre in its turn serving eight terminal exchanges. The Swedish Telecommunications Administration has itself assumed responsibility for these latter exchanges.

Awards of the Gold Medal, instituted by L M Ericsson in 1944, were made to veterans of the firm in December at the Stockholm Town Hall. The oldest in service among the 38 medalists was Gunnar Johansson (centre), who started his career with L M Ericsson in 1911 and has thus been with the firm for 43 years. On his left are Alfred Carlsson and Anna Thorsell, and right Ester Uddén and Inge Enander, Head of the Buying Department.

U.D.C. 621.38: 621.395.722

SVALA, G: *Electronic Identifier for Subscriber's Stage*. Ericsson Rev. *32* (1955) No. 1 pp. 2—7.

During the latter part of 1953 an identifier made up of cold cathode tubes and other electronic components was put into service at the Centrum Exchange in Helsinki. The apparatus was evolved to solve a particular problem and is, therefore, to some extent unique, but at the same time it constitutes an instructive example of the application of electronics to automatic telephony and has already provided valuable experience for future developments in this direction. As it may be considered to be of fairly general interest, an account of its construction and method of operation is given in this article.

U.D.C. 621.316.054.42

SCHMIDT, K & FORCHHAMMER, N: *Series Capacitors in 6—20 kV Overhead Transmission Line Systems*. Ericsson Rev. *32* (1955) No. 1 pp. 8—15.

Sieverts Cable Works' series capacitors have proved an efficient means of improving voltage regulation in distribution systems. A capacitor of this kind was delivered to the Bornholm Electricity Works at Rønne in the summer of 1953 for their 10 kV line. An account of the installation and its operation was given at the annual meeting of the Association of Danish Electricity Works in September 1953. The main points from the two addresses at that meeting are dealt with in the present article.

U.D.C. 621.317.39: 531.76

SVENSSON, Å: *New Electronic Time Meter*. Ericsson Rev. *32* (1955) No. 1 pp. 16—20.

L M Ericsson have designed and recently started to market a new electronic time meter LMK 2201. The wide range of the meter permits measurements from fractions of milliseconds up to 10 seconds which, added to its possibility of direct connection to the test object, gives it a large field of applications. The article describes the operation and construction of the meter and concludes with some examples of the measurements it can perform.

U.D.C. 621.397.62

NILSSON, B & ENFORS, U: *Ericsson TV Receiver*. Ericsson Rev. *32* (1955) No. 1 pp. 21—24.

Svenska Radioaktiebolaget, which has manufactured Ericsson radio sets for many years, has now started to produce television sets as well. This article describes the three types of television receivers with generally similar chassis which Svenska Radioaktiebolaget is now marketing.

U.D.C. 621.385.1: 621.395

EDSMAN, S: *Long Life Electron Tubes 18AQ5//6AQ5L and 18C51//2C51L*. Ericsson Rev. *32* (1955) No. 1 pp. 25—28.

In an article in Ericsson Review No 3/1954 mention was made of certain measures that had been taken in the development of S. E. R.'s long life tubes, types 18J6//6J6L, 18AK5//403B and 404A, and the results were given of life tests on these types. The present article deals with the remaining types 18AQ5//6AQ5L and 18C51//2C51L.

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Telefon Fabrik Automatic A/S *København K,* Amaliegade 7, tel: C 5188, tgm: automatic-københavn

Dansk Signal Industri A/S *København F,* Finsens Vej 78, tel: Fa 6767, tgm: signaler-københavn

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AB Ermex *Solna,* tel: 27 27 25, tgm: elock-stockholm

AB Ermi *Ulvsunda,* tel: 26 26 00, tgm: elmix-stockholm

AB Rifa *Ulvsunda,* tel: 26 26 10, tgm: elrifa-stockholm

AB Svenska Elektronrör *Stockholm 20,* tel: 44 03 05, tgm: electronics-stockholm

L M Ericssons Driftkontrollaktiebolag *Solna,* tel: 27 27 25, tgm: powers-stockholm

L M Ericssons Svenska Försäljningsaktiebolag *Stockholm,* Kungsgatan 33, tel: 22 31 00, tgm: ellem-stockholm

L M Ericssons Signalaktiebolag *Stockholm Sv,* tel: 19 01 20, tgm: signalbolaget-stockholm

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Corp. Sudamericana de Teléfonos y Telégrafos S. A. *Buenos Aires,* Belgrano 894, tel: 332071, tgm: cartefe-buenosaires

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Cia Comercial de Administración S. A. *Buenos Aires,* Perú 263, tel: 305011, tgm: cecea-buenosaires

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Thoresen & Co. (Malaya) Ltd. *Singapore,* P. O. B. 653, tel: 6818, tgm: thoresenco-singapore

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Georgiades, Moussa & Cie *Damas,* Rue Ghassan, Harika, tel: 10289, tgm: georgiades-damas

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Reunert & Lenz, Ltd. *Johannesburg,* P. O. B. 92, tel: 33-5201, tgm: rockdrill-johannesburg

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Cuba

Mc Avoy y Cia *Havana,* Apartado 2379, tel: U-2527, tgm: macavoy-havana

Curaçao N. W. I.

S. E. L. Maduro & Sons, Inc. *Curaçao,* P. O. B. 172, tel: 1200, tgm: madurosons-willemstad

República Dominicana

García & Gautier, C. por A. *Ciudad Trujillo,* Apartado 771, tel: 3645, tgm: gartier-ciudadtrujillo

Ecuador

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Guatemala

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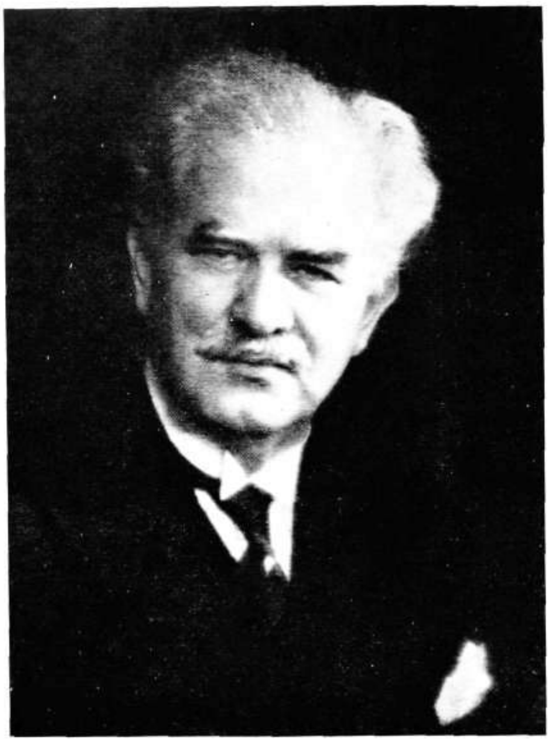


In Memoriam

A front-rank personage and pioneer in Swedish telephone industry has passed away after having devoted 60 years of his life to the world-wide activities of Telefonaktiebolaget L M Ericsson.

Hemming Johansson was born on May 8th 1869. After matriculating in 1888 he became B.A. 1890 and passed the Royal Institute of Technology 1893. In the same year he was appointed Exchange Engineer at Stockholms Allmänna Telefonaktiebolag and five years later he joined the L M Ericsson Company as Chief Engineer. In the period 1909—1925 he was Managing Director of the company and for 50 years member of the board of directors. His experience and knowledge have been claimed by other boards in the Ericsson concern and elsewhere. He has been a member of the State Trade and Industry Commission, governor in the Swedish Broadcasting Corporation, chairman of the Radio Manufacturers Association and the Swedish Society of Electrical Engineers.

Hemming Johansson has in a very noticeable way contributed to the higher technical education both as committee member of the Swedish Society of Electrical Engineers and for many years in the chair of the sectional advisory committees for the electrotechnical education at the Royal Institute of Technology and the Chalmers Technical High School.

In 1941 he was awarded the large gold medal of the Royal Academy of Technology and in 1944 he was made an honorary doctor of technology.

The exceptional and successful achievements accomplished by Hemming Johansson in the development of the Swedish telephone engineering are well known. He was one of those who raised and developed the enterprise of L M Ericsson to a worldwide industry and to this task he devoted all his brilliant talents, his singular energy and knowledge.

In the latest years he was engaged in writing the *history of the Swedish telephone industry from 1876* with special reference to Telefonaktiebolaget L M Ericsson. The first volume of this work was ready from the printers a few years ago and he has also as a whole been able to complete a continuation.

His friends and colleagues deeply regret his passing away and will remember him as a distinguished, kind-hearted and trustworthy gentleman.

Bernhard Wahlquist

Selective Calling Telephone Systems for Railways

M LINDEROTH, SWEDISH STATE RAILWAYS ADMINISTRATION

U.D.C. 621.395.24:656.254.15

The arrangement which in telephone engineering is referred to as party lines, has since the early days of railway telephony been used for such service telephone lines which have been drawn along the track and have provided means of telephone communication primarily between the railway stations. The railway telephony, in the first place with automatic operation, has in recent years been considerably developed and it is nowadays generally accepted that the railway party lines are constructed as selective calling lines. The present requirements are that the calls must be selective and that the cooperation with other lines and automatic exchanges must be provided for in a rational manner.

It is, however, clear that selective calling lines also can have other applications, for canals, motor high roads, floating ways and similar and for a great number of types of undertakings where the telephone problems are more or less identical with those of the railways.

A short description will be given below of the railway selective calling lines and the requirements of the telephone communication which these will cover.

The telephone requirements for the track

At least in case of the Swedish railways it is a general rule that stations and other service positions have telephone requirements which are in excess of what a single selective calling line can cover. It is, therefore, nowadays usual that a number of "parallel" selective calling lines are arranged when the telephone equipment for a track is modernized. In fact a way-station on a *main line* is often provided with a number of selective calling lines of the order 7 or 10. In junction stations the lines may even amount to twice this number or more. On track sections which *do not rank as main lines* 2, 3, 4 etc. parallel selective calling lines are arranged according to requirements and number of line pairs available.

It has been established that there is a certain relationship between the calling rate on a track and the amount of train traffic and attempts have been made to work out an approximate formula for the relationship between the calling rate in reference to telephone minutes per hour at peak load and the train traffic expressed in train kilometers per year. By such a formula it would be possible to prognosticate the required number of line pairs for a certain track section.

In view of the considerable capital investment which as a rule is necessary for the arrangement of each line pair, the telephone technician is aiming at equipment and line application which will give an optimum of utilization. If the selective calling system is constructed for automatic cooperation with the public telephone system a fundamental basis is established for a good line utilization. In order to attain an optimum, however, the parallel selective calling lines should, of course, be planned in such a way that they may be used as much as possible in common by the telephone positions involved. From this follows the requirement of equivalence as regards equipment, line arrangement and numbering.

The endeavour of the telephone technician to obtain good line economy will, however, collide with the wishes of the train operating staff to control selector lines of their own for *particular* telephone requirements. This desire is easy to understand and can be traced to the days before automatic operation was introduced. The gradual additions of telephone lines along the track resulted in those days often to special uses for each line. It has, however, proved advisable to retain certain special lines even after the introduction of automatic operation and after the heavy increase in the use of the railway service telephony. A very typical instance is *the track telephone line;* another is *the power telephone* when the track is electrified. These two lines fully retain their character of specially equipped individual line pairs.

Selector lines for the special telephone requirements of the track

Track telephone

The track telephone line, which incidentally this year (1955) has been in existence in Swedish railway engineering for just half a century, is the special service line for the track maintenance. The communications on the track telephone, thus, refer to orders and information between the section master and the track personnel regarding maintenance and other activities along the track, information between stations and the same personnel regarding alterations of the time table, special trains and similar matters and to a certain extent also calls of more local character. Nowadays the track line is constructed as a selective calling system. The line is sectionalized comparatively easily which is due on the one hand to the extensive number of telephone positions and on the other to the sectioning mostly following the division of the track maintenance. It should be connected to a great number of service posts other than the station offices and the linemen's huts. There are also the section masters' offices, stores and similar places.

Power telephone

With reference to the other of the above mentioned special lines—*the power telephone*—this is, as the name implies, the special service line for the electric traction system. In character it is very similar to the track telephone as regards the large number of instruments connected and comparatively close sectioning, but it is nevertheless difficult to equip it quite in the same way as the track telephone. Naturally the power telephone should by priority be available to the power distribution centres (the converter stations) and should in fact be dominated by them. This line communicates information regarding faults in the power distribution network and orders referring to fault segregation, cuts and circuit rearrangements. It is, therefore, of utmost importance to the traffic operations that the power telephone line is always ready and available for its special purpose.

From the above follows that the power telephone line if possible should be sectionalized at the power feed boundaries for the track electricity supply. A selective calling system has the advantage that cooperation between different sections can be easily arranged by means of a code digit and independent of manual switching. Although normally a suitable sectioning means that the bulk of the calls is restricted within the section itself (including the principal station), such cooperation with adjacent sections is nevertheless of great importance.

As the two special lines mentioned above are only intended for local traffic and to some extent to calls of short distance character, the transmission properties of the lines are not of great importance. It is possible to use comparatively thin (but loaded) line pairs. Amplifiers can be dispensed with. Consideration has, however, to be paid to the common call which will occur on these lines and which is intended for special instructions and information. As this means that a great number of instruments on the section will be simultaneously connected to the line, the impedance of the selector instrument must be matched for such a common call. L M Ericsson has developed a special instrument for this purpose.

Train dispatcher's telephone instrument

To the special telephone facilities required for the track should also be included the train dispatcher's communication to stations and other service positions. The tasks and functions of a train dispatcher varies in different countries and in different railway administrations. A common feature is, however, that the train dispatcher supervises and directs the train operation within his section. For this purpose he must be able to receive information regarding dislocations in the traffic and to issue instructions regarding the run of the trains, rearrangements, special trains, engine and truck disposals etc. He should in addition be able to receive acknowledgements from instructed service positions and also to establish connection with train dispatchers and engine masters of other sections in a prompt and easy manner.

Especially in case of traffic dislocations much depends on the prompt connection of the train dispatcher's calls. In actual practice train dispatcher's calls, therefore, have priority over other calls. It would, therefore, seem reasonable to demand a separate line along the track for this purpose. Such an arrangement has, however, not proved justified at least not for the Swedish railways except in the case of real main lines with intensive traffic. In spite of the importance of the train dispatcher's calls it is actually as a rule sufficient by means of special equipment to arrange priority for the train dispatcher to the selective calling lines which can be used also for other purposes. In this way the utilization of the selective calling lines is increased. The train dispatcher's priority facility means that he can obtain connection to the line even if this is engaged, to cut down calls in progress—with or without warning—and to dial the required number irrespective of the previous circuits being disconnected by the replacement of the handset.

The track sections supervised by a train dispatcher are comparatively extensive. It is, therefore, not necessary that the selective calling lines, used

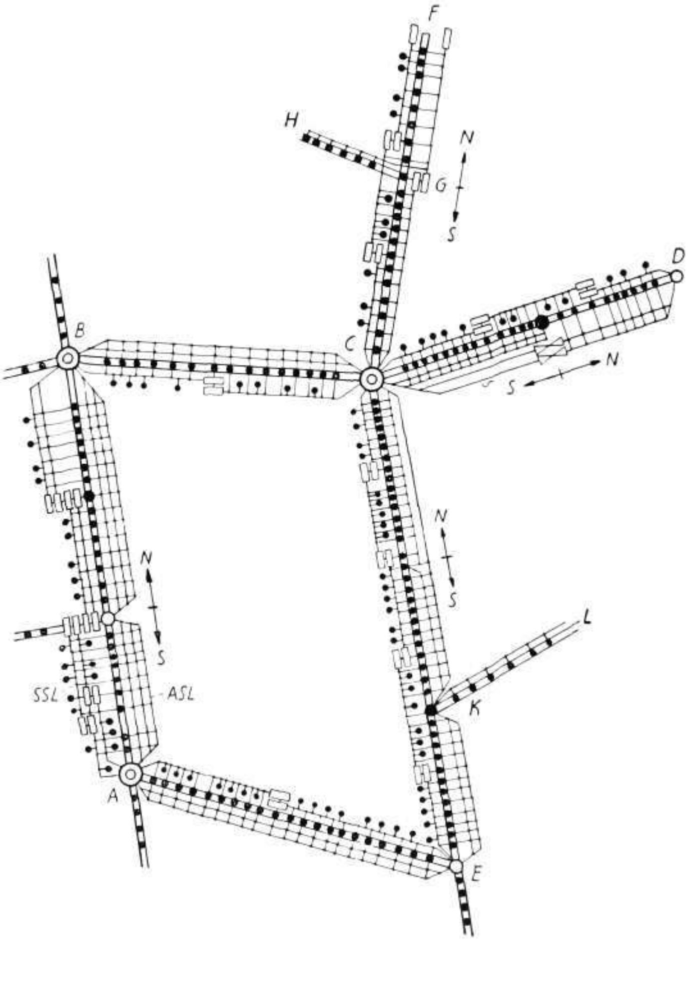


Fig. 1 X 6879 X 9135

Lay-out of the selective calling lines in a section of the railway network

- ◎ Junction station in the long-distance network
- ○ Terminal station in the long-distance network
- ● Sub-exchange (selective calling exchange)
- Sectioning of selective calling line
- Section of track with stations
- ASL Selective calling line for general calls
- SSL Selective calling line for special calls
- ~ Line portion with A.C. signalling

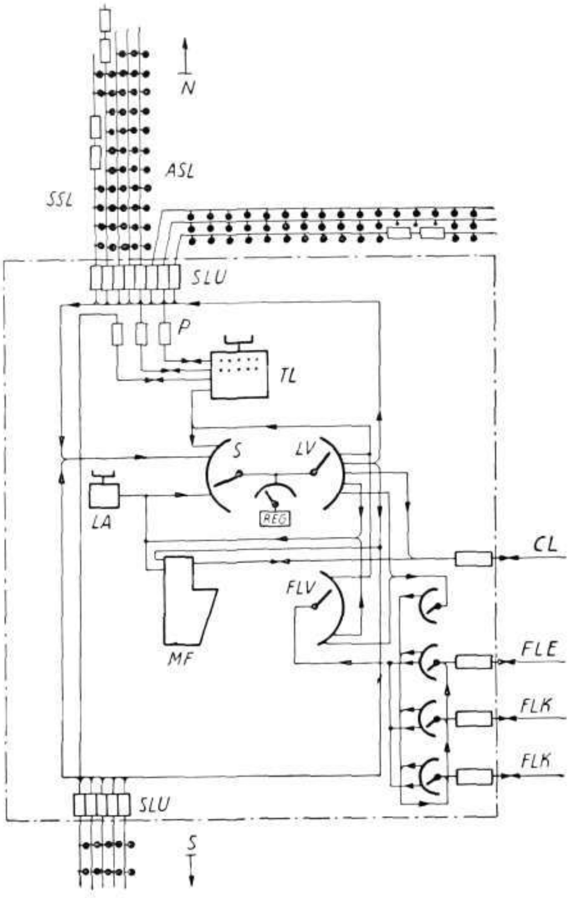


Fig. 2 X 6894

Simplified routing diagram for junction station exchange and train dispatcher's equipment. Corresponding to principal station A in fig. 1

SLU Selector equipment
P Priority equipment
TL Train dispatcher's equipment
S Line finder
LV Line selector
LA Local extension
MF Manual switchboard
FLV Long-distance selector
CL Exchange line
FLE Long-distance line to terminal station
FLK Long-distance line to junction station

by the train dispatcher, are very closely sectionalized. Actually the lay-out of these lines can often coincide with the selective calling lines for *general service calls*. Such a general selective calling line can, therefore, often with advantage also be used as train dispatcher's line by the inclusion of priority and other special train dispatcher's equipment.

Selective calling lines for the general telephone requirements of the track

Apart from the above special, local calling facilities the track also requires equipment for general service calls. These refer—apart from general queries between the stations—essentially to administrative matters, management, ticket and freight inquiries and similar transactions between the way-stations and their principal stations. To this should be added the telephone facilities required by the track section to be placed beyond the principal station including not only selective calling lines but also long-distance lines.

The transmission properties must naturally be better for the general selective calling lines than those required for the special lines. In a long-distance connection a general selective calling line will be included on the calling side as well as on the called side without the total attenuation in the connection exceeding a permissible maximum.

As a great number of track telephone positions will be sufficiently provided for by special lines, the instrument density on the general selective calling lines will be very much reduced. It is, therefore, not necessary to sectionalize these lines very closely.

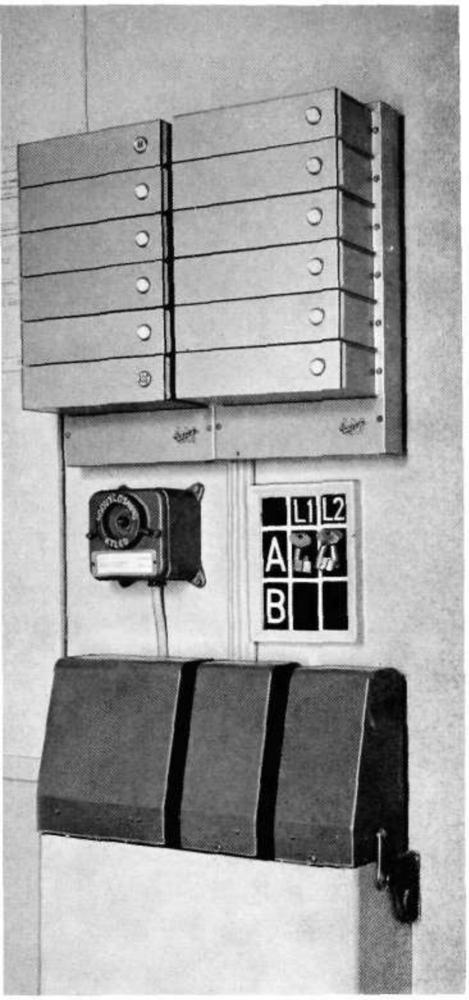


Fig. 3 X 2037

Installation of selectors and line connection set on a small track station

Fig. 4 X 2042

Manual line connection set for 10 (12) lines

Selective calling lines in the railway telephone networks

The application of the above principles of the L M Ericsson selective calling system is illustrated in fig. 1 which represents a portion of a railway network including selective calling lines. In this network the lines along tracks A—B and B—C—D are assumed to be run in cables and remaining sections by overhead lines.

The planning of the selective calling lines is often determined by the number of lines available rather than by the calculated amount of telephone traffic. The number of available lines is usually limited on sections which are not yet provided with cables.

The data quoted in the table below give an indication of the lengths, traffic volume and number of telephone positions for the track sections included in the network portion.

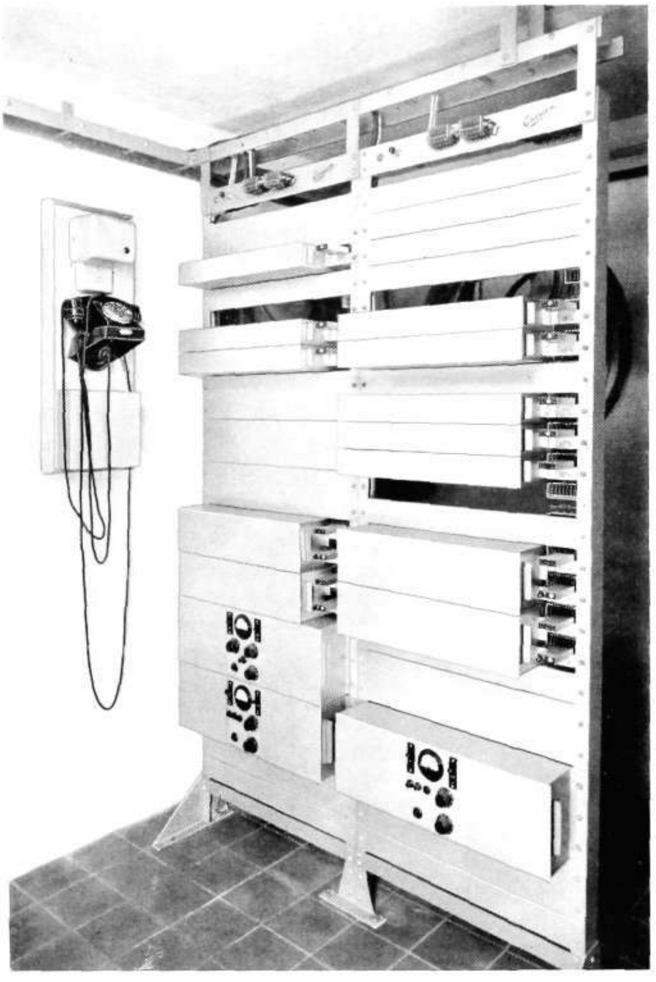
Track section		No. of lines		Train kilometers per year per 1000	No. of selective calling extensions on ASL	
designation	length km	SSL	ASL		S	N
A—B	175	2	3	2 500	11 +	18
B—C	90	1	2	1 200	16	
C—D	160	1	2	1 000	18 +	13
C—E	300	1	2	1 000	14 +	19 + 13 (K-E)
C—F	180	1	1	900	16 +	15
A—E	120	1	2	600	17	
G—H	20		1	200	5	
K—L	75		1	150	9	

In a modern railway telephone network the telephone exchanges are nowadays made for automatic operation. The exchanges are as a type a combination of automatic rural exchanges and PABX exchanges. In fig. 1 exchanges of junction station type have been indicated in the large places. Other exchanges are made for terminal stations. It should be assumed that the junction stations are mutually connected by adequate long-distance lines and that the terminal stations are connected star-wise to the junction stations over direct terminal exchange lines. The large exchanges often include a manual switchboard with an operator. In fig. 2 a simplified routing diagram is shown for a junction station corresponding to that indicated at A in fig. 1. A small automatic exchange—referred to as sub-exchange or selector exchange—is included in certain small stations where it on the one hand serves as a local exchange and on the other connects the local telephone positions over the selective calling lines to the other telephone network.

The general selective calling lines should consistently be arranged for connection to the telephone exchanges. As regards the special lines on the other hand there is sometimes a danger of the connection to telephone exchanges giving rise to unwanted connections which may impede the required special telephone traffic on the lines. Usually it is, however, advisable to make provisions in the exchanges for connection facilities for all selective calling lines.

Installation of selective calling systems

As a rule the space available for the railway telephone equipment is very limited. The L M Ericsson selective calling system for D.C. (*ATA 10*) is, however, designed with this scarcity of space in mind. The equipment is, thus, characterized by a pronounced concentration as regards the telephone positions



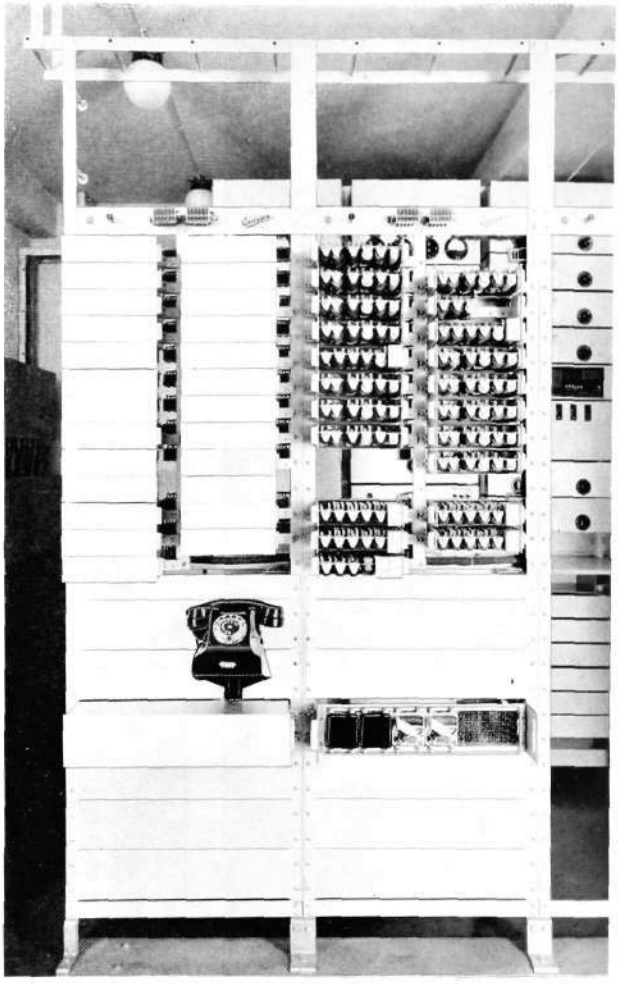


Fig. 5 X 6883

Medium sized sectioning position for selective calling lines

Fig. 6 X 6884

Installation of fully automatic and semi-automatic line connection equipment in a large station

Left, fully automatic line connection equipment (covers fitted), right, semi-automatic line connection equipment (covers removed)

as well as the power supply and sectioning positions. On the way-stations along the track the selectors and the power and ringing units are mounted as detachable units in extension frames which generally are fitted on the wall in the ticket office together with the line boxes. As only small accumulators (4 V) are required these may be placed inside the protection cover for the cables. An example of such an installation is illustrated in fig. 3. The line connection set, fig. 4,—in this case for maximum of 10 (12) lines—is designed as a key base for a normal selector telephone instrument.

In a sectioning position the installation may be made as shown in fig. 5. The racks take equipment for 10 selective calling lines including relay sets required for the connection of the lines to a telephone exchange. To the left on the wall is shown an example how the selector, telephone instrument and battery box have been assembled to a unit suitable for certain positions on a single selective calling line, for instance, on a track telephone line.

For stations at junctions, where the station staff must have immediate access to 10 or 20 selective calling lines, the line connection problem is more complicated. The selectors and relay equipment for the line connection set are placed in a separate room. The line connection sets may be deviced either for push button operation with one push button per line or for dial operation. In the first case a special push button instrument must be used, in the second case an ordinary telephone instrument with dial. The rack equipment for these "semi-automatic" and "fully automatic" line connection sets are shown in fig. 6 where both types are shown in the front row.

Standardization, erection rate and maintenance

The reliability of the train traffic depends to quite a high degree on the sufficiency and reliability of the telephone connections. A logical and uniform planning and supply of telephone equipment promotes good operation results. A fairly severe standardization must, therefore, be recommended as regards the selector material.

A mixture of different systems complicates the installations and makes the maintenance difficult. At the Swedish railways the installation of L M Ericsson selective calling system has been on a steady increase since its introduction 1934. The total length of track in traffic at the state railways amounts to roughly 15,000 km. In 1945 the state railways utilized 16,000 km of telephone lines provided with the L M Ericsson selective calling system corresponding to about 3,500 selectors. At present the corresponding figures have risen to approximately 50,000 km and 11,000 selectors.

The favourable operation results, on which these considerable purchases of L M Ericsson selective calling equipment naturally are based should, however, not be attributed to the selective calling system alone. It is true that the reliability of the modern telephone relays and other components, the construction of the system with relay sets easily mounted and dismounted etc. has contributed in no mean way to the reduction of the maintenance cost and the low fault rate. But the rational supervision of the selective calling installations by the maintenance staff obviously plays an important part even in this case.

As in the case of other automatic telephone material purely electrical faults are rare also on selective calling equipment. The faults which occur are essentially of mechanical nature and are traced and repaired—through adjustment and cleaning—by the application of exactly the same methods as used on telephone exchanges. In addition the circuit engineering and lay-out for the L M Ericsson selective calling equipment have their full counterparts in the automatic telephone exchanges from which the selective calling system also has been developed. It is, thus, natural that a common maintenance staff can be used for selective calling system and automatic exchanges and that the instruction and training in selective calling telephone engineering can take place as a subject based on automatic exchange engineering.

Applications for the L M Ericsson Telephone Answering Machine in Telephone Exchanges

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U.D.C. 621.395.625.3:621.395.722

The L M Ericsson telephone answering machine has earlier been presented in Ericsson Review No. 4, 1953. A detailed account was given of the design and function of this machine as well as expected applications for different categories of telephone subscribers.

In the article below a description is given of some of the application possibilities for the telephone answering machine in telephone exchanges for such purposes as weather forecast announcements and transfer messages to calling subscribers in case of temporary redirections of the traffic on fully automatic circuits.

The principal application of the telephone answering machine is to be found with subscribers such as doctors, solicitors and small business and tradesmen. The answering machine is then used in place of a secretary when no one is available to answer the telephone. Also in case of large offices and companies the answering machine can serve a similar purpose after office hours and during holidays. The machine is also being used for the newspaper information service, "telephone news". For such a service a number of answering machines is used all being arranged for common message recording and connected to a group number.

A rather special application range has been found for the telephone answering machine in telephone exchanges and this will be made the primary subject of this paper.

Weather forecast announcements

The first instance of the telephone answering machine being used in telephone exchanges is no doubt its application to weather forecast announcements. The equipment includes two telephone answering machines, one for normal use and one in reserve, as well as relay sets for the reception of up to 16 simultaneous calls. In order to allow simultaneous transmission for this number of calls each answering machine has been provided with an additional booster amplifier. The output impedance for the booster amplifier has been arranged extremely low in order to prevent cross talk between the simultaneously calling subscribers.

The lay-out for the announcement equipment with telephone answering machine is shown in fig. 1.

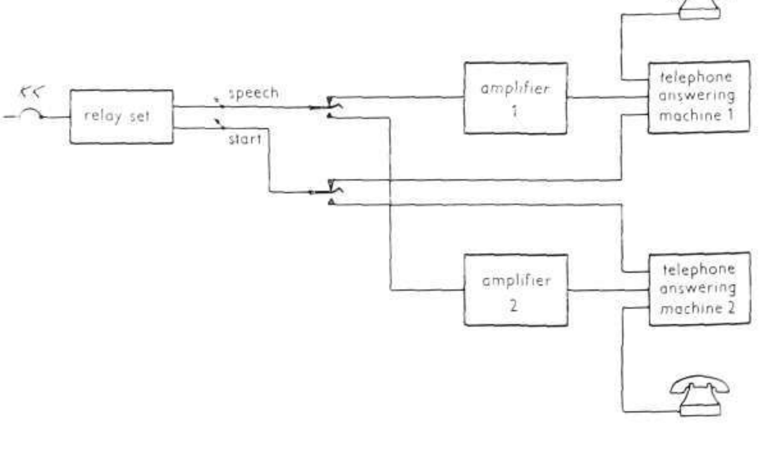


Fig. 1 X 6886

Lay-out of weather forecast announcement equipment with telephone answering machine

KK = distribution frame

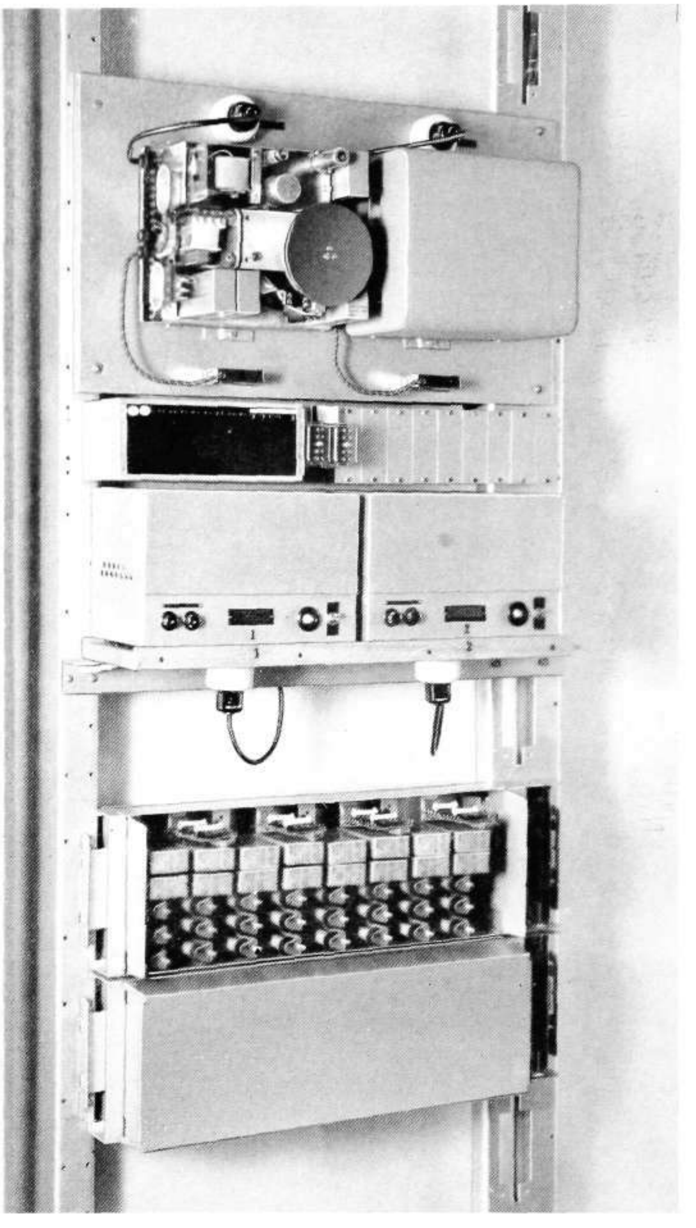


Fig. 2 X 6892

Rack with announcement equipment for weather forecasts with telephone answering machine

Fig. 2 illustrates a rack with announcement equipment for weather forecasts. The two telephone answering machines are mounted at the top of the rack and below these the jack box and the fuse blocks for the rack. The amplifiers are placed on a shelf under the jack box and further down two relay frames are mounted each containing 8 test relay sets. The bottom of the frame holds an alarm relay set as well as change-over and cut-out relays.

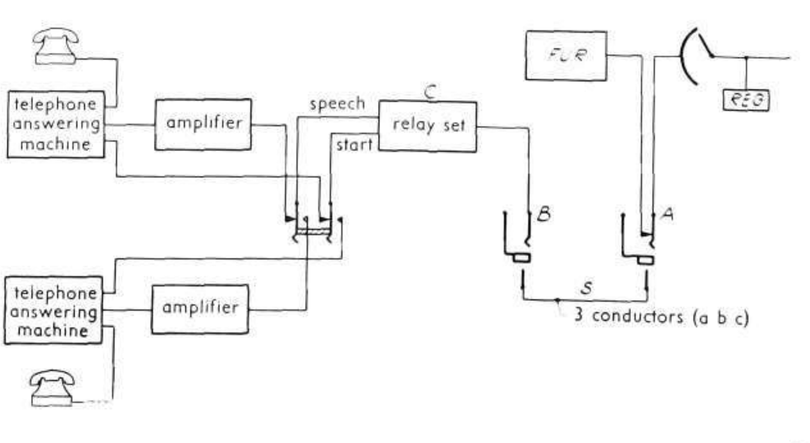


Fig. 3 X 6887

Lay-out of transfer message equipment with telephone answering machine

A, B jacks
C relay set
FUR repeater relays
REG register
S cord

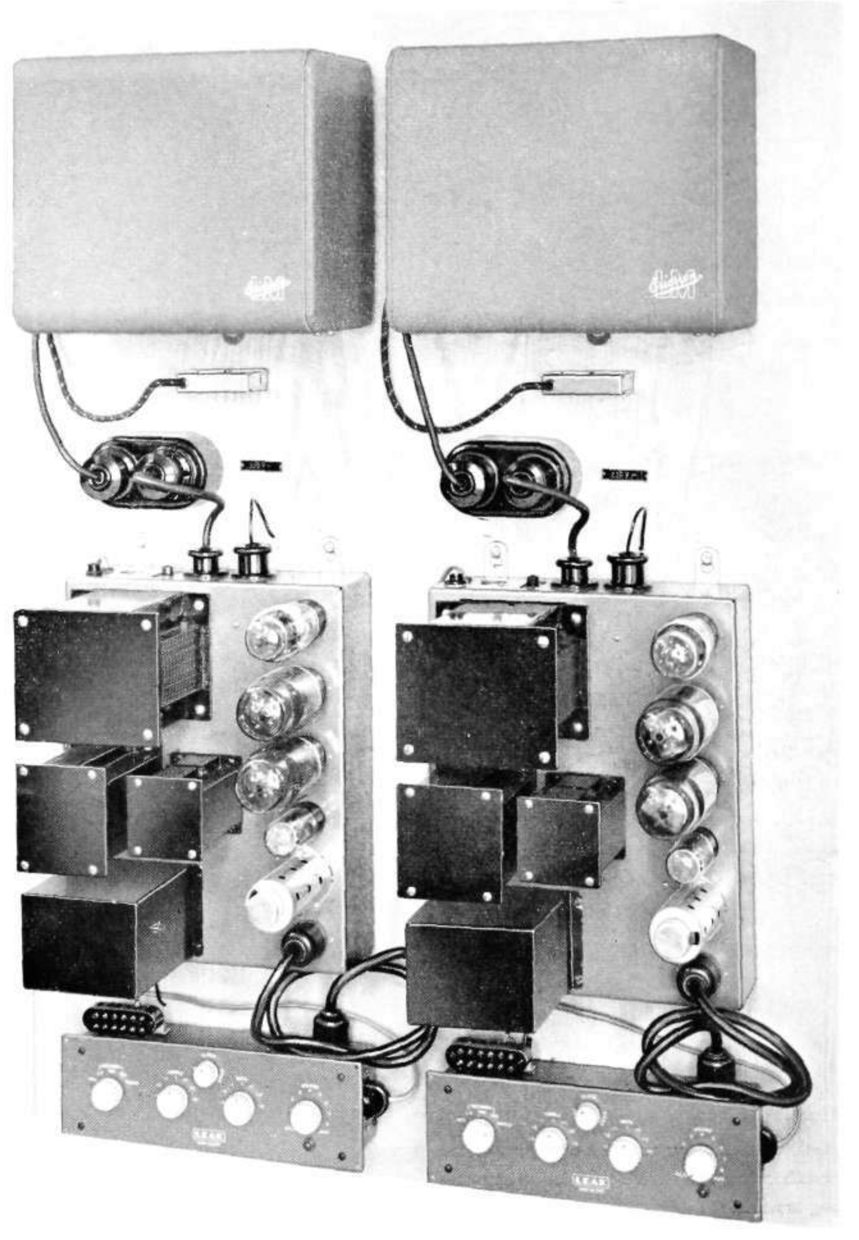


Fig. 4 X 6893

Transfer message equipment with telephone answering machine

The test relay sets are arranged in such a way that they provide instantaneous answering marking but they are not equipped for limitation of the listening time. When a call is received by a test relay set, the telephone answering machine is started from the relay set. If the answering machine has already been started by another relay set connection takes place at an arbitrary moment during the play-up in progress. The relay sets contain circuits for occupation and traffic metering.

Recording is carried out from a separate recording room by means of an ordinary telephone instrument.

Transfer messages

The telephone answering machine has also been used in telephone exchanges for the purpose of supplying information to calling subscribers, for instance, in case of faults on fully automatic trunk circuits and to supply instructions how to obtain connection to a temporary operator service. The telephone answering machine is then connected to the outgoing junction line between the outgoing group selector and repeater relays. This connection is prepared for the largest junction lines in such a way that certain connections, usually the last ones in the grading of an outgoing group selector, are connected over cut-off jacks in the relay rack for the transfer message equipment as shown in fig. 3. By means of this prepared connection it is possible to arrange a transfer message quickly in case of a fault or when other reasons call for a redirection or temporary rearrangement of the traffic. Telephone answering machines are then connected by plugging in a cord between the two jacks A and B (fig. 3) in the transfer message rack.

When a call is made on a junction line connected for reference instructions test takes place to a relay set C instead of the normally connected repeater relay FUR. The relay set C effects disconnection of the register previously linked in the circuit and line connection to the calling station is obtained. The relay set then connects the relevant telephone answering machine, which is started, and the transfer message is transmitted to the calling subscriber. If the answering machine has already been started by another relay set, connection takes place during the play-up in progress. The machine repeats the message while the caller remains connected. For transfer messages no count is made on the subscriber's meter.

The transfer message equipment, which so far has been installed for outgoing fully automatic junction lines, includes two telephone answering machines each with a booster amplifier. The answering machines with their amplifiers are mounted on a wooden base which in turn is mounted in a normal relay rack as shown in fig. 4.

The equipment also includes a number of relay sets mounted in relay frames. Each frame holds relay sets covering 4 junction lines. The corresponding jacks and keys are mounted in a separate jack panel in the relay rack. Recording on the telephone answering machines is carried out by means of ordinary telephone instruments which are placed in a tolerably silent room.

The telephone answering machine is also being used in telephone exchanges to provide a message in place of the transfer signal which normally is obtained when a call is directed to a number connected for transfer or number unobtainable. The reason for this is the difficulty of making the subscribers understand the meaning of the transfer signal. By supplying a recorded message from an answering machine misunderstandings will be avoided and the caller will receive word for word instructions regarding the number to the operator who will supply further particulars of the reason for the transfer connection.

When the transfer signal is going to be completely replaced by the telephone answering machine this must be connected over an amplifier to the common point for the buzzer windings which previously transmitted the transfer signal. The message from the answering machine will consequently be transmitted over a buzzer winding and is transformed to the calling subscriber's line connection. The connection will follow from fig. 5.

The relay set included in the equipment consists of two relays only and a capacitor. The relay set provides a starting impulse for the answering machine as soon as a call is received to a number connected for transfer, segregated or not obtainable. Connection can take place at any time during a play-up. The listening time is not limited, but time supervision is connected in the normal manner to the dialled circuit. The transfer message is of course supplied without call counting.

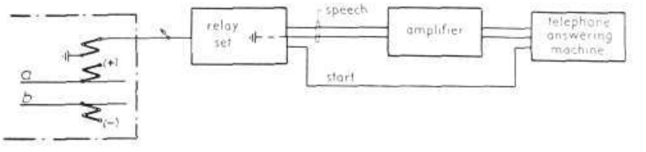


Fig. 5 X 6888

Lay-out of telephone answering machine for transfer message

As mentioned above the telephone answering machine offers several advantages in the cases described above. For weather forecast announcements the answering machine is superior to the earlier equipment with photoelectric calls and sound film disks due to the simplified technical lay-out. The capital cost of a telephone answering machine is also considerably less. A very favourable feature of the answering machine is the extended variation facilities for the recorded announcement. A completely new recording must, however, be made for each alteration of an earlier message, but on the other hand a more coherent message is obtained than that provided by the combination of the prerecorded part messages on sound film disks.

For transfer messages and information in case of faults on fully automatic junction lines the telephone answering machine has proved a very useful auxiliary. The answering machine provides facilities for a quick redirection of certain traffic in a very simple way and at low cost even for requirements not anticipated. As the answering machine supplies a direct message to the calling subscriber this facility is valuable also from service point of view as a subscriber need not be irritated by making new unsuccessful calling attempts. The direct message from the telephone answering machine to the caller eliminates the increased load with attendant congestion which will result from the repeated calling attempts or by inquiries to the operator. With regard to maintenance the message procedure has also proved convenient. When junction lines are temporarily closed for traffic, for instance, for transmission measurements, the calling subscribers can be informed about this and be recommended to make new calls later.

The use of the telephone answering machine in place of the transfer signal must be considered as a service improvement. It has not been possible to make the meaning of the transfer signal generally known to the public and this signal is very often mistaken for busy tone. Such a confusion may lead to unnecessary repeated calling attempts with additional load on the exchange equipment and irritation for the calling subscriber as a result. Even when the transfer signal is recognized, the directory will as often as not have to be consulted for the number to the operator which can supply further particulars regarding the transfer connected number.

All these inconveniencies are eliminated by the telephone answering machines as the calling subscriber is told directly where he can obtain further information regarding the transfer connection.

When a telephone exchange is converted to automatic operation, the manual department is nowadays often completely abolished even in case of large central exchanges. The remaining manually connected traffic is then transferred. to a large principal exchange manned by operators. The subscribers' attendant and transfer services are then also located to the principal exchange. It is now possible by means of the telephone answering machine to avoid manual connection for the subscribers' attendant service at the subordinate exchange. A telephone subscriber can, thus, in the usual manner arrange for transfer connection of his telephone number which results in the telephone answering machine being connected to the number and informing calling subscribers that they should call the principal exchange in order to obtain further information.

L M Ericsson's Combine-Unit System of Sound Distribution

H EKSTRÖM, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

U.D.C. 681.84.083

L M Ericsson has started to manufacture a new sound distribution system, particularly for use in schools, hospitals, at sports grounds etc. Its distinction from earlier systems lies in its special form of unit construction, which lowers the first cost and affords greater flexibility. The new system, which has been called the "Combine-Unit System", is adapted to small and large installations alike. The present article presents the general features of the system.

Fig. 1 X 2016

Central sound distribution equipment with combine-units stacked one on another

Counting from the top are the gramophone unit, three sound distribution units, radio unit, amplifier unit and two booster amplifier units

General

The main feature of the combine-unit system is that it is made up of a number of units for radio, tape recording, gramophone, sound distribution and amplification, which can be used either individually or in any desired combination. For the latter purpose the units are interconnected by jack-in cables. By a suitable choice of units a central installation can be formed which answers exactly to the initial requirements and can be very simply altered for future needs. Thus an installation starting from one or two units can be successively extended as required. The additional units can be placed either beside or on top of the existing ones, whichever arrangement is found to be most convenient and economical in space.

The advantages of the combine-unit system over the conventional method of mounting the units in racks are manifest. Thus the initial equipment can be installed completely regardless of future needs, either in regard to the number of units or their function. Nor need material be paid for which is not immediately required. Equipment designed to be housed in a certain room can be set up in another position irrespective of ceiling height or dimensions of the new accommodation, provided only that the necessary space exists.

A central equipment consisting of units stacked one on the other, so occupying the minimum of floor space, is shown in fig. 1. A different arrangement in fig. 2 permits greater facility in the operation of the equipment.

The most common combine-units are the following:

50 W amplifier unit ZGA 3901
50 W booster amplifier unit ZGA 3911
Gramophone unit with record changer KTC 2011
Radio receiver unit KTE 1001
Tape recorder unit KTB 2001
Sound distribution unit, 10-line, BGL 1101.

Every unit is contained in a metal case with drab rough-enamelled finish. All controls—knobs, selectors and tappings—are conveniently accessible from outside and equipped with readily visible scales and designation plates. The side walls are ribbed to ensure good ventilation.

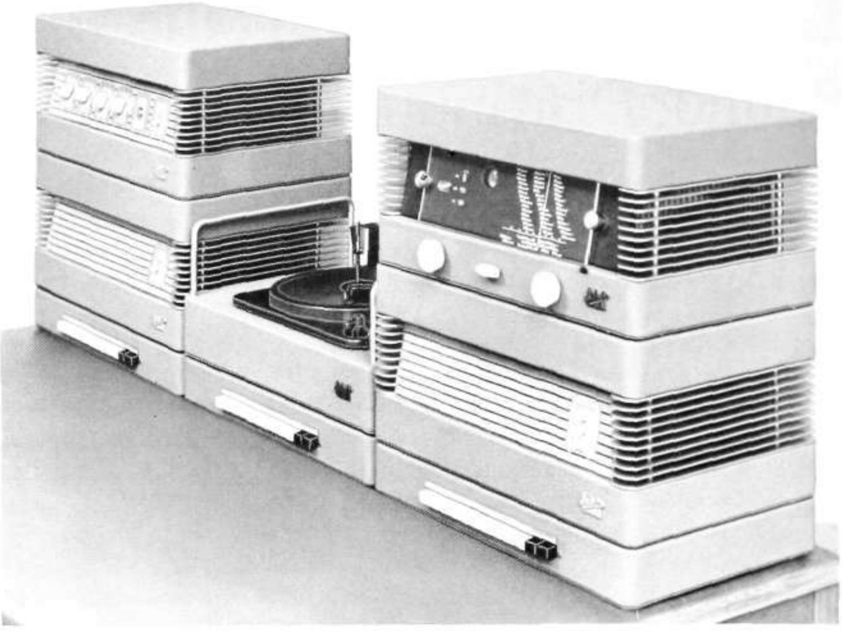


Fig. 2 X 6872

Central sound distribution equipment consisting of combine-units in studio consol

The combine-unit system has been designed for use in the form of loudspeaker installations at railway stations, airfields, open air theatres, sports grounds; as central radio equipments in hospitals, factories, schools and hotels; and for paging systems in offices and factories where for any reason acoustic signals are preferred to visual.

Having in mind these various applications, great emphasis has been laid on good sound reproduction and maximum reliability. The amplifiers are in full accordance with the Swedish Electrical Commission's class II standards for sound amplifier equipment. The combine-unit system also fulfils the requirements contained in the recommendation of the Swedish Schools Broadcasting Committee as regards the practical design of school radio installations.

All units have tappings for voltages between 110 and 245 volts a.c. Amplifier and radio units operate on 50—60 c/s, whereas gramophone and tape recorder units will only operate on 50 c/s. The change-over from one voltage to another is arranged by means of the selector switch on the rear of each unit.

Fig. 3 X 2017

Amplifier unit ZGA 3901

Amplifier Unit ZGA 3901

The amplifier unit has two individually adjustable input channels for the termination of high impedance microphones and a non-adjustable input channel for termination of the radio unit. By means of separate plugs the two high-impedance input channels can be easily modified for a low-impedance dynamic microphone, reception from local broadcasting station or dynamic, magnetic or piezoelectric pick-up and tape recorder. The amplifier output at 1,000 c/s is 50 watts with 2.5 per cent harmonic distortion, and 60 watts with 5 per cent harmonic. It is designed for 50 volts constant output voltage, according to Swedish standards, and fitted with taps for feeding a number of booster amplifiers, relays etc. The various in- and outputs are placed on a recessed connector shelf (see fig. 4). By this arrangement the plugs are protected from careless handling. All parts are over-dimensioned to provide good reliability.

Separate base and treble controls are provided, comprising two tube functions, by which means a good balance is obtained on the equalizing curve (a saddle curve). Controls and output level indicator are placed on an indirectly illuminated panel with easily visible scales.

Fig. 4 X 2018

Amplifier unit ZGA 3901

rear view with cover removed

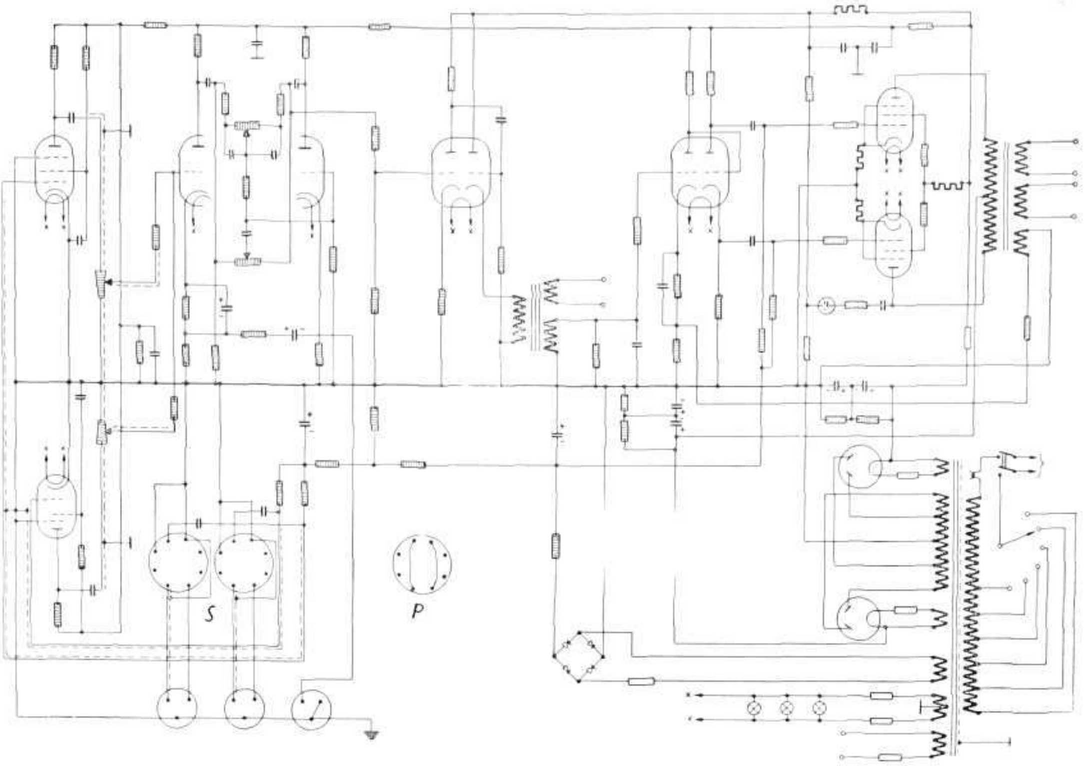


Fig. 5 X 6873
Circuit diagram of amplifier unit ZGA 3901
P plug
S jacks

The output impedances are 4 ohms and 50 ohms. There is also a 50-ohm driver output for feeding the booster amplifier units.

The amplifier unit has a frequency range of 50—10,000 c/s with a deviation of ± 1 decibel at 1,000 c/s.

The power consumption is 220 VA. The amplifier comprises the following tubes: two EF40, three ECC40, two EL34, one AX50, one AZ1, in addition to one selenium rectifier.

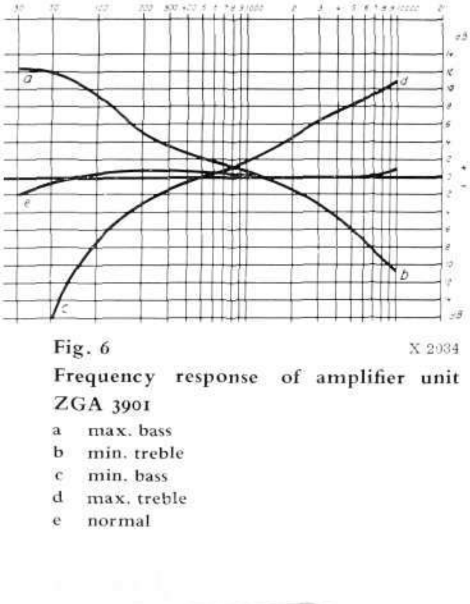


Fig. 6 X 2034
Frequency response of amplifier unit ZGA 3901
a max. bass
b min. treble
c min. bass
d max. treble
e normal

Booster Amplifier Unit ZGA 3911

The booster amplifier unit ZGA 3911 is designed on similar lines to the amplifier unit ZGA 3901, but does not contain pre-amplifier or equalizer. It has a symmetrical input channel with fixed level, and low impedance (500 ohms), designed for an input voltage of 1 V and adapted for connection to the driver output on amplifier unit ZGA 3901.

The power consumption is 210 VA.

The booster amplifier contains the following tubes: one ECC40, two EL34, one AX50, one AZ1, in addition to one selenium rectifier.

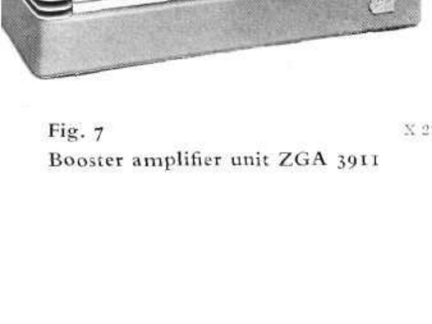


Fig. 7 X 2019
Booster amplifier unit ZGA 3911

Radio Receiver Unit KTE 1001

The radio receiver unit KTE 1001 operates on wave-bands 18—15.5, 168—580, 690—2,200 metres and has an indirectly illuminated acrylic linear scale. The scale can be easily removed from in front in the event of a revision of wave-lengths. The radio unit has combined tone and interference control and a magic eye to assist tuning. The sensitivity is 20 V for an output of 50 mW, and the selectivity 20 kc/s bandwidth at 40 db. There are six tuned circuits. Band spread is obtainable in any selected part of the shortwave band by means of the wave-band switch.

The power consumption is 30 VA.

Tubes and their functions: detector 1 and oscillator tube ECH42, intermediate frequency amplification 6BA6, detector 2 and audio frequency amplification 6AN6, output tube 6AQ5, indicator tube EM34 and rectifier tube 6X4.

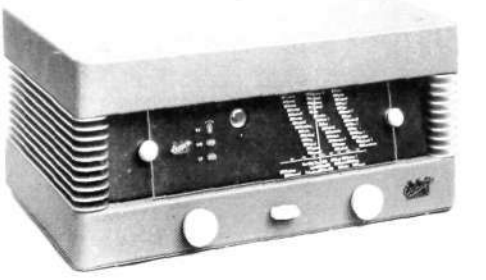


Fig. 8 X 2020
Radio receiver unit KTE 1001

Tape Recorder KTB 2001

The tape recorder unit is equipped with L M Ericsson's new *Ericorder*, a full description of which will be found in Ericsson Review No. 4, 1954. The unit is outwardly similar to the other units and is designed for connection to amplifier unit ZGA 3901. The power consumption is about 80 VA.

Fig. 9 X 2021
Gramophone unit KTC 2011

Gramophone Unit KTC 2011

The gramophone unit has a record changer for three speeds: 33 1/3, 45 and 78 r.p.m. The record changer takes ten records at a time and permits the playing of the three sizes of record (7", 10" and 12") in any order. The mechanism automatically stops after the last record has been played. The speed is changed extremely simply by turning the speed selector to one of three speeds. The heavy turntable is made of pressed steel plate and has a detachable rubber mat for protection of the brittle LP records.

The record changer has a first class crystal type pick-up with two sapphire needles, one for LP records and one for standard 78 r.p.m. records. Changing from one needle to the other is arranged by means of a small arm on the front of the pick-up. The pick-up has a wide frequency range as well as automatic compensation for the lower frequencies on the LP record. The needle pressure is only 10 grams. The record changer rests on soft suspension springs, whereby the risk of acoustic feed-back is eliminated. The gramophone unit connects to amplifier unit ZGA 3901 via a plug-in type filter included in the equipment.

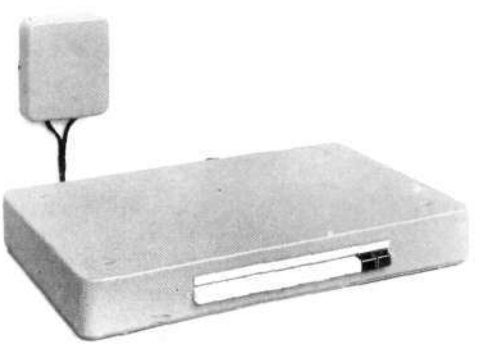


Fig. 10 X 2022
Sound distribution unit BGL 1101

Sound Distribution Unit BGL 1101

This unit is equipped with ten white keys for switching on individual loudspeakers or groups of loudspeakers, a red key for switching off all connected groups, and a black key for switching on all groups simultaneously (the "all" position). Switching to the "all" position can also be done by means of a

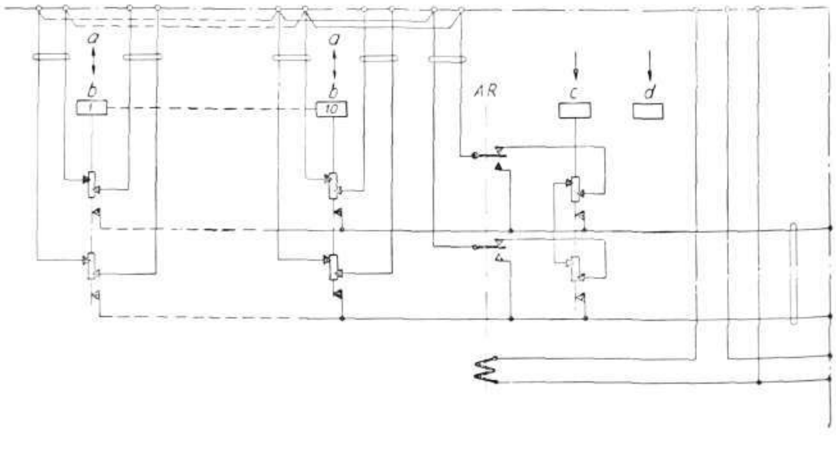


Fig. 11 X 6874
Circuit diagram of sound distribution unit BGL 1101

AR all-relay
a off
b on
c all
d restore

relay which is actuated by the depression of the microphone key. The operation of this relay connects all groups in parallel, irrespective of whether they were previously switched on or off. This arrangement is used, for instance, when communications are to be sent from any other site than the control room.

A location label is placed above each key. A terminal box, connected to the distribution unit by flexible cable, serves as central switching point for the entire central equipment. The necessary operating voltages are obtained from the amplifier unit ZGA 3901. A central equipment may comprise one or more sound distribution units of the above type, as required.

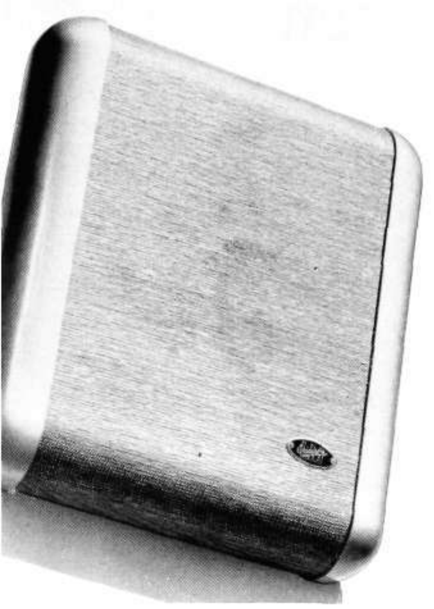


Fig. 12 X 2023
Loudspeaker RLE 268

Loudspeakers, Microphones etc.

Many different types of loudspeaker are used for sound distribution. For indoor installations there are loudspeakers with efficiencies from 2 watts up to 10 watts. They are designed for 50 V line voltage. The smallest type, RLE 267, is employed in small halls and as monitor loudspeaker. It has a 5″ permanent-dynamic loudspeaker system and built-in low-loss volume control consisting of line transformer and selector for regulation of the volume in seven steps. The selector has an absolute zero position, so that no separate switch is needed for complete silencing of the loudspeaker.

For schools and large auditoria is used loudspeaker RLA 268 (fig. 12), designed for an optimal load of about 5 watts. It has a 7 1/2″ permanent-dynamic loudspeaker system and is made with or without volume control.

Fig. 13 X 2324
Re-entrant loudspeaker

The sound-column loudspeaker RLA 269, composed of five interlinked cone loudspeaker systems, is suited to large indoor installations. Within a given frequency band it concentrates the sound to a disc-shaped area. The sound column loudspeaker has a high efficiency and is designed for an output of about 10 watts.

For outdoor use and indoor accommodation with poor acoustical conditions the re-entrant type loudspeakers are recommended. One of these is shown in fig. 13. These loudspeakers are insensitive to weather and wind and have a very high efficiency.

All types of indoor loudspeaker have beige-coloured plastic sides.

In hospitals and homes for the aged, headphones and pillow-speakers are used. They are connected to the distribution system via central radio outlets, which are supplied for one or two jacks, with or without volume control.

Fig. 14 X 2033
Cardioid microphone 55 C

To cater for the special demands placed on a modern loudspeaker installation there is a choice of a very large number of types of microphone, from the simple crystal microphone to the more expensive high quality microphone of cardioid type. The latter, which permits very high sound levels and works on the dynamic principle, has special directional properties for pick-up within a wide sector and is, therefore, ideal for sound reproduction both from the stage and from an orchestra.

In the choice of the right type of microphone account must be taken of directional properties, frequency response etc. For poor accoustical conditions there is a dynamic differential microphone, type RLC 502, of robust design and with excellent noise-cancelling characteristics.

Apart from the types of loudspeakers, microphones and other accessories described in this article, a large number of other types are produced, so that virtually every requirement met with in practice can be catered for.

Traffic Signals at Frescati, Stockholm

BENGT VON MATERN, THE STOCKHOLM STREETS IMPROVEMENT BOARD, STOCKHOLM

U.D.C. 656.05(487.1)

L M Ericssons Signalaktiebolag's vehicle-actuated road signals were described in articles in Ericsson Review No. 3, 1950, and No. 1, 1951. They have been installed at a large number of street crossings in towns throughout Scandinavia. In the present article the author relates how such signals have for the first time been employed on a heavily trafficked main road on the outskirts of a large town, and the experience gained therefrom. The article has been previously published in a somewhat different form in "Kommunalteknisk Tidskrift".

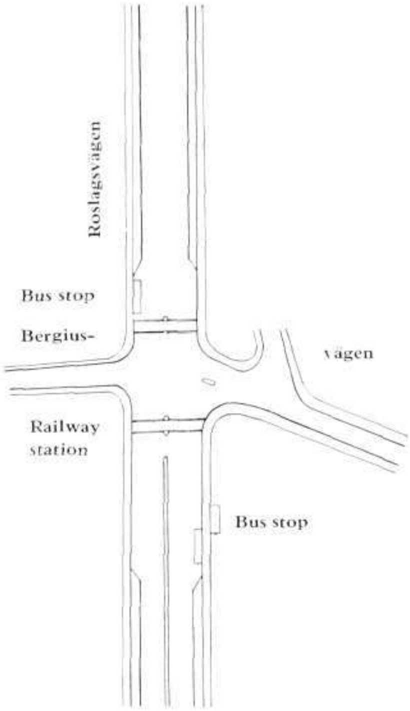


Fig. 1 X 2038

Roslagsvägen—Bergiusvägen prior to reconstruction

Traffic signals manufactured by Signalaktiebolaget were installed at the Roslagsvägen—Bergiusvägen crossing in June 1954. Situated about a mile and a half outside Stockholm, this crossing carries the heavy traffic between the capital and Roslagen (Norrtälje, Djursholm, and Vaxholm). The installation may be said to be the first of its kind in Sweden from the point of view of its special layout and its position on a thoroughfare through the outskirts of a main city. The smaller crossing road, Bergiusvägen, leads eastward to a minor residential area, Ekhagen, and on the west forms the approach to the Bergianska Nurseries. To the west of the crossing lies Frescati railway station on the Djursholm line.

Prior to the reconstruction (fig. 1) the crossing was a difficult one, especially for traffic from Stockholm to Ekhagen, and for pedestrians coming from the station, the nurseries and the bus stop on its western side. Speeds on the main road were often very high, and such difficulties were involved for the crossing traffic that police had to be employed for direction of the traffic during the morning and afternoon rush hours.

A number of proposals for improvement were discussed by the Stockholm civil authorities. Factors of economy and space, and the small amount of crossing traffic (see fig. 3), eliminated the alternatives of roundabout and "cloverleaf" intersection.

The question was considered initially as to whether a speed limit of 25—30 m.p.h., backed up by warning signs and marks, would not prove adequate measures. The police did not consider, however, that they would be able to exercise an effective control that the speed limit was being observed. Moreover, the problem lay not only in the speed but in the volume of traffic on Roslagsvägen. Thus the question of signals was taken up. Considerable doubt

Fig. 2 X 6885

Roslagsvägen—Bergiusvägen

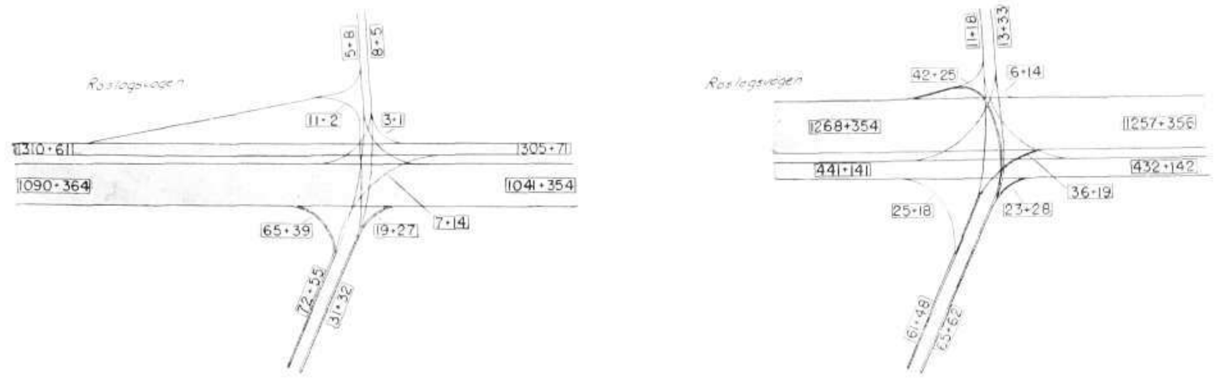


Fig. 3 X 7676

Traffic count on Tuesday, June 9th, 1953. The figures refer to the number of motor-cars and bicycles respectively.

(Left) 8—9 a.m.
(Right) 4.45—5.45 p.m.

existed as to whether road signals would provide the same traffic safety on this site as in the town, where speeds are lower and the respect for signals—owing to the presence of police—presumably greater. Vehicles travelling at high speeds would have to brake very suddenly when the lights changed to red. Against this argument it was contended that suitable pre-warning signs, and the knowledge by drivers that signals existed at the crossing, would have the effecting of lowering the speeds.

The proposal finally adopted was a vehicle-actuated signal installation with phases A and B. Vehicles and cycles approaching from the south and turning in to the right first enter the side-lane to the left and pass the crossing during the B-phase. "No Right Turn" signs were erected on each side of the north-going carriageway. Vehicles from Ekhagen turning left into the main road pass without signals. Southgoing cyclists, and cyclists from Ekhagen turning left, have special cyclist tracks and are not stopped by the signals. The crossing movements arising between streams B_2 and B_1 are few in number and have not caused any difficulty. Pedestrians can change the signals to B-phase by means of push-buttons placed on each side of Roslagsvägen.

The material which Signalbolaget has delivered and assisted in installing comprises lights, detectors and control apparatus. The detectors are directional and operate both to vehicle and cycle traffic. They are placed under the asphalt surface at a distance of about 80 yards from the stop line on Roslagsvägen, but only about 10 yards on Bergiusvägen. The different distances are determined by the layout of the crossing and by the different speeds on the two roads. The control apparatus has settings $A_{max} = 45$, $B_{max} = 15$, $A_{min} = 7$, and $B_{min} = 12$ secs. Thus $B_{min} = 12$ secs. is the guaranteed time available to pedestrians crossing Roslagsvägen. When there is no traffic, green is shown at A. From A to B the signals change through all-red if there is traffic in A. Change from B to A takes place without all-red. The green-amber aspect lasts 3 secs. in A and B, the red-amber 2 secs. in A and 3 secs. in B.

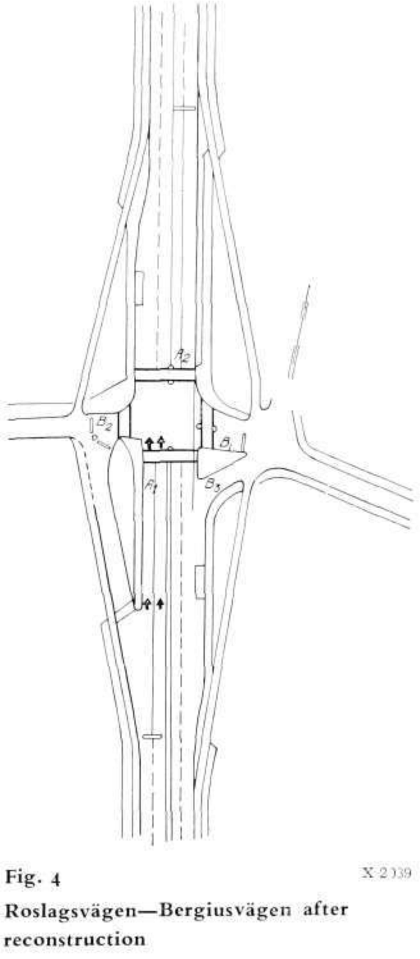


Fig. 4 X 2339

Roslagsvägen—Bergiusvägen after reconstruction

Railings have been erected to stop cyclists from entering the Roslagsvägen carriageways. "SLOW" has been painted on the roadway 150 metres north and south of the crossing, and illuminated signs reading "Signals 150 metres" and road-direction signs have also been set up. To further emphasize the "No Right Turn" injunction for A, straightahead arrows have been painted on the roadway.

The installation has been found to function very efficiently, both as regards traffic control and in its technical operation. Speeds on the main road appear to have dropped, drivers notice the changes of signal and have time to brake smoothly. It has been possible to withdraw the police direction of traffic.

Indeed it appears that drivers observe the signals here at an earlier stage than in the town. They are seen to slow down at a distance of 200—300 yards when the lights change from green to red, and then approach the crossing at a reduced speed, sometimes without changing down (in USA this has been termed "chronothropic driving"). It has not at present been considered necessary on that account to arrange for slower changing of signals—so guaranteeing the evacuation of the B-phase against these flying starts in A—since the visibility is very good.

It is seen from the layout of the crossing that northgoing vehicles which meet the red light when about 100 yards distant are able to dodge in to the left and continue northward after passing the green light in the B-phase. With a thought for the pedestrian crossing on the north side of Roslagsvägen, and cyclists from Stockholm turning to the right towards Ekhagen, it is of course undesirable that such a procedure should be allowed. The Stockholm Streets Improvement Board is therefore considering the erection of a sign "No Thoroughfare to North" on the side-lane.

The long A-phases mean that the traffic in B is obliged to wait for a corresponding period. It appears, however, that this waiting time—which was long even before the installation of signals—is accepted. It is appreciated that the main road traffic must be favoured. That children find fun in pressing the pedestrian signal buttons is hoped to be merely a temporary phenomenon.

The technical experience of this signal installation—as, in fact, of the other Signalbolaget installations in the service of the Stockholm Streets Improvement Board—has been satisfactory. Particular mention should be made of the fact that there is no irritating delay in the changing of signals and that the detectors under the roadway require very little maintenance.

It is probable that the successful experience gained from the installation of signals on so fast a thoroughfare as Roslagsvägen will be followed by similar installations at many other points as a preliminary to the construction of the very much more expensive "cloverleaf" intersections.

New Line Identification Equipment

L ÖLANDER, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

Fig. 1 X 2041
The line identification equipment in use

U.D.C. 621.317.799:621.395.7

The need has long been felt for an electrically and mechanically reliable means of wire identification in a telephone exchange to replace the ordinary bell method. A new wire identification set which fulfils these requirements has been designed by L M Ericsson's Telephone Exchange Department. The construction and properties of the new apparatus are briefly described in this article.

Line Identification Set LTR 1261, 1262

The line identification set, in its present form, has been combined with a telephone headset. The actual line identification apparatus consists essentially of a transistor-oscillator for 1,000 c/s which is brought into oscillation by the application of negative potential to the wire to be tested.

The line identification set is split into two units, A and B. The two units are constructed in the form of fabric-base laminate boxes with aluminium cover. Their dimensions are 135 × 65 × 40 mm. The boxes have jacks for the plugging in of speech wires and a test-pick for line identification. There is also a headset jack. For ease of handling, the equipment has a waist-belt attachment (fig. 1).

The A-unit contains the oscillator equipment, transistor OC 70, transformer, capacitors, resistors and two 1.5 V dry cells.

The B-unit houses only two 1.5 dry cells, a capacitor and a resistor.

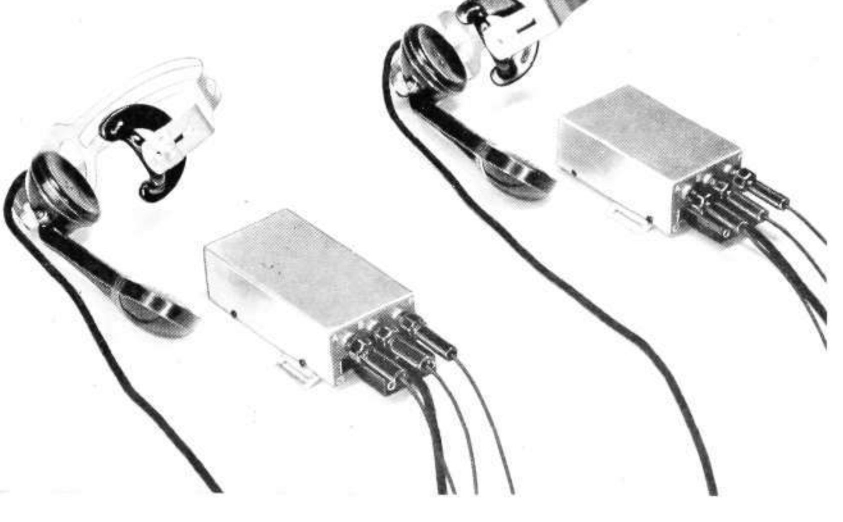


Fig. 2 X 6890
Line identification apparatus LTR 1261, 1262
(Left) A-unit, (right) B-unit

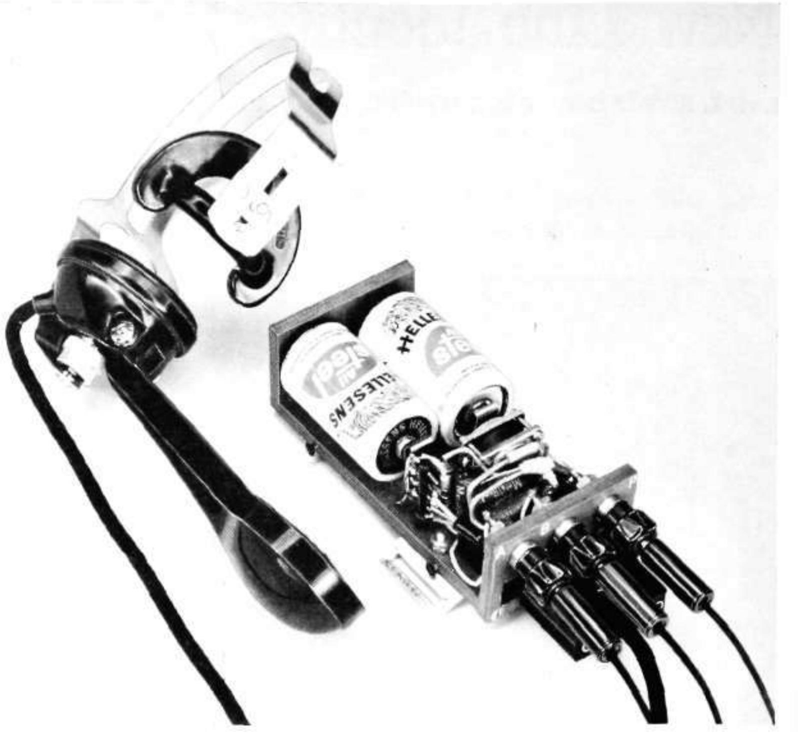


Fig. 3 X 6891

Line identification apparatus with cover removed

A-unit B-unit

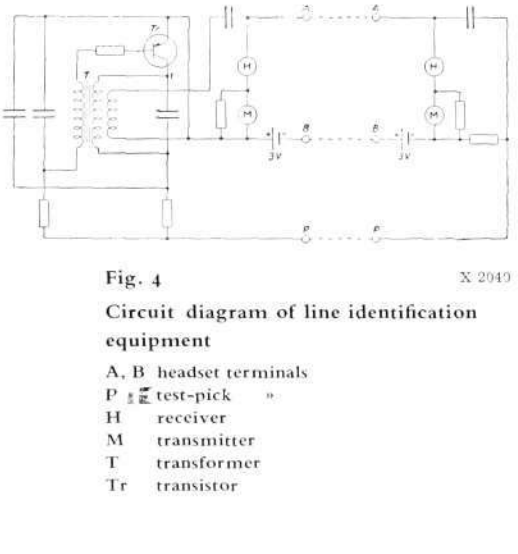


Fig. 4 X 2049

Circuit diagram of line identification equipment

A, B headset terminals
P test-pick »
H receiver
M transmitter
T transformer
Tr transistor

In the headset jack is a 1,000-ohm resistor, connected in parallel with the transmitter. This resistor prevents interruption in the transmitter circuit due to the transmitter being held at the wrong angle by the lineman.

The power consumption is very low and batteries need seldom be used. Experience shows that the line identification set has operated on the same batteries for a period of three to four years of continual use.

For line tests with this equipment the speech wires must first be connected to the A and B terminals of the two units.

Test-picks are then applied to both A and B-unit, terminal P, to hunt for and identify each wire in turn. When the test-picks of the A and B units make contact, each at its own end of the tested wire, a 1,000-cycle tone is heard on the wire. The strength of the tone is so balanced as to be clearly audible without causing irritation.

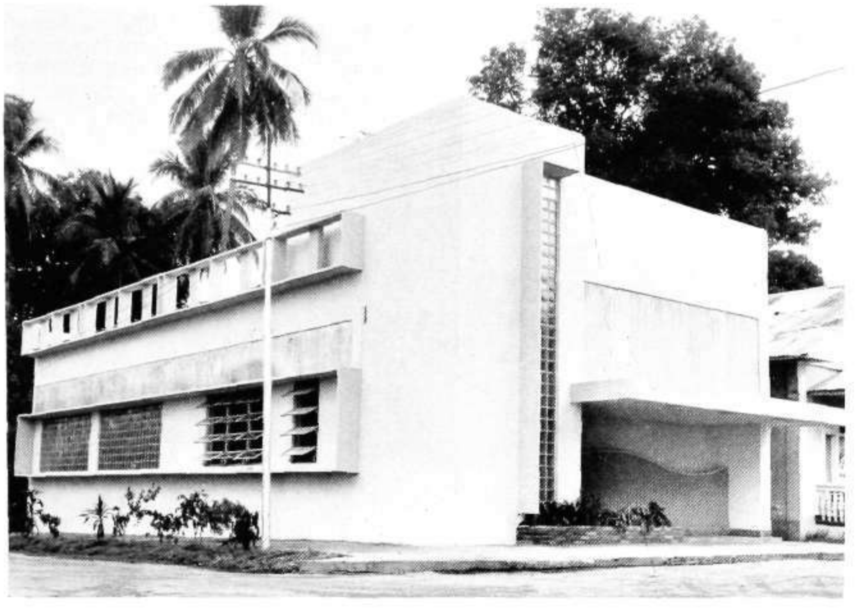
NEWS *from* *All Quarters of the World*

Grant of L M Ericsson Scholarships 1955

The Telefonaktiebolaget L M Ericsson Foundation for the Promotion of Electrotechnical Research has granted scholarships this year amounting to 18,500 kronor. Hein Hvatum, of Gothenburg, received 3,500 kronor for the study of low noise technique for microwave frequencies in U.S.A.; Gösta Lange, Gothenburg, 4,000 kronor for the study of electro-acoustics in U.S.A.; Göran Flodman 2,000 kronor, and Börje Larsson, Stockholm, 3,000 kronor for licenciate studies at the Chalmers Institute of Technology, Gothenburg, and Royal Institute of Technology, Stockholm; and Sten Olof Johansson, Börje Rask and Ulf Sjögren, Stockholm, 2,000 kronor each for studies at the Royal Institute of Technology, Stockholm.

The Foundation for Travel and Study Scholarships has allotted 33,525 kronor to 17 employees of L M Ericsson companies and 6 members of the Swedish Telecommunications Administration.

This is the tenth year in which these scholarships have been awarded. The foundations were instituted in 1946 in connection with the celebration of the 100th anniversary of the birth of Lars Magnus Ericsson.



New Automatic Exchange in Panama

In Panama a new L M Ericsson automatic exchange has been brought into service in Ciudad David on the Pacific coast. Ciudad David is the second Panama town to install a 500-selector exchange—two exchanges of this type, comprising altogether 9,000 lines, were already in use at the capital, Panama City.

The new exchange is built for 1,000 numbers and has line equipment for 800 subscribers. The external plant was also constructed by L M Ericsson.

Development Laboratory started in Germany

On April 1 L M Ericsson opened a development laboratory at Darmstadt, Western Germany, with a present staff of 20 under the leadership of Mr. Hjalmar Tuveson. The laboratory has two sections, for system development and apparatus development. It is located in Hochhaus 94, a recently erected block of offices in this severely bombed city. L M Ericsson occupies two floors of the building.

Dr. Christian Jacobæus (left) and Dr. Yngve Rapp

Awards to L M E Men from Polhem Fund

According to the decision of the Swedish Technological Society, awards have been made from the Polhem Fund to Dr. Christian Jacobaeus and Dr. Yngve Rapp of Telefonaktiebolaget L M Ericsson. Grants from this Fund are generally made every fifth year for meritorious dissertations on Technical subjects written by Swedish citizens. The awards were made at a meeting of the Swedish Technological Society on May 13, 1955, when the dissertations were presented by Professor Torbern Laurent of the Royal Institute of Technology in the following words:

The paper "A study on congestion in link systems" is Christian Jacobaeus' doctor's dissertation. The subject of his argument is bound up with the following circumstance in an automatic telephone exchange. When a subscriber calls another through an automatic telephone exchange, he may, on occasions, have to wait longer than usual before his call gets through. This is due to the fact that the switching devices in the exchange required to establish the connection between the subscribers are engaged on other switching functions and are thus not immediately available. A state of "congestion" is then said to exist—or, in other words, the call is "lost".

Congestion in the exchange is, of course, an inconvenience to the subscriber. Lost calls can be reduced, i.e. the telephone service can be improved, the greater the number of switching devices with which the exchange is equipped. This costs money, however, and adds to the expense of the plant. It is the job of the telephone engineer, when planning an automatic exchange, to make calculations of the congestion from available information of the telephone traffic in order to decide how many switching devices the exchange must have to render adequate service at a reasonable cost.

During recent years the link systems have become of great significance in automatic telephony, especially in connection with the modern crossbar switching systems. When the attempt was made to calculate the congestion in link systems, apparently insuperable difficulties were encountered. Jacobaeus, however, with great good judgement and skill, has succeeded in overcoming the difficulties by deducing approximative formulae for calculating the congestion in link systems. He has thereby paved the way for these systems, which is an invaluable achievement. His contribution must be considered a very strong justification for his award.

The paper "The economic optimum in urban telephone network problems" is Yngve Rapp's doctor's dissertation. He shows in this paper how an urban telephone network can be planned on the most favourable economic basis.

A large proportion of the very considerable capital invested in telephone plants is taken up by the subscriber's network. This is due to the large number and small utilization of subscribers' lines compared with the long distance lines. Rapp has realized that great savings can be effected by any reduction in the cost of subscribers' networks.

He has therefore attacked the extraordinarily difficult and complicated problem of rationalizing the construction of subscribers' lines by the method of optimal calculus, and taking into account all factors of significance. He has not only taken account of the technical design of the line network, but also of such matters as the life and the ultimate scrap value of the line materials, probable subscriber development, adaptation to unexpected subscriber development etc, and the results he arrives at are of extraordinary interest and great economic importance. Rapp's work may be considered as a pioneering contribution to the scientific planning of telephone networks, which is undoubtedly a very strong justification for his award.

New Telephone Factory in Brazil

The telephone manufacturing plant, on which work was commenced by L M Ericsson's associates, Ericsson do Brazil Comércio e Indústria S.A., in 1953, was completed at the end of last year. The production of telephone instruments started immediately—but only on a comparatively minor scale. The workshops are now being doubled in size.

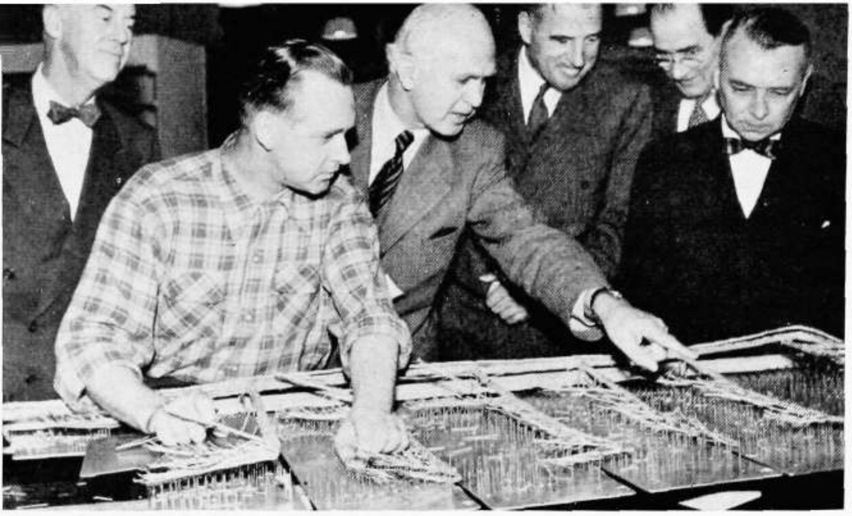
The factory (below) is situated at São José dos Campos, a town some 50 miles from São Paulo on the main route from São Paulo to Rio de Janeiro.

Growth of North Electric Co.

A new office building was completed this spring for L M Ericsson's American associate, North Electric Company, Galion, Ohio. An extension of the factory buildings has also started, which will double the capacity of the Galion factory.

The factory has started production of crossbar switch systems adapted to the American market. Orders are on hand for crossbar offices in the towns of Seymour, Ind., Mansfield, Ohio, and Winterpark, Fla., totalling about 40,000 lines.

From the Visitors' Book



Dr. Harald S. Osborne from Brazilian Traction and Dr. João A Wiltgen from Companhia Telefônica Brasileira recently visited L M Ericsson at Midsommarkransen, when this photograph was taken in the director's dining room. (From left to right) Mr. Hans Thorelli, Dr. Osborne, Mr. Sven Ture Åberg and Dr. Wiltgen.

The American Ambassador, John Moors Cabot, paid a visit to the head factory in May. In the photograph above, the Ambassador (to the right of his guide, Nils Sköldberg) is examining the work of cable forming. With him, from the left, are Commercial Attaché Harris Hungerford, Labour Attaché William Lloyd White and the Ambassador's Economic Adviser, William A Fowler.

From Thailand came a delegation to look for industrial contacts in Scandinavia. In the picture below Dr. Charug Ratanrat, head of Thailand's industrial scientific research (far left), Miss Rabub Prachankadee and Miss Sakuntab Bhodiprasan are studying the soldering of cables to crossbar switch racks. Between the two ladies is Mr. E Klingström of L M E.

During the visit of the British Navy to Stockholm in June a group of officers were shown round the Midsommarkransen plant. Here Signalling Officer J A Johnson is seen in the demonstration room, where his attention was caught by L M Ericsson's ship's telephone. Lieutenant J W Cowton and Commander Bengt Celander of the Royal Swedish Naval Administration are interested onlookers.

In the middle of June a congress of the International Standardization Organization (I S O) was held in Stockholm. A group of members (below right) are studying the cutting of relay springs in one of L M Ericsson's shops.

An international exhibition was recently arranged at Bogotá, capital of Columbia, in which L M Ericsson took part. The L M E stand was visited by the President of Colombia, General Gustavo Rojas Pinilla, seen on the left of the photograph. Mr. Hans Hellberg and Señor Hernán Gómez of Compañía Ericsson Ltda are on the right.

LM Ericsson Raises Capital Stock

The decision was made at the annual general meeting of Telefon AB L M Ericsson on June 13 to increase the capital stock from 122.3 million to 163.1 million kronor by the issue of new shares at a nominal value of 40.8 million kronor. The issue is being made at a rate of 110 per cent of par (35 kronor), that is 38 kronor 50 öre per share. The new shares will be entitled to the payment of dividends as from 1955.

The reason for the issue is the considerable increase in the company's activities and the consequent need for extension of plants and other investments.

LM Ericsson Support to Electronic Research at Royal Institute of Technology

An annual contribution of 150,000 kronor—provisionally for three years—has been made by L M Ericsson to the Electronics Division of the Royal Institute of Technology, Stockholm, for the promotion of research.

Half of this amount will be used for entirely free research, the programme for which is in the charge of Professor Hannes Alfvén, the leader of the research activities of the Electronics Division. The fields of primary interest are the behaviour of electrons and ions under special conditions in ionized gases and in non-linear systems; also electron paths in inhomogeneous magnetic fields.

The other half of the contribution will be devoted to directed research under the joint guidance of Professor Alfvén and L M E. For the present this work will be conducted on tubes for microwave frequencies and on a special switching tube, also for microwave frequencies, the plasma resonator.

Large Finnish Order for LM Ericsson

The Finnish P.T.T. has placed an order with L M Ericsson for four automatic trunk exchanges for Helsinki (1,362 trunk lines), Tammerfors (528), Lahtis (314) and Tavastehus (234). The order constitutes a step in the comprehensive extension and modernization of the trunk network, involving a high degree of subscriber-dialled long distance traffic.

Other purchases from L M E are equipments for the conversion of Borgå and district to automatic working. The order comprises a 2,500 line autoexchange for the town of Borgå and 34 exchanges amounting to 2,620 lines for the surrounding district.

Ericsson Telephone Sales of Canada, which in 1954 opened a branch office in Toronto, has moved into new premises. The building is situated in a new industrial area on the West side of Toronto. The front part of the building is occupied by offices, and the rear by commodious storage space. The Toronto branch has both sales, installation and service departments.

U.D.C. 621.395.24:656.254.15

LINDEROTH, M: *Selective Calling Telephone Systems for Railways.* Ericsson Rev. *32* (1955) No. 2 pp. 37—43.

The arrangement which in telephone engineering is referred to as party lines, has since the early days of railway telephone been used for such service telephone lines which have been drawn along the track and have provided means of telephone communication primarily between the railway stations. The railway telephony, in the first place with automatic operation, has in recent years been considerably developed and it is nowadays generally accepted that the railway party lines are constructed as selective calling lines. The present requirements are that the calls must be selective and that the cooperation with other lines and automatic exchanges must be provided for in a rational manner.

It is, however, clear that selective calling lines also can have other applications, for canals, nestor high roads, floating ways and similar and for a great number of types of undertakings where the telephone problems are more or less identical with those of the railways.

A short description is given of the railway selective calling lines and the requirements of the telephone communication which these will cover.

U.D.C. 621.395.625.3:621.395.722

STRIGÅRD, G: *Applications for the L M Ericsson Telephone Answering Machine in Telephone Exchanges.* Ericsson Rev. *32* (1955) No. 2 pp. 44—48.

The L M Ericsson telephone answering machine has earlier been presented in Ericsson Review No. 4, 1953. A detailed account was given of the design and function of this machine as well as expected applications for different categories of telephone subscribers.

In the article a description is given of some of the application possibilities for the telephone answering machine in telephone exchanges for such purposes as weather forecast announcements and transfer messages to calling subscribers in case of temporary redirections of the traffic on fully automatic circuits.

U.D.C. 681.84.083

EKSTRÖM, H: *L M Ericsson's Combine-Unit System of Sound Distribution.* Ericsson Rev. *32* (1955) No. 2 pp. 49—53.

L M Ericsson has started to manufacture a new sound distribution system, particularly for use in schools, hospitals, at sports grounds etc. Its distinction from earlier systems lies in its special form of unit construction, which lowers the first cost and affords greater flexibility. The new system, which has been called the "Combine-Unit System", is adapted to small and large installations alike. The present article presents the general features of the system.

U.D.C 656.05(487.1)

von MATERN, B: *Traffic Signals at Frescati, Stockholm.* Ericsson Rev. *32* (1955) No. 2 pp. 54—56.

L M Ericssons Signalaktiebolag's vehicle-actuated road signals were described in articles in Ericsson Review No. 3, 1950, and No. 1, 1951. They have been installed at a large number of street crossings in towns throughout Scandinavia. In the present article the author relates how such signals have for the first time been employed on a heavily trafficked main road on the outskirts of a large town, and the experience gained therefrom.

U.D.C. 621.317.799:621.395.7

ÖLANDER, L: *New Line Identification Equipment.* Ericsson Rev. *32* (1955) No. 2 pp. 57—58.

The need has long been felt for an electrically and mechanically reliable means of wire identification in a telephone exchange to replace the ordinary bell method. A new wire identification set which fulfils these requirements has been designed by L M Ericsson's Telephone Exchange Department. The construction and properties of the new apparatus are briefly described.

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ESSELTE. STHLM 55

ERICSSON Review

3
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CONTENTS

On cover: Testing a Crossbar Switch with High-Speed Camera in L M Ericsson Laboratory at Midsommarkransen.

Dynamic Measurements — a necessity in the development of High Speed Telephone Systems

A OLSSON AND N-Å ÅKESSON, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

DK 621.317:621.3.012.6

The development of automatic telephony has placed continuously growing demands on the electromechanical components employed. It is no longer sufficient to know merely their static properties—the study of the dynamic conditions has become increasingly essential. This article describes some of L M Ericsson's special resources for these studies. A few typical examples illustrate the special measuring technique that has been developed.

Measuring technique

The cathode ray oscillograph is unquestionably the most important instrument in the examination of dynamic processes. It provides a ready means of studying electrical quantities such as current and voltage processes, and by means of various attachments mechanical and magnetic quantities can be converted to their electrical equivalents. Direct comparisons between the different processes can be made in a multichannel oscillograph, and the action and reaction can be analyzed. However, for accurate study, and especially for investigation of non-recurrent processes, photographic recording is also required.

To obtain an instrument meeting these particular requirements, L M Ericsson had a recording cathode ray oscillograph specially constructed in

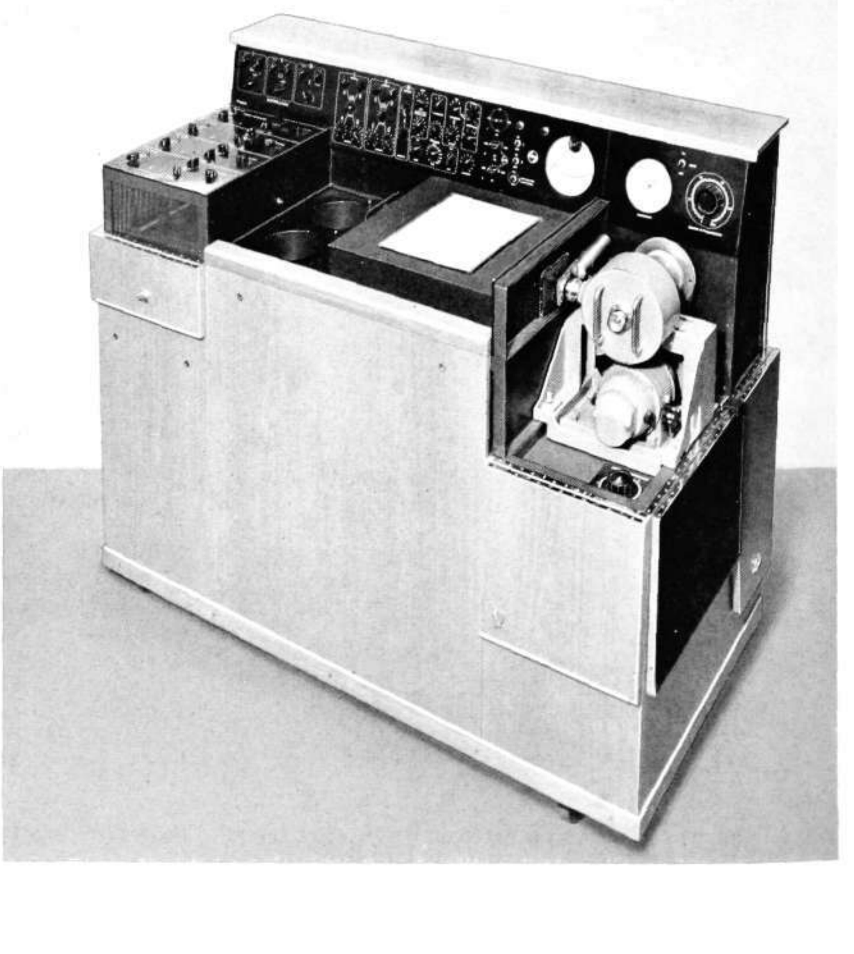
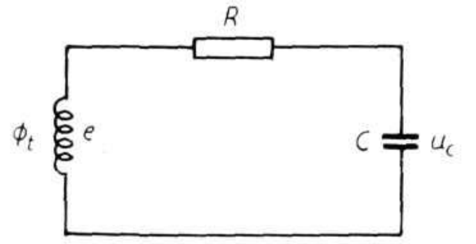


Fig. 1 X 6926
4-channel recording cathode ray oscillograph



$$e \sim \frac{d\Phi}{dt};$$

$$u_c = \int_{t=0}^{t} \frac{e}{RC} \cdot dt \text{ ; if } u_c \ll e$$

$$\therefore u_c \sim \Phi_t - \Phi_0.$$

Fig. 2
Integrated circuit

X 2050

1946—47. The oscillograph has two dual beam cathode ray tubes, permitting simultaneous study and recording of four processes. Each channel has its amplifier for continuously variable amplification. A third cathode ray tube provides time indication. By superimposing two frequencies each tenth indication is magnified for easy reading. The tubes are not affected by saw-tooth voltage during recording. A mirror reflects the light from the screen through a high-speed lens, which presents a reduced picture on a strip of film attached around a rotating drum. The speed of the drum can be adjusted to the desired time scale on the film within the limits 10 μs/mm—100 ms/mm, corresponding to a recorded length of process of 5 ms—50 s. The maximum time scale of about 1 μs/mm (1 s/km) is obtained on a print enlarged to normal size. Exposure takes place when a voltage, which suppresses the cathode rays, is cut out for an adjustable time which should be slightly shorter than the time of revolution of the drum. A special apparatus, in which the desired time displacement from 1 ms to 10 s between the two starting impulses can be set, is provided for starting the process and exposure. By this means, any desired part of the process can be easily selected for study.

Voltage processes can be studied direct in the oscillograph; current processes are taken as the voltage drop across a small series resistance. Certain accessory equipment has been constructed for conversion of magnetic and mechanical processes to equivalent voltage fluctuations.

Fluctuations in magnetic flux are thus studied by means of an integrating circuit. A test winding is so arranged that it surrounds the flux to be measured. A voltage, proportional to the flux derivate, is induced in the winding. The principle and formula of the actual integration are as shown in fig. 2. Since the necessary integration times are comparatively long, the integration must take place via special pre-amplifiers.

Mechanical movements are studied by means of a photocell. The principle is as shown in fig. 3. The shadow from the moving component under study produces on the photocell a linear variation in the size of the illuminated

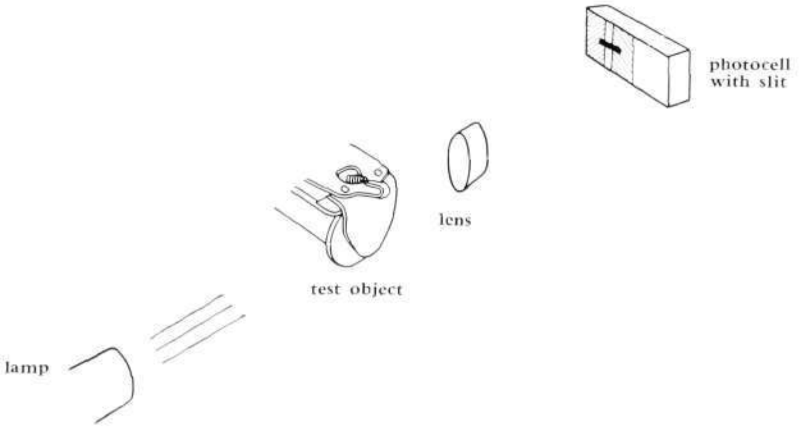


Fig. 3
Use of photocell for study of movements

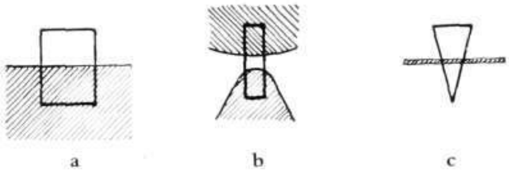
X 6925

Fig. 4 X 2051

Slits for study of movements

a, b for components which are wide longitudinally to the movement. b gives the relative movement between two bodies

c for components which are narrow longitudinally to the movement



surface and controls the current which passes it. Voltage fluctuations are thus set up across the loading resistance of the photocell which are also directly proportional to the displacement. The photocells used for these purposes are carefully checked for constant emission over the entire surface so that true linearity is obtained. The form of the slits in front of the photocell opening depends upon the shape of the moving component. The most usual forms are shown in fig. 4. The 4 a and 4 b types are used when the component is wide longitudinally to the movement, 4 a being used for the armature movement and 4 b for the contact gap in the example in fig. 6. The 4 c type is used when the component is narrow longitudinally to the movement. The shaded portion of the slit varies linearly with the position of the shadow in the slit. The selecting finger in the example in fig. 9 is studied with a similar slit.

The speed of a component is obtained either by graphic derivation of the movement curve or by electrical derivation of the voltage from the photocell on a principle analogous to integration.

The electrical recording of contact action is easily arranged by causing the contact to make and break the current to a resistor connected to the input of the oscillograph. In order to indicate different positions in a more complicated contact action, a network is required which, for change-over contacts, will be of the type shown in fig. 5. The extreme positions of the change-over spring correspond, as is seen, to two separate extreme values *a* and *d* of the voltage to the oscillograph. The two intermediate positions, when the change-over spring has contact with both or neither of the contacts, produce two slightly different levels *b* and *c* between the extreme values.

Purely mechanical processes may also be studied by means of a stroboscope or high-speed camera. For components with periodic movement, e.g. an impulsing relay, a stroboscope is used with impulsing frequencies up to 250 light impulses per second. If the method is to be accurate, every cycle of the component's action must be identical to the preceding one. This seldom occurs, so the method is used chiefly to obtain a rapid preliminary survey of the problem. For more accurate investigations some other method is used.

An indispensable item of equipment is the high-speed camera. Its maximum speed of 3,000 pictures per second gives a time "magnification" of about × 200 when shown at normal speed. The extreme intensity of illumination required for high-speed filming is obtained from two high pressure mercury vapor lamps with three phase feed, which preclude any danger from overheating. As distinct from the stroboscope, the high-speed camera may also be used for non-recurrent processes and, moreover, provides a more accurate picture of the working process of the test object. High-speed photography is particularly necessary when all cooperating components in a structure must

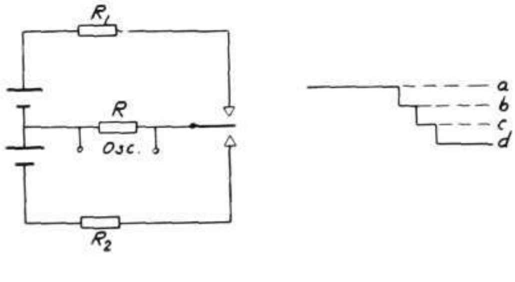


Fig. 5 X 2052

Circuit for electrical recording of a change-over contact

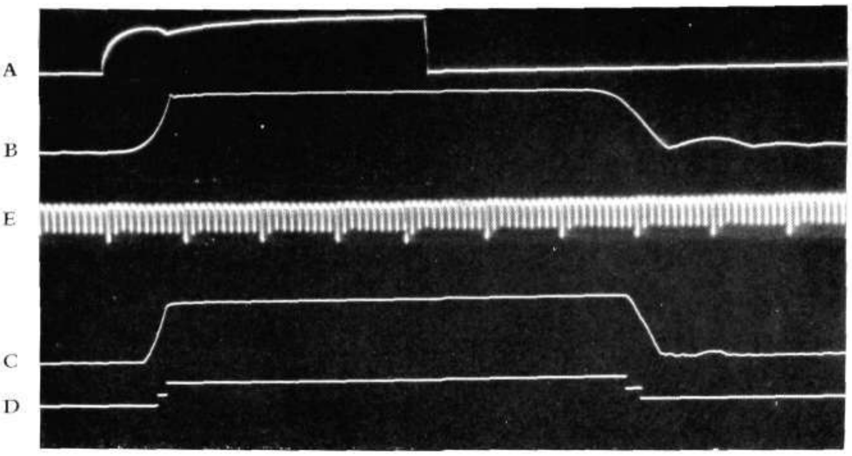


Fig. 6 X 6928

Oscillogram showing the course of events in an impulsing relay

A current process in the relay winding
B movement of the armature, recorded by photocell as in fig. 4a
C clearance between make contacts in break-before-make contact, recorded as in fig. 4b
D the electrical recording of the contact action in the same contact as in C, recorded on the same lines as in fig. 5
E time indication, with recording at every ms, and with every tenth ms emphasized

be taken into consideration. After examination with the camera, a particular component can often be selected for further investigation with the cathode ray oscillograph.

In many oscillographs of conventional design provision is made for "locking" the ray in the starting position of the sweep, and then releasing it at a given moment by means of an electrical impulse, so that it makes a single sweep across the screen. By releasing the ray immediately prior to a given portion of the process, this portion can be studied with a very large time scale. This method has found a particular application in the study of contact vibration, often in comparison with stroboscope pictures.

Some examples of measurement

Both in the development of a construction and for the final examination of its performance, the charting of the actual course of events is necessary.

The following examples, which are taken from our most common switching units, show how such a survey has been made possible by the measuring methods described.

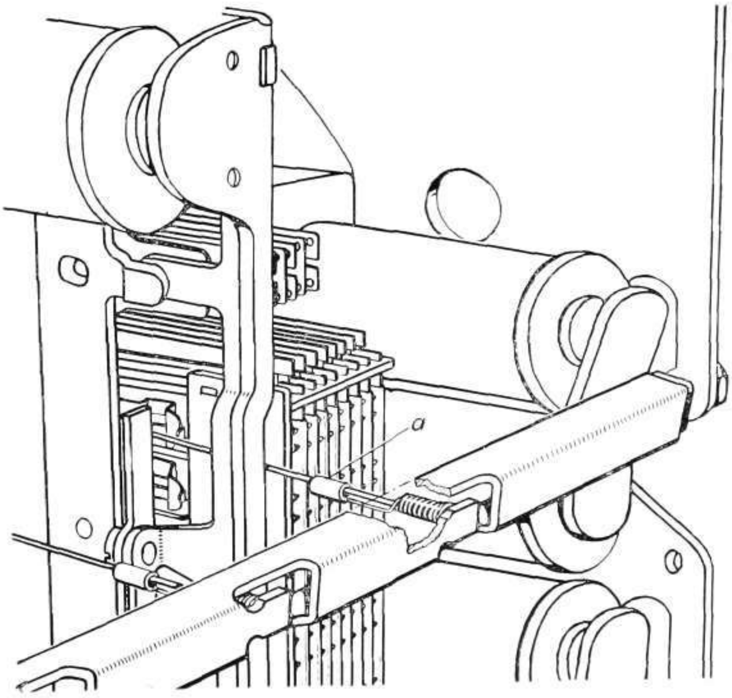
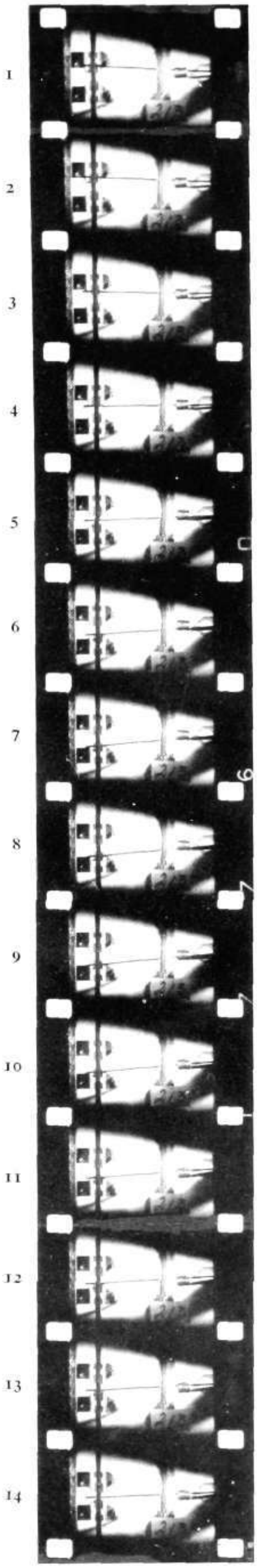


Fig. 7 X 6929

The selecting finger of the crossbar switch, equipped with damper

a damper



The finger is liberated on the release of the vertical.

The finger accelerates more quickly than the damper . . .

. . . and meets its lower edge before a dangerous amplitude has arisen.

If the damper is of suitable mass the finger will bounce back, whereas the damper continues at increased speed.

This movement of the finger is prevented by the upper edge of the damper.

In this way the kinetic energy is reduced without the occurrence of dangerous amplitudes.

X 2049

Fig. 8

High-speed film showing the operation of the selecting finger damper on release of vertical. The interval between each exposure is 1 ms.

Fig. 6 shows how a picture of the processes in an impulsing relay is obtained with the cathode ray oscillograph. The five curves show the following processes:

A. Current process in the relay winding.

B. Movement of armature, recorded with photocell as in fig. 4 a.

C. Clearance between make contacts in a break-before-make contact, recorded as in fig 4 b.

D. The electrical recording of the contact action in the same contact as in C, recorded on the same principle as in fig. 5.

E. Time recording, with indication for every ms, and with every tenth ms emphasized.

When the voltage is applied to the relay, the current first rises on an exponential curve which is determined by the inductance with the armature released. After 3 ms the current has risen to such a value that the armature has clearly started to operate. After a further 4 ms, the contact action has been completed, and 1 ms later the armature has operated fully. The sudden increase in inductance on closing of the magnetic circuit causes a lowering of the current in the relay winding. The current then increases again in accordance with an exponential function, which is now determined by the inductance with the armature operated. The two values of inductance that are characteristic of the relay can be calculated from the curve of current growth. The time between closing the circuit and recording of the contact action constitutes the operation lag. The release lag is obtained similarly from the A and D processes. From the movement curve of the armature, any risk of the springset being unwarrantably actuated by the armature can be detected, e.g. due to armature bounce during the release. The contact clearance curve shows the magnitude of the risk of unwarranted contact, e.g. due to vibration in the springs or the effect of armature bounce. From the recording of the contact action one can see to what extent unwarrented "makes" really occur. The change-over time on operate and release is also seen from the recording of the contact action, being 1.5 and 2 ms respectively.

For the study of more complicated mechanisms a high-speed camera may be preferable. It provides a clearer picture of the behavior of the various components, and quite unexpected events may be disclosed directly. Previously it was necessary to make lengthy tests of wear and operation on different models in order to decide upon the most suitable design. Now the same thing can generally be decided by the study of high-speed films, from which, in many instances, it can even be seen where and why the wear is likely to occur.

An example of the use of the high-speed camera has been taken from the experimental work with freely suspended selecting fingers on the crossbar switch. The selecting wire was provided with a damping device in the form of a sleeve (fig. 7). By suitable dimensioning of the damper it is possible to obtain such vibration in the damper as to avoid vibration in the selecting finger. The high-speed film in fig. 8 shows how the damper functions on the release of a vertical unit.

Pictures 1—5	When the vertical armature releases, the finger is liberated and moves rapidly out to the center position. During this time the damper has hardly moved.
Pictures 6—10	Before the finger has time to get in under the opposite lifting spring, the finger bounces against the lower edge of the damper and then moves upwards, while the damper increases its speed downwards.
Pictures 11—14	This movement of the finger is, however, stopped by the upper edge of the damper. In this way the kinetic energy is damped without the occurrence of dangerous amplitudes.

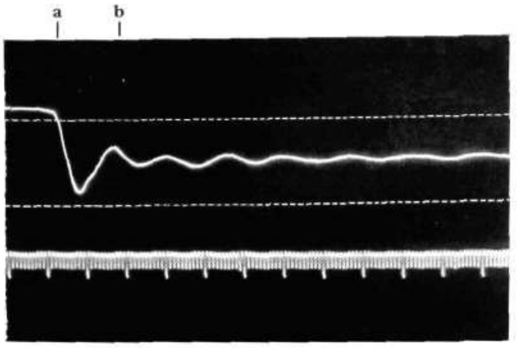


Fig. 9. X 2053

Oscillogram showing the movement of the selecting finger during release of the vertical unit

The dotted lines show the amplitude necessary for the finger to come under the lifting spring. The process during the interval a—b will also be seen from fig. 8.

The film also shows that the amplitude can be further reduced by a small correction of the mass and diameter of the damper.

It would be erroneous to assess the performance of the damper from single high-speed films. In order to obtain full clarity on how the manufacturing and adjusting tolerances affect its properties, bulk measurements and distribution studies will be necessary.

For such studies the oscillograph is preferable. An oscillogram of a finger with the same damping device as in the high-speed film is shown in fig. 9. Movement of the finger is recorded on a principle similar to that in fig. 4 c.

10-Line Relay Switchboard with Built-In Battery Eliminator

G RODNERT, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

DK 621.395.24

The increasing demand for minimum maintenance operation of private branch exchanges has led to extensive use of relays or similar units as switching devices. To meet this demand, L M Ericsson has replaced their OL 15 with a new private automatic exchange, AMD 22101, which is a newly-designed switchboard using only relays as switching devices.

This new P.A.X., fig. 1, has a capacity of 10 lines with one link circuit (the same capacity as the *OL 15*) which, in most cases, is adequate for small offices, factories, or house telephone systems. The calls are secret.

Its small size, light weight, and silent operation permit its installation in practically any location, for instance, in an office or a corridor.

General Constructional Features

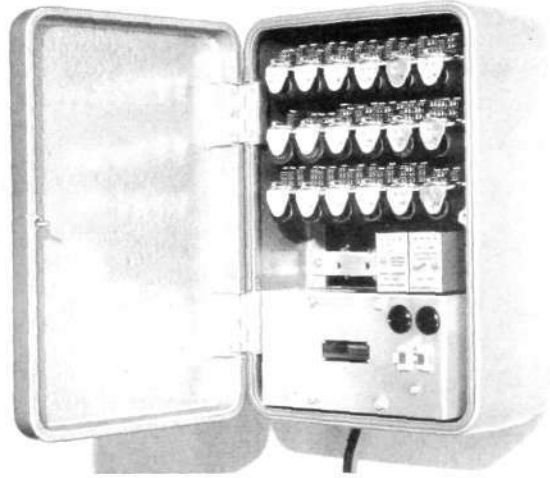
AMD 22101 employs only relays with spark-protected twin contacts. All switchboard units, as well as the power unit described below, are mounted in a frame which is hinged to a back plate. This plate carries the terminal block for extension lines, and terminals for rearrangement of the circuits. In front of the frame is a hinged door. Rubber packings on the door and back plate create a secure seal, fully enclosing the switchboard and protecting it against dust. The frame, door and back plate are cast aluminium with a grey hammer-tone finish. The switchboard measures 250 × 360 × 165 mm, and weighs only 15 kg.

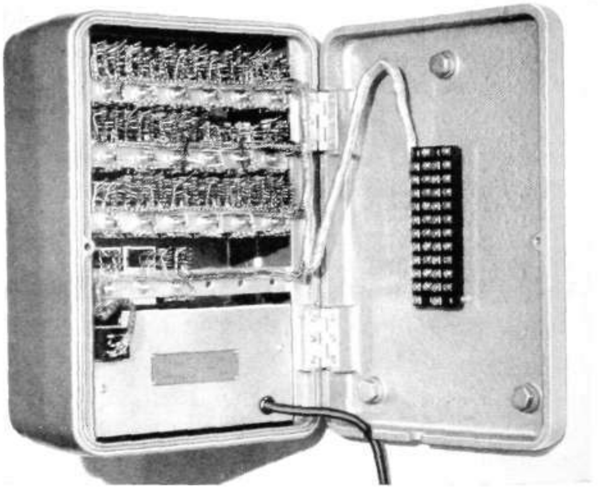
The switchboard contains a plug-in power unit for 50-cycle A.C. which is factory wired for 220 V, but can be adjusted for 110, 127 or 150 V. Fluctuations in mains voltage of ± 14 % and in frequency of ± 20 % are

Fig. 1 X 6918 X 6919

L M Ericssons Automatic Relay Switchboard AMD 22101

(left) front view, with door open
(right) wiring side





permissible. The power unit supplies an operating voltage of about 24 V, a ringing voltage of about 85 V for transmission of ringing signals, and a dial tone with a frequency of about 100 c/s. The mains connection cord has 3 conductors, one of which grounds the metallic components of the switchboard.

The switchboard has very low power requirements. When no conversation is in progress, power consumption is only 5 W. Moreover, the high reliability of the switchboard makes it extremely economical to operate.

Ordinary dial telephones are connected to the switchboard by two-wire lines. Extension bells may be connected to the telephones. The extension numbers are 1—9 and 0. Resistance of the extension line should be 500 ohms maximum. Using ordinary telephone wire, this corresponds to a distance between switchboard and telephone of 2 to 3 km, which should be ample for most normal systems.

Operation

Normal Calls

The lines are connected to line relays arranged in a chain circuit in which only one relay at a time can operate. This relay chain at the same time corresponds to the line finder of larger exchanges. When the extension user lifts his handset, his line relay operates and connects the line to an impulse and battery supply relay, which transmits dial tone to the extension. When the number is dialled, it is recorded by the impulse relay of a second relay chain which corresponds to the final selector of a larger exchange. At the end of dialling a ringing signal is immediately sent to the called extension. On the cessation of ringing signals the called line is also connected to the impulse and battery supply relay.

Only one ringing signal is transmitted, which is adequate in a normal office, thus avoiding annoyance to adjacent persons. If one ringing signal is insufficient, the caller can either replace his handset and dial the number again or he can dial digit 1 (i.e. one impulse) and the wanted number alternatingly.

Priority

Priority can be given to extension no. 1 by insertion of a strap in the terminal block on the back plate. This means that if a conversation is in progress and extension no. 1 lifts his handset, he is directly connected to the call in progress. At the same time a faint buzzer tone is heard which indicates that a priority extension is on the line.

General Calls

Extension no. 1 can make calls to several extensions simultaneously. Extensions which are to be called by this general call arrangement must have special strap connections on their terminals on the back plate. A general call is initiated by extension no. 1 dialling his own number.

Non-Secret Calls

The switchboard is delivered wired for secret calls. In the case of a switchboard with only one link circuit, it sometimes may be desirable that extensions can enter a call in progress, and this can be achieved by a simple rearrangement of the strapping on the terminal block. It can be provided that all calls can be overheard or that calls between certain extensions are secret and between other extensions non-secret.

Program Distribution Plant for United Nations

A TRÄGÅRDH, TELEFONAKTIEBOLAGET L M ERICSSON, DIVISION ERGA, STOCKHOLM

DK 621.395.97

For the past year a program distribution plant has been in service in the stately United Nations headquarters in New York. The honor of supplying this plant was won by L M Ericsson in stiff competition with a number of other manufacturers. The purpose of the program distribution plant is to enable national delegates to follow from their own offices any non-confidential session in progress in the various conference rooms. Loudspeaker sets are installed in 150 offices where officials can connect to any one of 23 conference rooms by operating the dial on the loudspeaker. In each conference room is a microphone which is switched on at the beginning of all non-confidential sessions.

The program distribution plant comprises microphones, loudspeaker sets, central equipment, lines and battery with automatic charging arrangements.

The two W.E. 639 B cardioid type *microphones* are placed on either side of the speaker's rostrum.

The *loudspeaker sets* are desk models with mahogany-stained cabinets. The actual loudspeaker is of the electrodynamic type with permanent magnet, having matching transformers for impedances 2,000, 4,000 and 16,000 Ω. The loudspeaker contains a resistor with a variable tap for adjusting to minimum volume. On the front of the cabinet are the dial and two control keys. A 2.5 meter cord and a wall terminal block are supplied with the set.

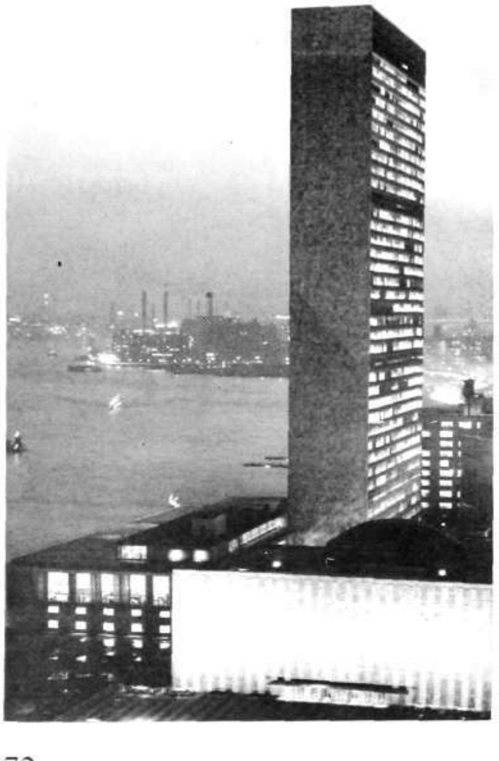


Fig. 1 X 2044
The United Nations building

Fig. 2 X 6898
Loudspeaker set being connected to a conference room

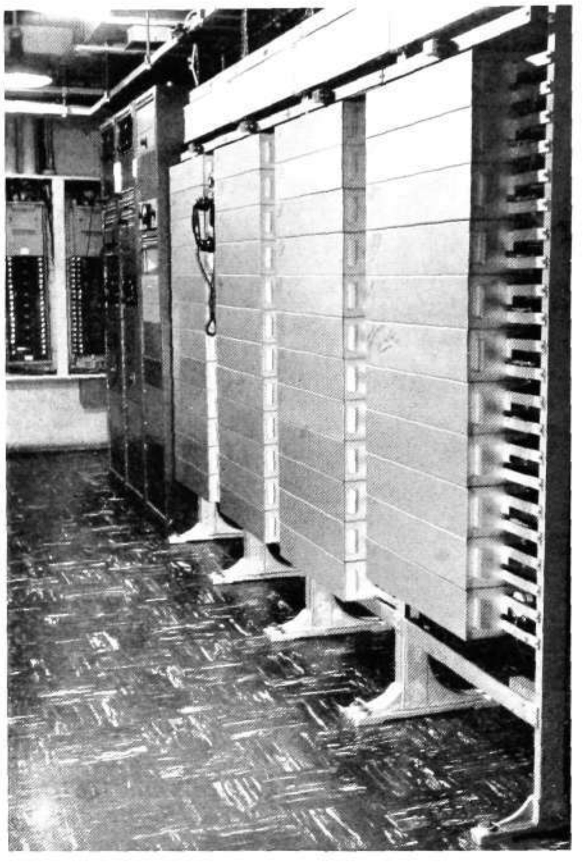


Fig. 3 X 6899

Central equipment

comprising four racks with line selectors, relays, capacitors etc.

The *central equipment* comprises four racks containing 150 line selectors with relays, capacitors and signal voltage equipment. The operating voltage for relays and selectors is 24 V.

The *line plant* consists of 4-wire telephone cable, type EEB 4 × 0.6 mm, running between each loudspeaker station and the central equipment.

The plant battery has automatic charging supply operating on 110—220 V A.C.

Operation

When an official wishes to monitor a conference, he sets the right-hand key on the loudspeaker to "Dial". He then hears a buzzer signal, telling him that he can dial the number to the desired conference room. To connect to rooms 1—9 he dials the same digit as the room number, for rooms 10—19 digits 01—09, and for rooms 20—24 digits 001—004. To switch off the loudspeaker he restores the right-hand key to "Off". If he wishes to switch from one conference to another, the loudspeaker must be restored before dialling the next room. The left-hand key on the loudspeaker is normally set to "On". If the volume is too high, it can be lowered by setting the key to "Mute".

L M Ericsson's Manual Block System

I BOBERG, L M ERICSSONS SIGNALAKTIEBOLAG, STOCKHOLM

DK 656.256

L M Ericssons Signalaktiebolag has designed a manual block system (Swedish patent no. 148660), which is both simple and reliable in operation and employs to a large extent the same components as a normal relay interlocking plant. The manual block system is suitable mainly for single track lines where traffic has not yet attained such volume as to justify introduction of an automatic block signaling system and, possibly, C.T.C.

This article describes first the historical development of manual block systems, then the goals set for the design of L M Ericsson's manual block system and, finally, in more detail, the circuitry and operation of the system.

Ever since the first railways were constructed, a simple means of avoiding train collisions has been an active problem. Many engineers and traffic experts have wrestled with it, and many ingenious solutions have seen daylight.

In the good old days, when there were only a few trains on a line, when everyone had plenty of time, and train speeds were extremely low (an American railway at one time used a horseback rider in front of their trains to make sure the line was free), the risk of collision was insignificant. If two trains happened to meet on the line, they could easily stop and, after the usual argument between the engineers and passengers of the respective trains, a friendly agreement was reached as to which train should back to its starting station.

If there were some guarantee that trains would run exactly on schedule, there would still be no risk of collision. The timetable would simply be arranged so that trains run at time intervals. But since we cannot always rely on train schedules, the engineers must be given additional orders—train orders—and there must be some means of checking that there is not more than one train on one section of line at the same time (a line section consisting of a whole or part of a station-to-station section). The train orders must be issued ultimately by the station staff. On some railways the check that a line section was occupied by only one train at a time was effected by hoisting a colored ball—the color varying with the position of the train—on a high pole at a section boundary. The ball could be seen through a telescope by a man who climbed a pole at the next section boundary. This system of control was later superseded by telegraphic or telephonic communication. A manual block of this kind, however, may lead to errors which can cause train collisions.

Other solutions to the problem of line safety, however, which virtually eliminate all risk, have been found in different countries at different times. To start with, a pilot, with special arm band which authorized him to dispatch trains on his section, was allotted to every station-to-station section. The pilot had to follow every "last" train moving in one direction, so that he could then dispatch trains in the opposite direction from the other end

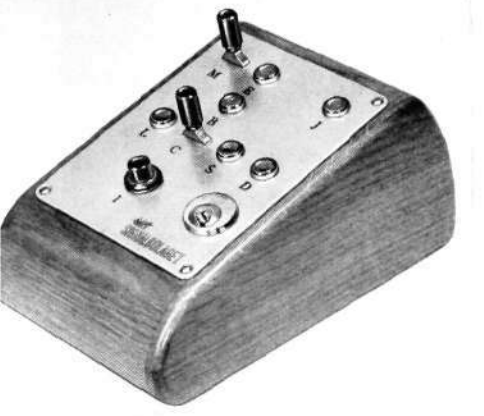


Fig. 1 X 2047

Keyset for manual block system with key *M* for operation of home and starting signals, and key *C* for operation of the block system. The indication lamps give information of permission requested, permission received, train on line etc.

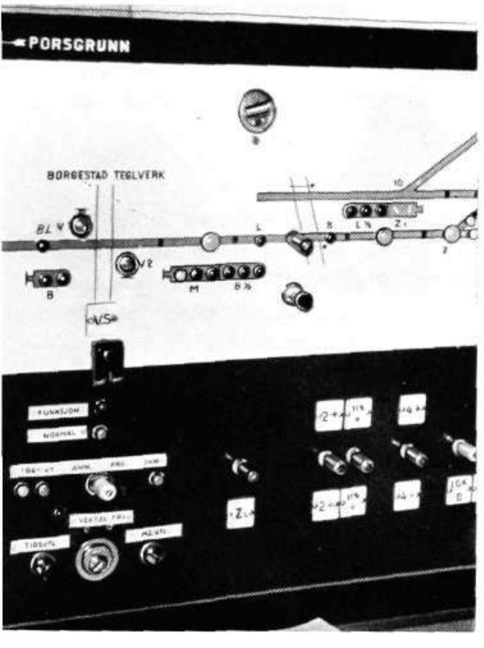


Fig. 2 X 2046

When the manual block system is used on a line with relay interlocking plants, the control and indication equipment of the block system can be placed on the relay interlocking control panels, as for example in the system in Norway shown in the figure. The control buttons and indicating lamps of the block system are seen at the bottom left.

of the line. The arrangement involved considerable work and expense, and there was the risk that the pilot was at the wrong end of the section when the train arrived. A less expensive arrangement was to replace the pilot by a train staff, which accompanied all trains on their passage between the two stations to which the staff was allocated. This system, however, was even less flexible than that with the pilot, since the trains had to run alternately in the two directions. The train staff was later replaced by a key with which to open a box at the stations concerned. At the station where the key happened to be, a ticket could be taken out of the box which gave the train crew the same authority to proceed to the next station as the staff itself. This made the train staff system as flexible as the pilot system.

With line wires between stations an electric tablet system could be introduced. This consisted of a number of tablets placed in a container at each station; the containers were electrically connected so that the removal of a tablet from either station prevented the taking of another tablet. Thus if a train at station *A*, on a section *AB*, had taken a tablet, no new tablet was obtainable at station *A* or *B* until either the train had returned its tablet at station *A* or, after arrival at station *B*, had replaced it in the box there.

Electrical train staff and tablet systems are still being used on many railways and should be satisfactory from the safety standpoint. The exchange of staffs or tablets at the stations, however, is a troublesome and tedious business. It was natural, therefore, that other means of manual block system should be constructed. Several such systems have been in use for a very long time. They consist of "block instruments" at the stations connected by an inter-station electric circuit. Two stations can inform one another of the departure and arrival of trains by signaling on the block instruments. If the block instrument is suitably connected with the station's starting signals, it is possible to prevent a signal from being set to proceed if there is a train on the line.

Requirements in a manual block system

When L M Ericsson was preparing to design equipment for manual block systems, it was decided that the following requirements must be fulfilled.

1. The equipment should be simple and reliable in operation and should, as far as possible, comprise the same components as a normal relay interlocking plant. The block equipment should provide full traffic safety. The system should not require any track circuits on the line.
2. The system should operate on two line wires without grounding connection.
3. All equipment should operate on direct current, and its power requirement should be low enough to be supplied by primary cells.
4. The restrictiveness of the block system should not be lessened by short or open circuit faults.
5. It should be possible to set the station for unattended movement of trains, and the block system should be usable between the nearest attended stations under these conditions. Indication of line occupation should be given to the normal extent at the unattended station or stations.
6. It should be possible to factory-wire the relay equipment on suitably designed racks.

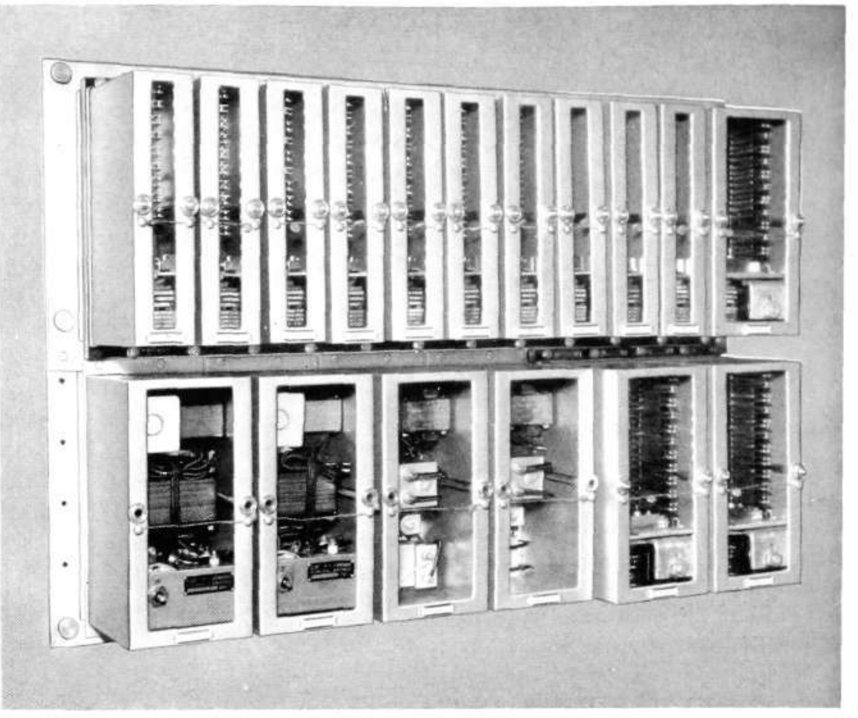


Fig. 3 X 6920
The relays, transmitters and receivers of the manual block system are erected on factory-wired racks

L M Ericsson's manual block system

L M Ericsson's solution to the above requirements is described briefly below.

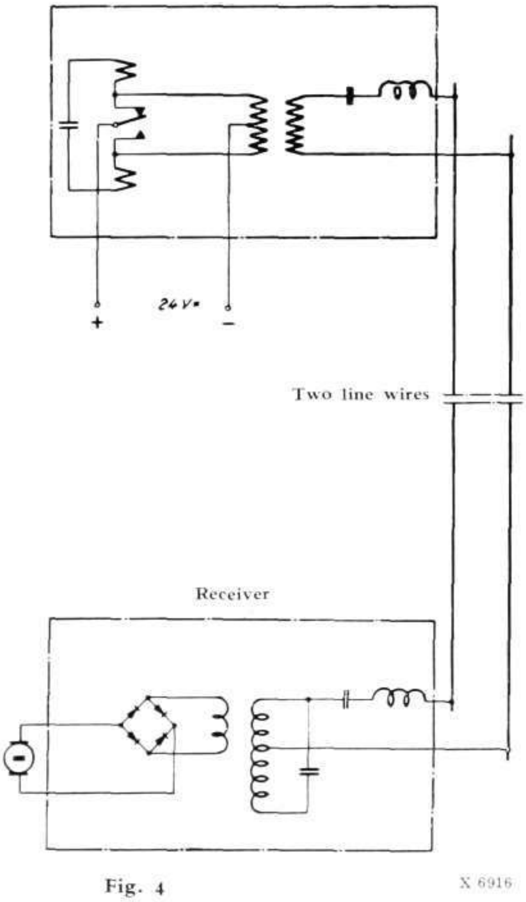


Fig. 4 X 6916
Simplified diagram of transmitter and receiver designed for 24, 38 and 60 c/s

Equipment

The equipment for the manual block system, apart from the two line wires, contains key-sets, signal relays, transmitters, receivers and station track circuits and station signals.

The block system key-set for the stations is designed as shown in fig. 1. If the manual block system is installed on several adjacent station-to-station sections, there must be two key-sets at every station. If a station has an electric interlocking machine, the control and indication equipment of the block should be placed on the control panel of the machine, for example as shown in fig. 2. In both cases the control and indication equipment is so placed and electrically connected that the indications are easily understandable and the controls readily effected.

The mounting and wiring of relays, transmitters, and receivers is shown in fig. 3. If a station has an electric interlocking plant, it is preferable to place the equipment in the interlocking relay rack.

Fig. 4 shows the circuits of a sender and a receiver. The transmitter contains a polarized relay, operating on 24 V, which generates alternating current in the transformer. The secondary side of the transformer is connected to the line via a series-resonant circuit matched to the frequency of the transmitter.

The receiver is connected to the line via a series-resonant and a parallel-resonant circuit. In the latter circuit is a transformer with rectifier bridge and direct current relay on its secondary side. Transmitters and receivers are made

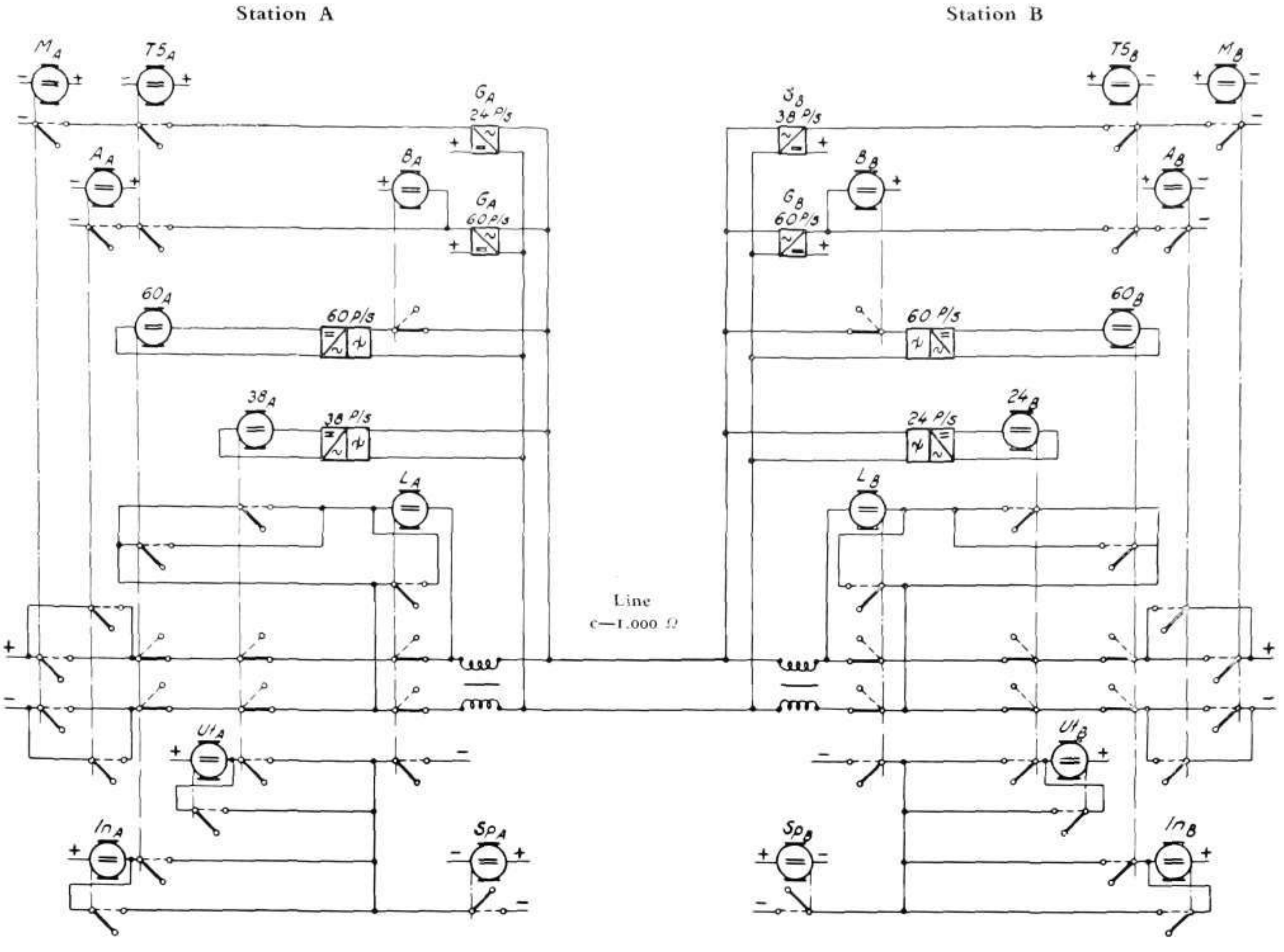


Fig. 5 X 7678

Greatly simplified diagram of the manual block system

for three different frequencies, 24, 38 and 60 c/s. The relays are L M Ericsson's plug-in JRK-type.

Short track circuits and home and starting signals are arranged at each end of the stations.

System schematic and operation

The transmission of information on the line wires is effected by a short duration A.C. of 24, 38 or 60 c/s and continuous D.C., possibly of different polarities. D.C. and A.C. of one frequency are used for clearing the line, and two A.C. frequencies for release.

Fig. 5 shows the schematic principle of the block system.

When station *A* (left), by operating a block key, requests station *B* (right) for permission to dispatch a train on the line, relay A_A and (for roughly 5 secs.) relay $T5_A$ operate. Relay B_A, which operates, disconnects the 60-cycle receiver of station *A*. D.C. and 60 c/s A.C. is transmitted on the line. At station *B* relay 60_B operates as long as station *A* transmits 60 c/s. Relay L_B operates and sticks. Relay In_B likewise operates and sticks. A call lamp lights on the control panel at station *B*. In this position station *A* can, if desired, recall its request by returning the block key to normal, whereupon all relays at stations *A* and *B* restore.

Station *B* grants permission to station *A* by operating its block key. Relay M_B and (for roughly 5 secs.) relay $T5_B$ operate. A.C. 38 c/s is transmitted on the line, and relay 38_A at station *A* operates. The D.C. from *A* is cut off, and D.C. is connected instead to the line from station *B*. Relay L_A operates. Relay Ut_A also operates. A permission lamp lights on the control panel at station *A*. In this position station *B* can, if desired, recall its granted permission by restoring the block key to normal. It can, however, release the block only by cooperation from *A*. This is because, when station *B* operated its block key, the lock relay Sp_B also released and relay In_B was energized through a contact on Sp_B. The lock relay cannot re-operate unless *A* transmits 60 c/s and 24 c/s simultaneously. Station *A* can also recall a permission received by direct transmission of 24 and 60 c/s.

The train dispatcher at station *B* can refuse to grant permission by setting his block key to the request position. A.C. 60 c/s is then transmitted to the line and the D.C. from station *A* is cut off.

When station *A* sets its starting signal to proceed in the direction of station *B*, relay Sp_A releases and the *H*-relay of the starting signal is energized through a contact on relay L_A. Relay Ut_A is energized through a contact on Sp_A. In this position station *A* can restore the signal to stop, but the block will not be released until after a certain interval, and only on condition that the train to which the signal applies has not moved on to the line during the interval. Station *B* can also set the starting signal at station *A* to stop. This is done by cutting off the direct current from the line, whereupon relay L_A and the *H*-relay of the starting signal release. Station *B* thus has no possibility of releasing the block, but this must be done in the normal way, which will be described below.

If any of the block keys is restored to normal when there is a train on the line, the block system is not affected except that a buzzer sounds at the station at which the block key was operated.

When the train dispatcher at station *B* has checked that the entire train has entered the station, he restores the block key to normal. A.C. 60 and 38 c/s are transmitted on the line. At station *A* the lock relay Sp_A operates, after which 60 and 24 c/s frequencies are transmitted on the line, causing the operation of lock relay Sp_B at station *B*.

The schematic in fig. 5 is greatly simplified and does not show, for example, what happens when a station is connected for unattended train movement.

The block system can be wired so that a station can grant advance permission to its neighboring station.

The indication lamps on the panel provide information of permission requested, permission received, permission refused, train on line etc.

For some time the majority of railways seem to have been in agreement that safety arrangements on single track lines are necessary, even when train speeds are fairly moderate. When such arrangements are introduced nowadays, it is often desirable at the same time to improve the efficiency of traffic controls by converting block signaling to automatic operation and adopting C.T.C. Before doing so, however, it must be decided whether installation of automatic blocking and possibly C.T.C. offers greater advantages—considering volume of traffic, size of station staffs required for purposes other than operation of the signaling system, capital costs, etc.—than the introduction of merely a manual block system. There are at present, and will undoubtedly continue to be in the future, many railways with moderate traffic, where a station staff is required at all times and the price of capital is fairly high. The introduction of a manual block system, which offers much greater security to traffic than purely telegraphic or telephonic communication may then prove to be the rational solution, even though it does not permit reduction in station staff otherwise than by putting stations on unattended train movement.

L M Ericsson has already installed its block system in Sweden, Norway and Spain.

High-Efficiency 10-Watt Amplifier

H EKSTRÖM, TELEFONAKTIEBOLAGET LM ERICSSON, STOCKHOLM

DK 621.375

The reproduction properties of the now so popular tape recorders and long-playing gramophone records have created a demand for a high-quality amplifier with moderate output. For a long time Telefonaktiebolaget L M Ericsson has manufactured amplifiers for sound distribution systems and has recently brought out a 10-watt amplifier, ZGA 3921, for high quality reproduction. The following is an account of the construction and the various applications of this amplifier.

Construction and Technical Data

Amplifiers for high fidelity reproduction require carefully and amply dimensioned components. It is particularly important that the output transformer be of adequate capacity. The *ZGA 3921* amplifier has a powerful output transformer, and its other components are carefully chosen to provide high fidelity and reliability. Nevertheless, it is sufficiently compact for modern requirements and its light weight makes it easily transportable.

The amplifier is housed in a grey, hammer-tone enamelled metal case. All controls, knobs, switches and terminals are conveniently mounted on the outside of the case and with legibly marked scales and name plates.

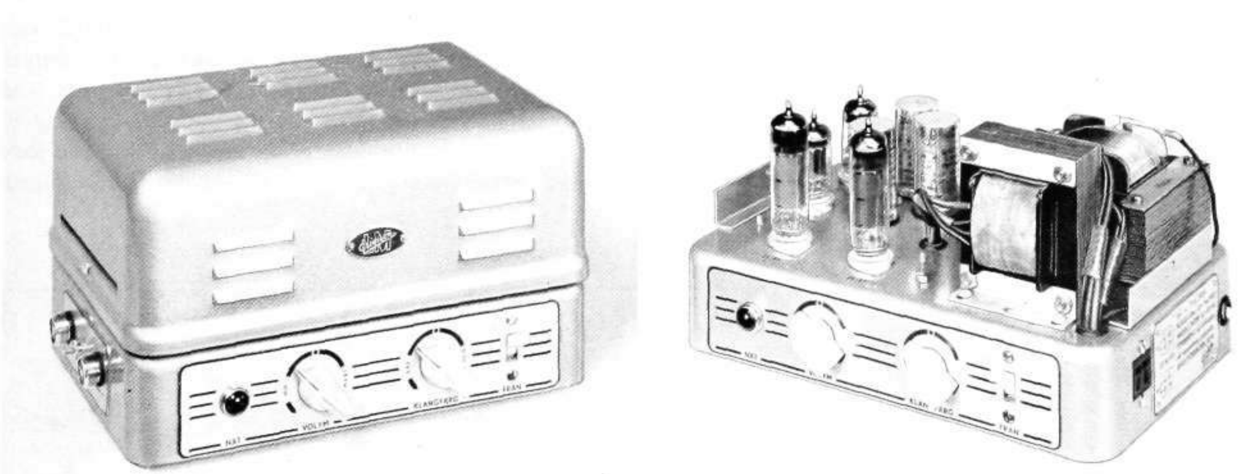
The amplifier has two adjustable input channels for the connection of high impedance microphone and high impedance pick-up. By means of separate input transformers, which screw on to the input terminals, the input channels can be easily adapted for a low impedance dynamic microphone or for a magnetic or dynamic pick-up.

The output impedances are 4 Ω and 16 Ω.

The amplifier will operate on 110, 127, 140, 150, 220, and 245 V, 50—60 c/s. Its power requirements are 50 W. The change-over from one voltage to

Fig. 1
Amplifier ZGA 3921
(right) with cover removed

X 7679



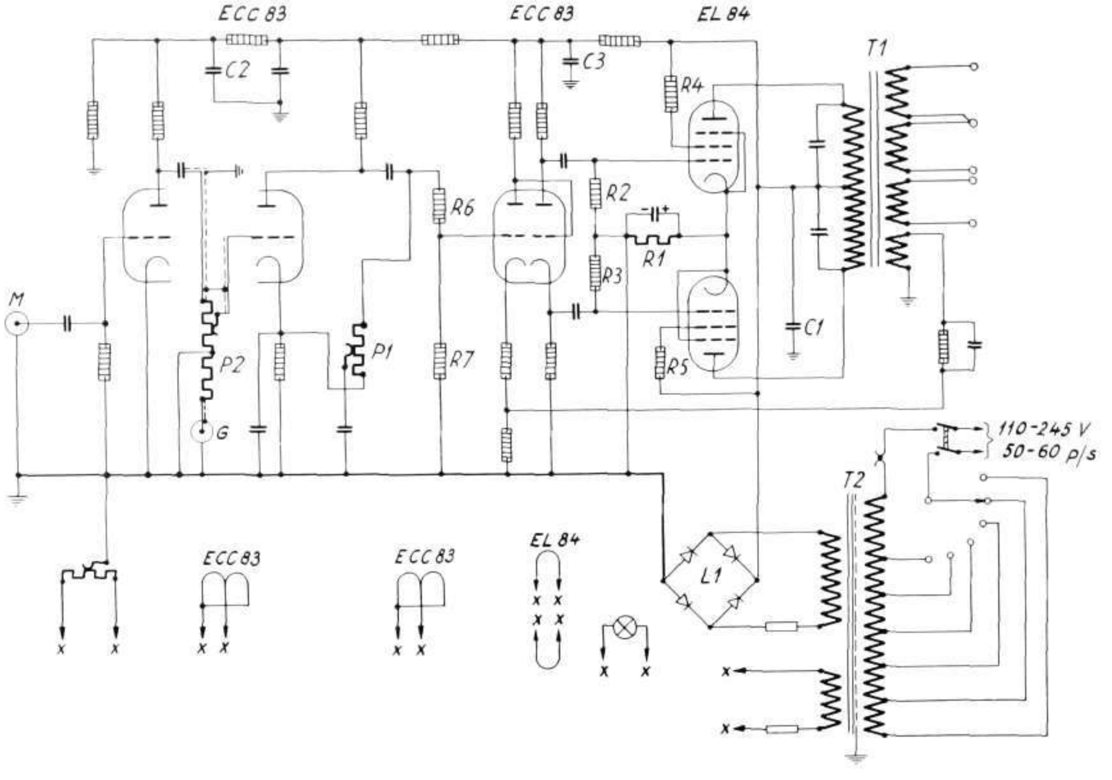


Fig. 2 X 6923

Circuit diagram for amplifier ZGA 3921

another is effected by means of voltage switches underneath the base of the amplifier.

The circuit diagram is shown in fig. 2. All amplifier stages are resistance coupled, and the output stage is in push-pull coupling class AB. The grid bias is obtained through the voltage drop across the cathode resistor *R 1*, which is wire-wound. The resistors *R 4* and *R 5* in the screen grid circuit prevent tendencies to oscillation. In the second triode unit of the second amplifier tube the plate and cathode resistances are identical, thus providing that the control voltages to the power amplifiers shall be equal and opposite in phase, regardless of the frequency. The pre-amplifier stage has a twin triode which supplies voltage to the grid of the second tube after the step-down resistors *R 6*—*R 7*.

To obtain full output in the output stage, 5 mV is required in the microphone channel *M* and 200 mV in the gramophone channel *G*.

To counteract non-linear distortion, the amplifier has been provided with negative feed-back. This is taken from a special winding on the output transformer *T 1* and applied to the cathode circuit of the second tube. The negative feed-back is very powerful and provides the desired damping of the loudspeaker speech coil. The output voltage of an amplifier with no load is only about 15 % higher than the output of an amplifier with optimum load.

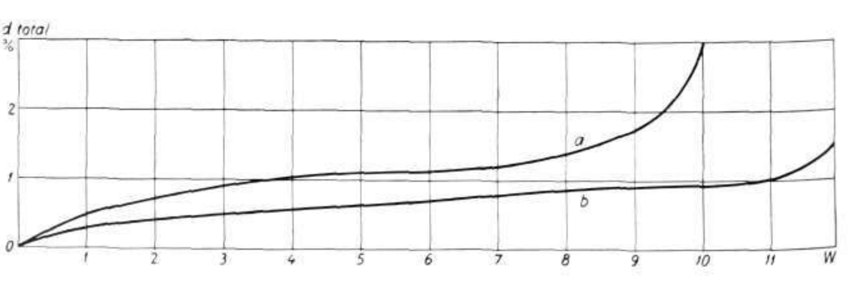


Fig. 3 X 6915

Distortion curve of amplifier ZGA 3921

a at 50 c/s
b at 400 c/s

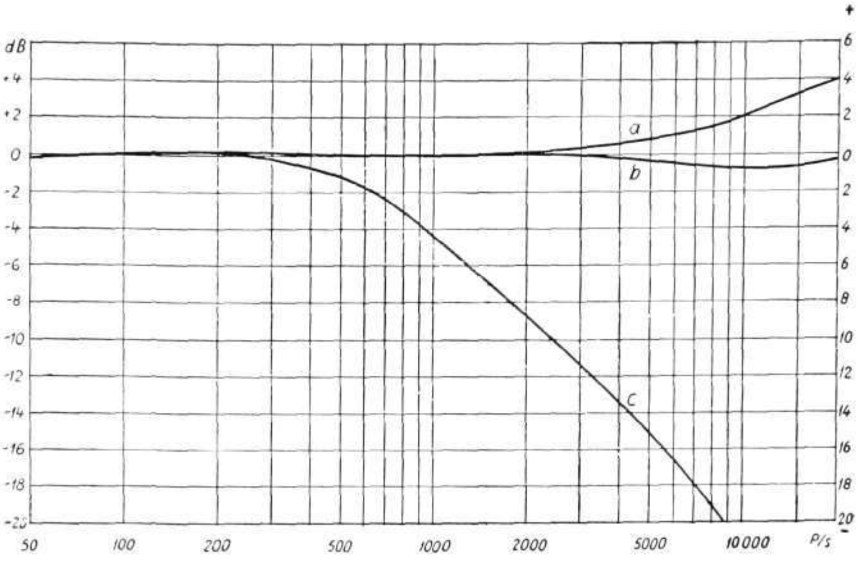


Fig. 4 X 6914

Response curve of amplifier ZGA 3921

a max. treble
b normal
c max. bass

A 120 mA selenium rectifier is used instead of a rectifier tube. The plate voltage to the power amplifiers is smoothed by the capacitor *C 1*, and the plate voltages of the pre-amplifier stages by capacitors *C 2* and *C 3*.

The output at 1,000 c/s is 10 W with 1 % harmonic distortion. The distortion curve of the amplifier is shown in fig. 3. The measurements were made at 50 and 400 c/s with 16-ohm load. The distortion is unusually low, even at full output, and is almost independent of the frequency.

The tone control, *P 1*, provides a wide range of adjustment in both the base and treble registers. The frequency range of the amplifier is 50—15,000 c/s, with a deviation of ± 0.7 dB at 1,000 c/s. The response curve is shown in fig. 4. It runs straight over a very wide range of frequencies. Fig. 5 shows the intermodulation curve measured on the secondary side of the output transformer at test frequencies of 60 and 6,000 c/s with amplitude ratio 4 : 1.

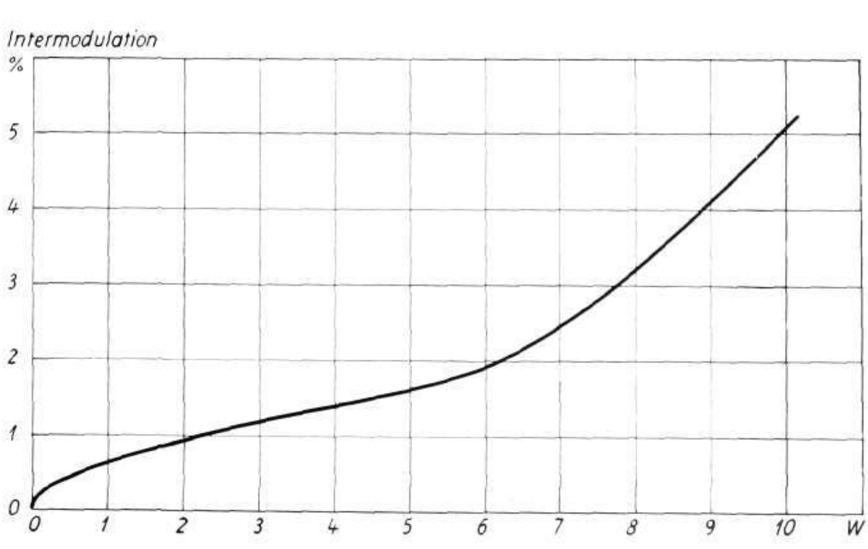


Fig. 5 X 6921

Intermodulation curve of amplifier ZGA 3921

Test frequencies 60 and 6,000 c/s with amplitude ratio 4:1

Technical Data of Amplifier ZGA 3921

Supply voltage	110/127/140/150/220/245 V
Supply frequency	50—60 c/s
Power requirement	50 W
Output	10 W
Distortion	1 % (at 1,000 c/s)
Output impedance	4 Ω, 16 Ω
Response	
Microphone input	5 mV
Gramophone input	200 mV
Range	50—15,000 c/s (within ± 0.7 dB)
Signal-noise ratio	54 dB
Tubes	Two ECC 83, two EL 84, selenium rectifier
Dimensions	
Length	250 mm
Width	180 mm
Height	145 mm
Weight	9.5 kg

Applications

ZGA 3921 is an ideal amplifier for the home. It ensures full value in listening to the new high-fidelity, long-playing gramophone records and tape recorders. Its reproduction far surpasses that of the amplifier in an ordinary radio. It also finds applications in record shops and in juke boxes.

ZGA 3921 can also be used for small loudspeaker systems, e.g. in restaurants and churches, on open-air stages and sports arenas, and in private intercommunication systems for staff location, etc.

ZGA 3921 will be introduced shortly in an additional model to fit the combine-unit system (described in Ericsson Review no. 2, 1955). With this amplifier, central equipment can be assembled in a convenient and attractive manner for systems with moderate power requirements.

New Automatic Circuit-Breaker

J HAGDAHL, AB ERMI, ULVSUNDA, STOCKHOLM

DK 621.316.542.1

About ten yars ago L M Ericsson started to manufacture a single-pole automatic circuit-breaker with thermal release, designed for voltages around 30 V. They have now started production of a new automatic circuit-breaker of similar type but with improved properties.

The construction and properties of the new circuit-breaker are briefly described in this article.

The new automatic circuit-breaker, *RMF 202*, is a rocker arm operated switch with instantaneous make/break. The break clearance is 4.5 + 0.5 mm (two break points). Making is always done manually. Breaking may be performed manually or take place automatically on overloading through actuation of the switching mechanism by a bi-metallic strip directly heated by the loading current, known as thermal release.

The circuit-breaker is made in single-pole, double-pole and triple-pole types.

In the double and triple-pole design, a single-pole switch is combined with one or two side sections respectively without operating arms, but with mechanical switching units for the transmission of operate and release movements, compositely mounted on a base plate.

In the double and triple-pole switches all circuits are automatically broken whenever one of them is overloaded.

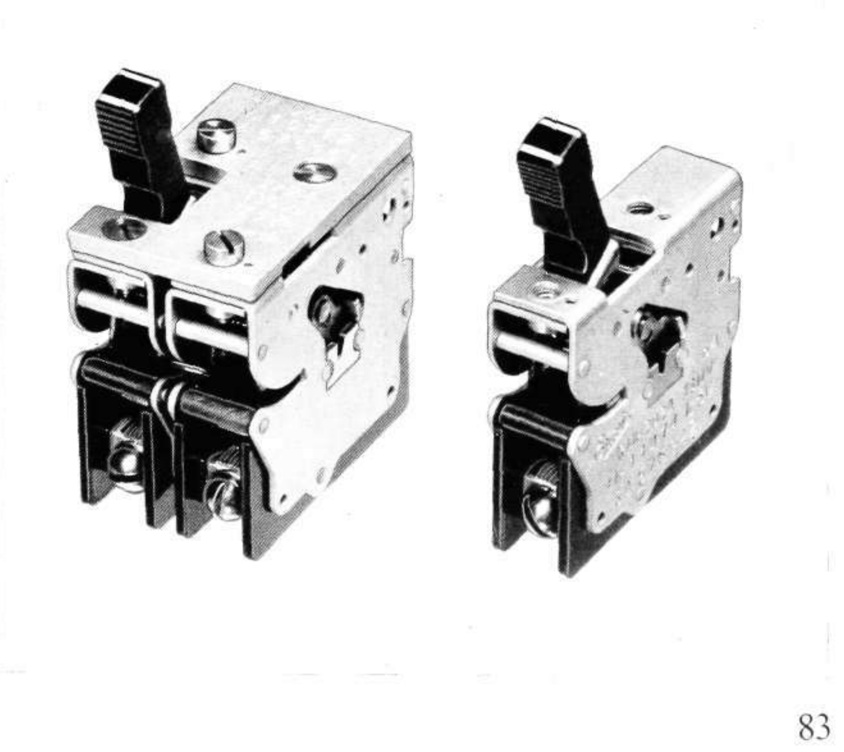
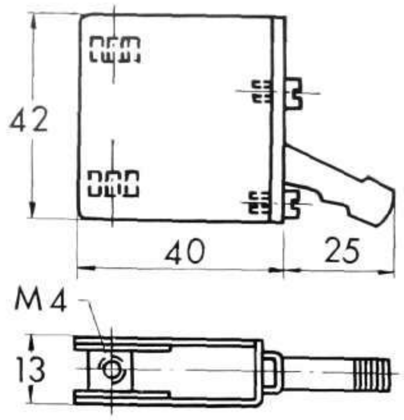
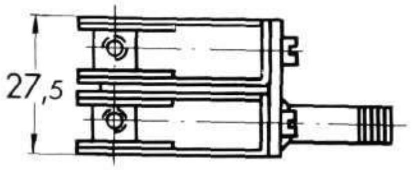


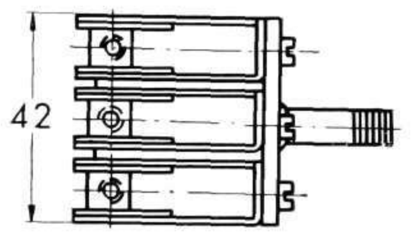
Fig. 1 X 6924
Automatic circuit breaker RMF 202
(right) single-pole and (left) double-pole



1-pole



2-pole



3-pole

Fig. 2 X 2055

Dimensional sketches of automatic circuit-breaker RMF 202

The RMF 202 switch is designed for the following current and voltage ratings:

Rated current A	Rated voltage V∼	V=	Voltage drop mV
2	220	220	ca 250
6	220	220	ca 100
10	130	30	ca 100
15	130	30	ca 100
20	130	30	ca 100
30	—	30	ca 100
40	—	30	ca 100
50	—	30	ca 100

Thermal release times:

at rated current	no release
1.2 × rated current	> 10 mins.
1.8 × » »	< 10 mins.
2.5 × » »	> 5 secs.
6 × » »	< 5 secs.

The temperature compensation of the switch is so arranged that the above release times apply within the temperature range — 55° C — + 70° C.

Test voltage: at 760 mm Hg 2,000 V
» 50 » Hg 700 V

(R.m.s. value 50 c/s sinusoidal alternating current.)

Weight: single-pole 36 g; double-pole 77 g; triple-pole 117 g.

The appearance of the circuit-breaker in the single and double-pole types is shown in fig. 1. Fig. 2 shows dimensional sketches of the switches.

Other performance data:

Type tests show that the circuit-breaker withstands impact with acceleration of 50 g and duration 1 ms, and vibration with acceleration 5 g at 50 c/s, 10 g at 100 c/s and 20 g at 400 c/s, without release or momentary breakdown. The type tests also show that the circuit-breaker performs at least 10,000 operate and release movements at the rated current, and 1,000 operate and release movements at 2.5 × rated current and ohmic load.

6760 and 6761 — Two New Power Amplifiers in the SER Series of Long Life Tubes

S EDSMAN, AB SVENSKA ELEKTRONRÖR, STOCKHOLM

DK 621.385.1:621.395

6760 and 6761 are two additions to the long life tube series. They are both designed for fairly low supply voltages. Typical conditions of operation are given for both a simple output stage and two tubes in push-pull operation.

After amplifier 6AQ5L/18AQ5 was re-designed (see Ericsson Review No. 1, 1955) it seemed impossible to obtain further improvement of the output at low supply voltages. In certain couplings two or more power amplifiers were needed to attain a satisfactory output, especially when supply voltages were 130 V or below. The desire for a new power amplifier was repeatedly expressed, and the requirements may be summarized as follows.

1. At 130 V max. supply voltage the output should be at least 1.5, preferably 2 W, at 5 % distortion.
2. The figure of merit of the tube should be the highest possible consistent with reasonable cost.
3. The optimum load impedance should be as low as possible.
4. When the grid bias is zero, the plate current should be as high as possible, even at moderate screen grid voltages.
5. The tube should be of the miniature type.

These requirements have been fulfilled by an SER 9-pin miniature tube, with a cathode so durable that high cathode currents are permissible, even with permanent operation. Since it is the screen grid dissipation which usually sets the limit for the maximum cathode current (point 4), it has been ensured that the screen grid current shall constitute only a very small portion of the cathode current.

The base diagram of the tube is shown in fig. 1, and all essential ratings are given in table 1. 6760 is designed for 18.0 V heater voltage, and 6761 for 6.3 V. Otherwise the two types are identical.

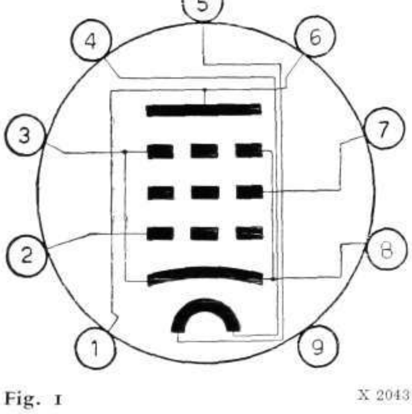


Fig. 1
The same base connection is used in 6760 and 6761

Table 1

		Without shield	
Capacitances			
Control grid to plate	max.	0.4	pF
Input		11	pF
Output		5.5	pF
Maximum Ratings			
Plate voltage		250	V
Screen grid voltage		200	V
Plate dissipation		10	W
Screen grid dissipation		1.5	W
Cathode current		100	mA
Voltage heater—cathode		100	V

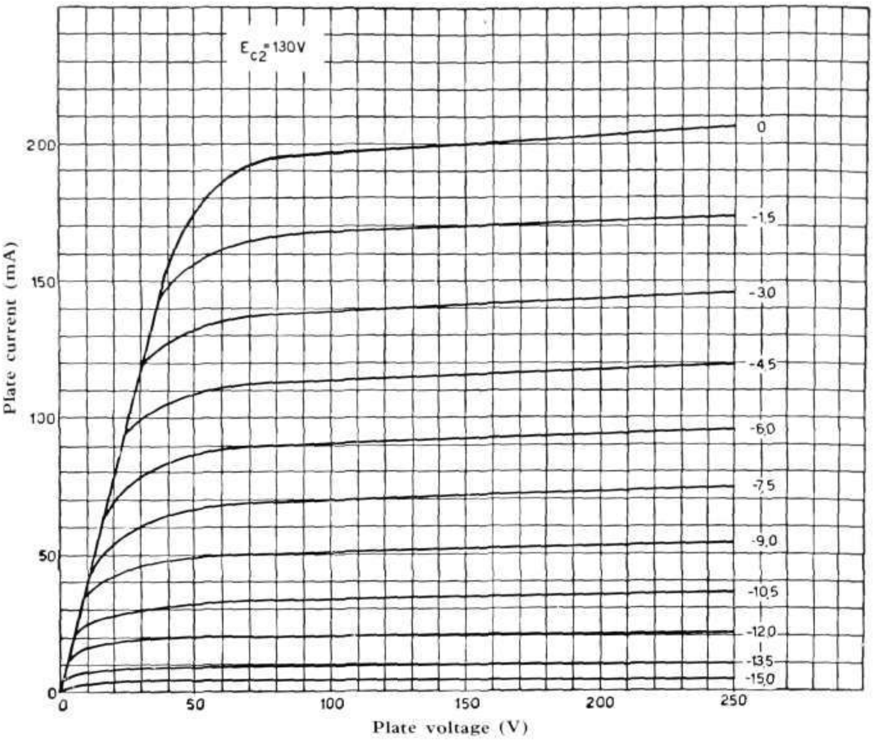


Fig. 2 X 6895

Plate voltage/plate current characteristics for tubes 6760 and 6761

The absence of secondary emission from the plate means that there are no dips in the curves at low plate voltages. The knee of the zero curve occurs at low plate voltage and high current.

Typical Operation

Heater voltage 6761*	6.3 ± 5 %	V
Heater current 6761	1.0	A
Heater voltage 6760*	18.0 ± 5 %	V
Heater current 6760	0.35	A
Plate voltage	130	V
Screen grid voltage	130	V
Cathode—bias resistor	100	ohms
Plate current	70	mA
Screen grid current	3.5	mA
Transconductance	12	mA/V
Plate resistance approx.	30,000	ohms
Control grid voltage for 100 μA plate current approx.	— 25	V
Load resistance	2,000	ohms
Output at 10 % distortion	2.9	W
Output at 5 % distortion	2.0	W

Aside from the above-mentioned points, attention has been given to the mechanical structure of the tubes to ensure that, like other tubes in the long life series, they shall adequately withstand vibration in every direction.

The design of control grid and cathode follows the principles adopted in all SER long life tubes; and since a similar power amplifier has passed 10-year life tests with good results, the life of the new tube should prove satisfactory. This is also shown at the present stage of testing. The new design has, however, been improved by reducing the lateral grid wire from 0.10 to 0.05 mm. This provides a straighter control grid characteristic and, consequently, lower distortion.

The plate voltage/plate current characteristics are shown in fig. 2. At 130 V screen grid voltage the knee of the plate current curve at zero bias occurs at about 190 mA and plate voltage around 60 V.

* To attain the longest possible life the heater voltage of the tube should be kept within narrow limits.

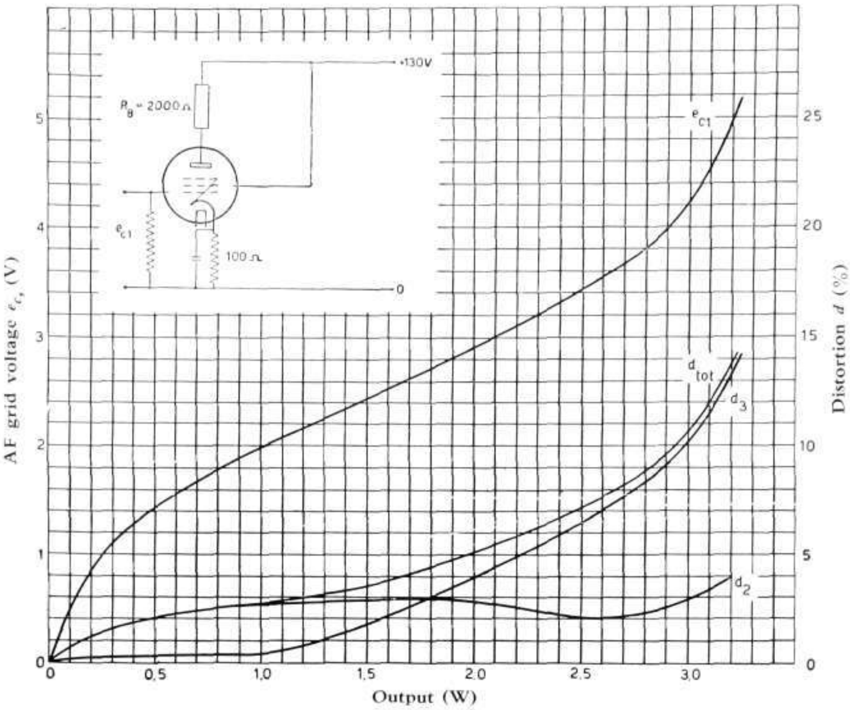


Fig. 3 X 6896

Distortion and AF grid voltage as function cf output

A grid voltage as low as 3 V produces an output of 2 W with 5 % distortion at a load resistance of 2,000 ohms.

The plate current cut-off grid voltage is only about 25 V, in spite of the fact that the tube must have a low amplification factor between control grid and screen grid to enable it to be used at low supply voltages.

The use of the tube as audio power amplifier is shown in fig. 3, in which distortion and grid voltage are plotted as function of output. It will be seen that no more than 3 V audio grid voltage produces a 2 W output with 5 % distortion. Fig. 4 shows the output at different load resistances and at a

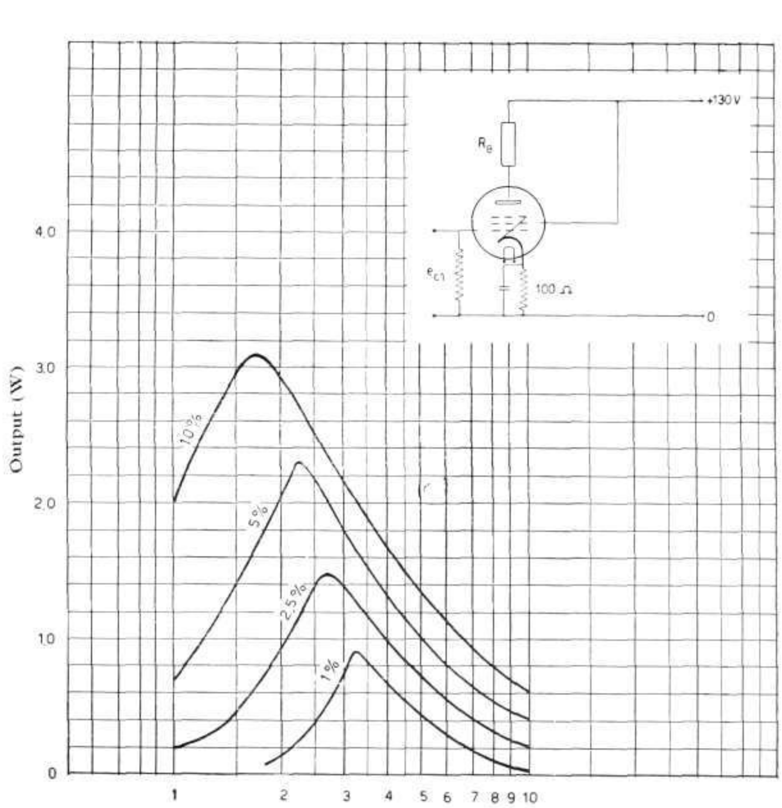


Fig. 4 X 6897

Power output as function of load resistance at a distortion of 1—10 %

If a very low degree of distortion is aimed at, the load resistance should be fairly high (3,200 ohms for 1 % distortion and 0.9 W output).

distortion of 1—10 %. The maximum output for the respective degrees of distortion is reached at a load resistance varying between 3,200 ohms (1 % and 0.9 W) and 1,700 ohms (10 % and 3.1 W).

It is indeed desirable that a good output should result from low load resistances, since it is sometimes difficult to obtain high resistances in broad band circuits.

As evidence of its versatile applicability, it may be mentioned that at 35 V supply voltage a tube has an output of about 90 mW with 10 % distortion for the same cathode resistor and the same load resistance as at 130 V (100 ohms and 2,000 ohms respectively).

Table 2 lists a number of suitable conditions of operation for output stages in push-pull operation, class A—AB. The measured values apply to a distortion-free driving stage and with fully balanced even harmonics. Since it is difficult to achieve this condition in practice, approximately 1 % distortion of the second harmonic should be expected, which raises the total distortion to about 1.5 % instead of 1 %. For the higher degrees of distortion the difference will be negligible. Thus the highest output at 1.5 % total distortion will be slightly above 10 W at 50 % plate efficiency. The low driving voltage means that a phase inverter stage, immediately prior to the final stage, provides fairly low distortion. Measurements have confirmed the above figure of 1.5 % total distortion at 10 W primary output. This distortion can, of course, be reduced to the desired level by negative feedback.

Table 2. Output stage in push-pull operation

Plate supply voltage	130	130	130	200			200			V
Screen grid supply voltage	130	130	130	105			150			V
Cathode bias resistor	50	70	100	60			100			Ω
Plate current, without signal	140	102	82	95			100			mA
Screen current, without signal	7	6	5	3			5			mA
Load resistance plate-plate	2.2	2.5	2.5	3.5			3.5			kΩ
Audio grid voltage	2.7	5.0	7.5	6.4	6.6	7.4	8.0	8.5	9.7	V
Power output	6.4	6.3	6.3	8.5	8.5	8.5	10.2	10.7	11.7	W
Distortion	5	5	5	1	2.5	5	1	2.5	5	%
Plate current at stated output	140	106	92	96	97	100	102	105	112	mA
Screen current at stated output	14	16	20	5	6	7	15	18	23	mA

Among other applications, the tubes are used as serial tubes for stabilized rectifiers. At 100 mA plate current the voltage drop is only about 100 V when the grid voltage is zero. A further use in power units is as a substitute for chokes; the plate resistance, which is about 30,000 ohms, corresponds to a choke of about 50 H at 100 c/s. The weight of the tube and necessary circuit components is considerably less than that of a choke.

The New Pello Switch

S. LJUNGH, AB ALPHA, SUNDBYBERG

DK 621.316.542.3

For the past two years AB Alpha has been producing a new type of Pello switch which, like its predecessors, is a single button switch. The mechanical design is entirely new with a more efficient and modern appearance.

AB Alpha started manufacturing a push-button switch named Pello in 1931. The name derives from the latin verb *pello* meaning "I push". The design was based on a patented mechanism of high reliability and durability. The main feature of this mechanism was that it was operated by a *single* button and for a long time Pello remained the only single button switch on the market. From the start, the high quality and simple operation of the Pello switch won the confidence of industry and the general public alike. The increased demand for the switch over the course of the years is witness to the growing appreciation it has met with.

Since the last world war, the call for improved installation materials and the desires expressed by electrical contractors for smaller dimensions and simplified installation arrangements caused AB Alpha to redesign entirely its push-button switch. At the end of 1953, after a long period of experimenting and testing, a new Pello switch was ready for production. The switch is approved by the Swedish Bureau for Testing Electrical Equipment.

Nearly two million of the switches have now been manufactured and sold, and this may be reason to present the switch in greater detail.

Like its predecessors, the new Pello switch is a single button unit. It is made in white or brown for both recessed and surface mounting. The recess-mounting switch is made for either grip lever or screw attachment, which means that it can be fitted in both 60 and 65 mm sockets. When mounted on the wall, the recessed Pello differs very little in appearance from its prede-

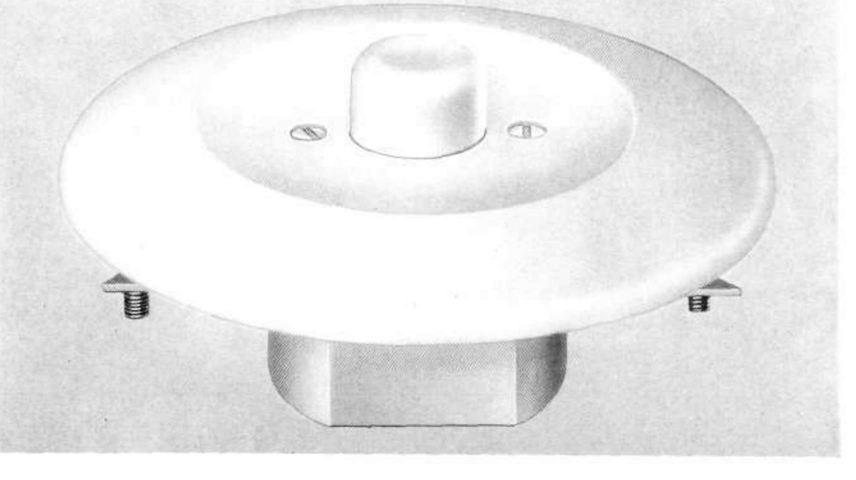
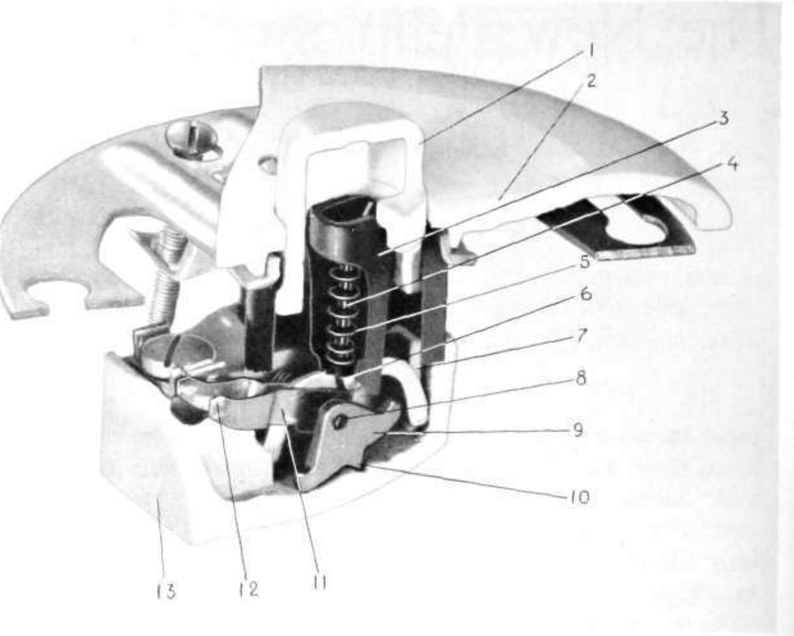


Fig. 1 X 6927
Alpha's new Pello switch
for recessed mounting

Fig. 2 X 6922

Pello push button switch for recessed mounting: cross section

1 push button
2 cover
3 rocker
4 guide pin
5 pressure spring
6 cut-off roller
7 yoke
8 spindle
9 cradle
10 pivot
11 contact bridge
12 self-cleaning contact
13 base



cessor. The plastic cover, however, has smooth lines, without dust collecting pockets, and the push button is smaller than before in both height and diameter. The surface-mounting switch has a completely changed shape, the cover now being much lower and much more attractive in appearance.

The inside of the switch is entirely re-designed. The mechanism consists principally of button, pressure spring, rocker and a lever-action contact bridge. The rocker is two-armed and is pivoted in the button which is actuated by the pressure spring. Each of the two arms actuates its cradle, which is formed at the bottom like a knife edge, pivoting on the base.

The two cradles are connected to a spindle in which the contact bridge is journalled. The contact bridge is constructed in the form of a double two-armed lever with, at one end, contacts shaped in such a way that they are self-cleaning and, in coordination with the fixed contacts, assist in quicker breaking of the switch. The contact bridge is actuated by two cut-off rollers mounted on a single pin. The pin pivots in a yoke which moves in the vertical direction of the button, guided by two slots in the base. A plastic guide pin, on which the pressure spring is mounted, is secured to the yoke. The pressure spring, which is held between the rocker and a flange on the guide pin, actuates the two cut-off rollers so that they rest with a certain tension against the contact bridge. On operation of the switch and movement of the rocker, the cut-off rollers roll on the contact bridge and carry the bridge alternately to its two extreme positions.

Fig. 3 X 2054

Pello push button switch

2 one way for surface mounting

This construction leads to an instantaneous make/break in the circuit and allows great reduction in the outer dimensions of the switch, thus allowing adequate space for wiring in contrast to the comparatively confined accommodation of recessed-type sockets. The contact screws are easily accessible. The mechanism is partly recessed in the steatite base and is surrounded by the guide cover, thus enclosing the entire mechanism and protecting it against dust and mechanical disturbance both before and after installation.

Ericsson LM NEWS *from*
All Quarters of the World

The Venezuelan Minister of Communications, Col. Félix Román Moreno, is seen signing the contract with L M Ericsson. From left are Mr Sven Lagergren, LME; Sr Enrique Marquez, legal adviser of the Ministry of Communications; Mr. Ivar Hilfing, head of CEV; Sr Eduardo Marcano Guzmán, head of the Cabinet; Mr Göte Fernstedt, LME, and Sr Henrique Vegas Léon, technical advisor of the Ministry.

Large telephone order from Venezuela

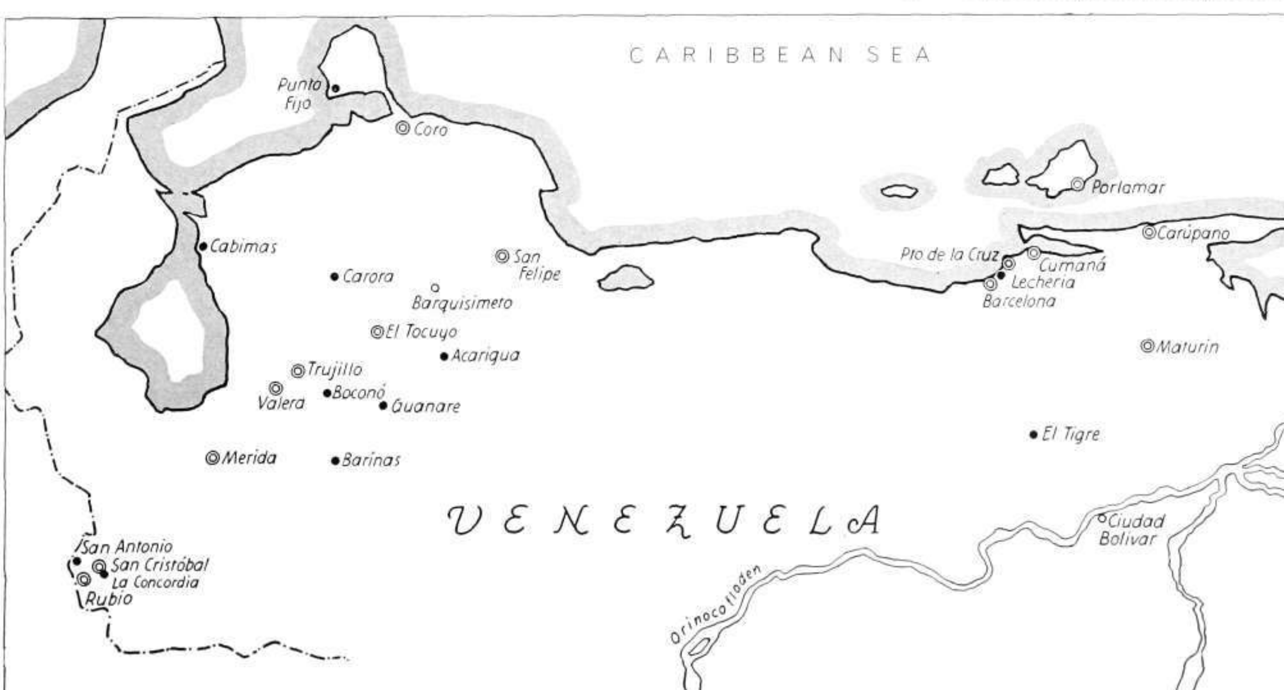
L M Ericsson has received a telephone order from the Venezuelan government amounting to no less than 12½ millions of US dollars. The contract was signed in Caracas, capital of Venezuela, by the Minister of Communications, Col. Félix Román Moreno, and Mr Ivar Hilfing of Cia Anónima Ericsson. The contract comprises the construction and installation of 11 new automatic exchanges with 500-line selectors and crossbar registers, and the extension of 14 other L M Ericsson exchanges in Venezuela built under contracts of 1946, 1948, 1950 and 1953. LME is also to supply complete cable and conduit plant for the exchanges, as well as telephone instruments. The contract is to be completed within 39 months, by which time L M Ericsson will have built a total of 27 automatic exchanges in 26 Venezuelan towns.

This large order is a step in the program undertaken by the Venezuelan government to provide better communications for its rising population, which is at present estimated at about 5 million persons. Extensive projects within different fields have been recently decided and put into execution under the leadership of President Marcos Pérez Jiménez. A number of super-highways have been built in different parts of the country, a housing programme is in full swing in the capital city of Caracas and other large towns—ultramodern apartment houses are springing up in various places—and considerable interest is being devoted by the government to schools and hospitals. A number of electric power plants have been installed, and large sums have been spent on the exploitation of iron ore deposits—Venezuela's main wealth otherwise lies in oil, in which the country stands second among world producers.

Map of L M Ericsson exchanges in Venezuela

◎ **extension of old exchanges**

• **new exchanges under 1955 contract**



Heads of State at Zagreb Fair

At the international fair at Zagreb in September, the joint pavilion organized by L M Ericsson and Nikola Tesla was visited by two heads of state. At left Marshal Tito of Yugoslavia is welcomed by Mr Peter Kovač of Nikola Tesla, and to the right is King Paul I of Greece with Mayor Vladimir Bakarić of Zagreb.

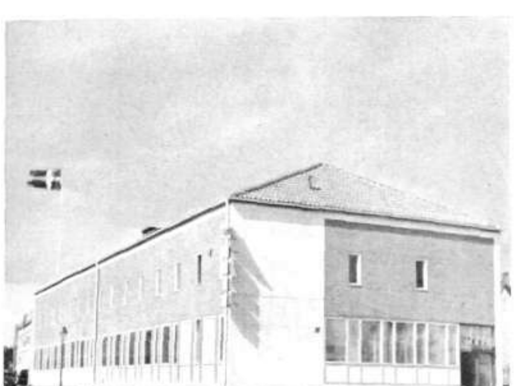
New Automatic Exchanges installed in Skåne

The new automatic exchange at Ystad, constructed by L M Ericsson, was put into service on July 10. The installation work on this exchange, which was built according to the Swedish Telecommunications Administration marker system, was started in August last year and completed in April.

LME's work in Ystad comprises the extension of a local exchange for 4,000 subscribers, and a toll exchange to which 21 rural exchanges are connected. Two of the latter, Skurup and Löderup, are junction centres, the former supplied by LME.

LME has also built nine automatic exchanges within the Ängelholm area, the terminal exchanges of Förslövsholm, Vejbystrand and Hjärnarp, which went into service on June 3, and the junction centres at Båstad and Västra Karup with associated terminal exchanges at Grevie, Ramsjöstrand, Torekov and Ängalag, cut in on September 30.

Subscribers in the Ystad and Ängelholm areas will now have facilities for automatic calls to Malmö and, via Malmö, to large parts of Skåne converted to automatic operation earlier.



Inauguration of Izmir Exchange . . .

A new trunk exchange in the Turkish town of Izmir (Smyrna) was inaugurated on August 21 by the Turkish Minister of Communications, Muammer Çavusoglu, in the presence of Governor Kemal Hadimli of Izmir, a number of representatives of the Turkish Parliament, Cahit Akayar, director general of the PTT, Mayor Selahattin Akçiçek of Izmir, and others.

(Left) The new exchange in Ystad. (Right) The inauguration in Izmir. From the centre to the right are seen Director General Cahit Akyar of the PTT, a woman member of parliament, Minister of Communications Muammer Çavusoglu and Assistant Technical Director Turhan Bey.

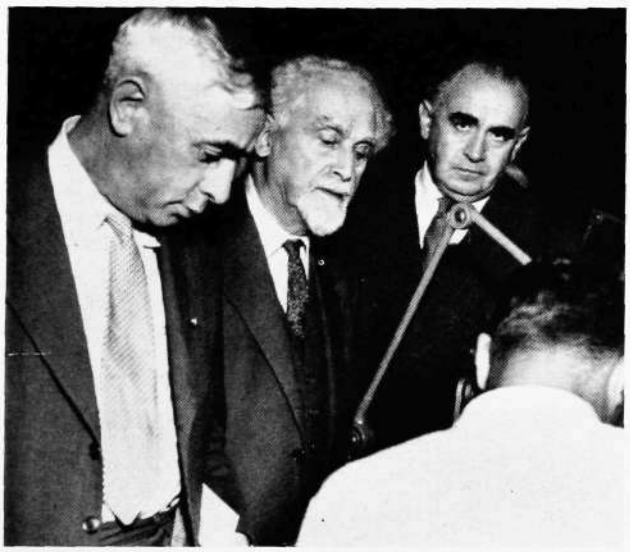
In addition to the construction of this new exchange, with 16 trunk positions, L M Ericsson have also extended the Merkez Santral exchange in Izmir, which was cut into service at the same time. During 1955 LME have, moreover, rebuilt all registers in the Izmir exchanges from a 4 to a 5-digit numbering system.

. . . and in Cartagena

The city of Cartagena in Colombia now has a dial telephone system. The two exchanges—Centro, 3,500 lines, and Bosque, 500 lines—were cut in on May 28. L M Ericsson constructed both exchanges and external plant, the exchanges being of OS type.

The head of the Telecommunications Administration in Western Germany, Mr Balke (centre) and Dr Orth, ministerial councilor (far left), visited L M Ericsson at the end of August. The photograph shows them on a tour of the factory, watching crossbar switch wiring.

A group of Israel's Interparliamentary Delegation passed through Sweden on return from the Soviet Union at the end of the summer. In addition to its leader, former Minister of Defence and Agriculture Pinhas Lavon, the delegation included Rabbi Mordechai Nurock, first Israel Post Office minister and Mr Jacob S Shepiro, chairman of the executive committee of the Interparliamentary Delegation, who are seen (left to right below) studying a manufacturing process in the L M Ericsson main factory.



A seven-man delegation from Lebanon recently visited L M Ericsson and was received by President Sven Ture Åberg. He is seen (left) in conversation with the leader of the delegation, Mr Habib Bey Abi-Shahla, former speaker of the Lebanon Parliament (right). In the centre is Mr Dick Tosbath, member of parliament and editor of the Lebanese newspaper Le Soir.

The Philippine envoyé to Sweden, Leon Guerrero, who is stationed in London, visited L M Ericsson at the end of September. Here he is seen listening to the reproduction quality of an 1892 model telephone.

A ten-man delegation from the Norwegian Parliament has also paid a visit to the main factory in Stockholm. Some of the visitors are seen with their leader, Mr Lars Evensen, standing at right.

Peaceful Load on Military Plane

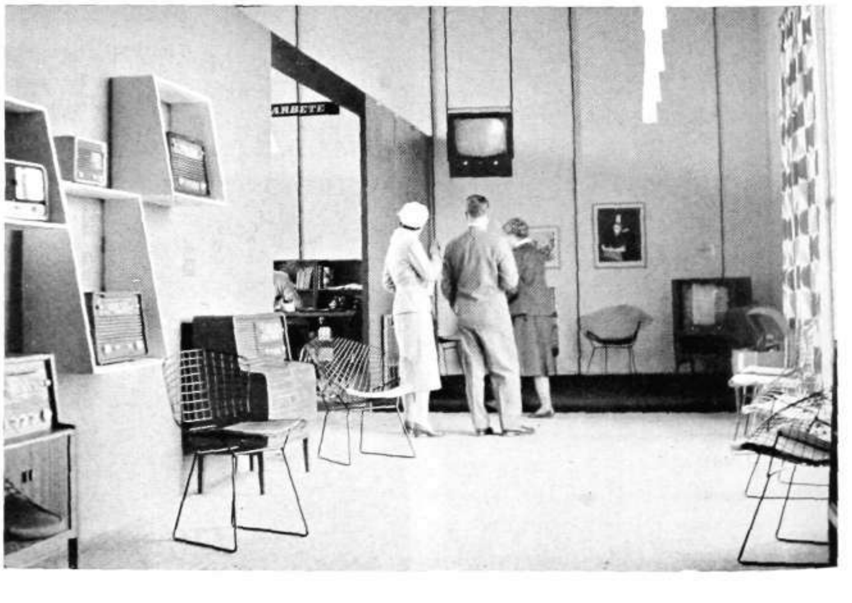
Loaded only with L M Ericsson products, an Ethiopian military transport plane left Bromma one day in July, with the head of the Ethiophian Air Force, Col. Carl Gustaf von Rosen, at the controls. The reason for this unique transport was that the Imperial Board of Telecommunications of Ethiopia was in urgent need of certain telecommunication material for exhibition in Addis Abeba and Gondar, Ethiopia's second city. The consignment comprised 73 parcels with a total weight of 5,500 pounds, containing, among other things, a 200-line P.A.B.X. and a demonstration rack for 500-line selectors.

L M Ericsson Service at Radio-Rally in Holland

The name of L M Ericsson was to the fore in the South Dutch town of Hertogenbosch this summer. Hertogenbosch had its fifth Radio-Rally —a motor competition, so-called because the competitors receive their driving orders over the radio. A station wagon with a large L M clock, to which were connected twelve slave clocks along the course, and an LM loudspeaker installation for announcements and music recorded on an Ericorder was installed at the goal for the recording of running times. A team manned by staff from Ericsson Telefoon-Maatschappij in Haag was also among the competitors.

In the photograph to the left is seen the crew of the station wagon, also from the Ericsson sales office in Haag: Mr Godefridus van Hellenberg, Mr Adrianus van Wegen and Mr Georg Heppe.

H 55 in Hälsingborg has been the great sensation among Swedish exhibitions this summer. L M Ericsson and its associated companies were among the many exhibitors and showed a representative collection of their manufactures: private automatic exchanges, loudspeaker telephones, staff locators, telephone answerers, Ericorder etc. — The photo to the right is from the Svenska Radioaktiebolaget exhibition, in which the new radio and TV instruments were shown.



U.D.C. 621.317: 621.3.012.6

OLSSON, A & ÅKESSON, N-Å: *Dynamic Measurements—a necessity in the development of High Speed Telephone Systems.* Ericsson Rev. 32 (1955) No. 3 pp. 64—69.

The development of automatic telephony has placed continuously growing demands on the electromechanical components employed. It is no longer sufficient to know merely their static properties–the study of the dynamic conditions has become increasingly essential. This article describes some of L M Ericsson's special resources for these studies. A few typical examples illustrate the special measuring technique that has been developed.

U.D.C. 621.395.24

RODNERT, G: *10-line Relay Switchboard with Built-in Battery Eliminator.* Ericsson Rev. 32 (1955) No. 3 pp. 70—71.

The increasing demand for minimum maintenance operation of private branch exchanges has led to extensive use of relays or similar units as switching devices. To meet this demand, L M Ericsson has replaced their OL 15 with a new private automatic exchange, AMD 22101, which is a newly-designed switchboard using only relays as switching devices. This new P.A.X. has a capacity of 10 lines with one link (the same capacity as the OL 15) which, in most cases, is adequate for small offices, factories, or house telephone systems.

U.D.C. 621.395.97

TRÄGÅRDH, A: *Program Distribution Plant for United Nations.* Ericsson Rev. 32 (1955) No. 3 pp. 72—73.

The honour of supplying the program distribution plant in service in the stately United Nations headquarters in New York was won by L M Ericsson in stiff competition with a number of other manufacturers. This plant, that enables national delegates to follow from their own offices any non-confidential session in progress in the various conference rooms, is shortly described in the article.

U.D.C. 656.256

BOBERG, I: *L M Ericsson's Manual Block System.* Ericsson Rev. 32 (1955) No. 3 pp. 74—78.

L M Ericsson's manual block system employs to a large extent the same components as a normal relay interlocking plant. It is suitable mainly for single track lines. The article describes first the historical development of manual block systems, then the goals set for the design of L M Ericsson's manual block system and, finally, in more detail, the circuitry and operation of the system.

U.D.C. 621.375

EKSTRÖM, H: *High-Efficiency 10-watt Amplifier.* Ericsson Rev. 32 (1955) No. 3 pp. 79—82.

The reproduction of the now so popular tape recorders and long-playing phonograph records have created a demand for a high quality amplifier with moderate output. For a long time Telefonaktiebolaget L M Ericsson has manufactured amplifiers for sound distribution systems and has recently brought out a 10-watt amplifier, ZGA 3921, for high fidelity reproduction. A short description of the construction and the various applications of this amplifier.

U.D.C. 621.316.542.1

HAGDAHL, J: *New Automatic Circuit-Breaker.* Ericsson Rev. 32 (1955) No. 3 pp. 83—84.

About ten years ago L M Ericsson started to manufacture a single-pole automatic circuit-breaker with terminal release designed for voltages around 30 V. The construction and properties of a new circuit-breaker are briefly described in the article.

U.D.C. 621.385.1: 621.395

EDSMAN, S: *6760 and 6761—Two New Power Amplifiers in the SER Series of Long Life Tubes.* Ericsson Rev. 32 (1955) No. 3 pp. 85—88.

6760 and 6761 are two additions to the long life tube series. They are both designed for fairly low supply voltages. Typical conditions of operation are given for both a simple output stage and two tubes in push-pull operation.

U.D.C. 621.316.542.3

LJUNGH, S: *The New Pello Switch.* Ericsson Rev. 32 (1955) No. 3 pp. 89—90.

Short introduction of AB Alpha's new type of Pello Switch which, like its predecessors, is a single button switch. The mechanical design is entirely new with a more efficient and modern appearance.

The Ericsson Group

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Productos Mundiales, S. A. *Panama, R. P.*, P. O. B. 2017, tel: 2 2003, tgm: mundi

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ERICSSON Review

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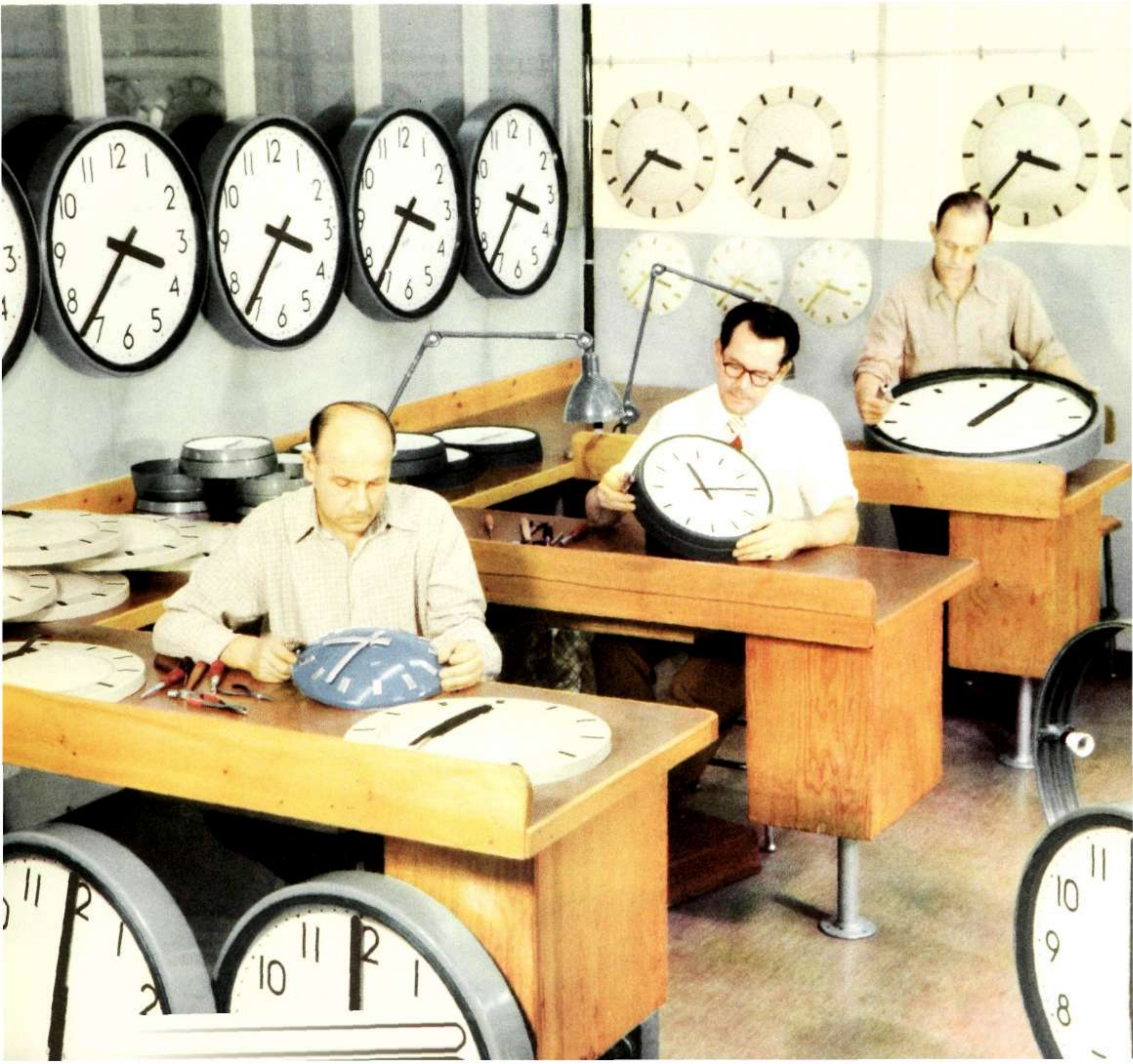
1955



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K G HANSSON, TELEFONAKTIEBOLAGET LM ERICSSON, STOCKHOLM

U.D.C. 621.395.722.004.5

The organization of maintenance in an automatic telephone exchange is a matter of prime importance to the telephone administration. A well managed exchange means that subscribers are satisfied with the service offered them, that the number of subscriptions rises, and that the administration can operate on a more efficient basis. The constant rise in wages in all parts of the world is making it imperative for every administration to choose a telephone system that is inexpensive to maintain because of its low requirements of manpower, counted per line and year.

L M Ericsson has devoted very considerable efforts to the design of reliable, robust switching plant, soundly engineered and with good traffic properties, and also to the development of rational maintenance methods and aids. This article discusses the assumptions for economic maintenance of L M Ericsson's 500-line selector and crossbar systems, and puts forward certain new viewpoints in regard to maintenance methods.

General Assumptions

There are three main factors to be taken into account in the maintenance of all automatic telephone exchanges, viz. the schematic and mechanical design of the system, the external conditions—the plan of the building, dust and moisture problems—and, thirdly, the qualifications of the maintenance staff.

The most careful attention is always given to the circuit design of 500-line selector and crossbar systems, and the equipment is put through stringent laboratory and acceptance tests. Experience has shown, moreover, that the more extensive and efficient methods of installation testing that are now followed, including so-called load testing of certain exchanges, has eliminated practically all risk in the cut-over of new exchanges and has reduced their running-in time to a minimum.

Thus, in a properly designed and trimmed up automatic exchange, the sole criterion governing its reliability and length of life will be the mechanical functioning of the individual items of equipment. The efficiency of switching equipment does, of course, primarily depend upon the mechanical design and precision of manufacture, but its performance will also be affected by external conditions and, above all, by whether it receives proper treatment from the maintenance staff. This latter point implies, as will be understood from the remarks later on, that the correct procedure is generally to leave the equipment alone as far as possible.

Before considering the questions of external conditions and qualifications of staff, it may be worth while having a look at the switching equipment employed in L M Ericsson's automatic exchanges.

The 500-line selector

In the 500-line selector systems the 500-line selector itself, with its power drive, is the only machine-driven unit. The remaining equipment consists of relays and crossbar switches, the latter having replaced the earlier mechanical switches in the registers.

The 500-line selector has been working as the switching element in automatic telephone exchanges in all parts of the world, and under widely differing conditions, for the last 30 years. Up to the present date considerably above one million of these selectors have been manufactured and put in service, and they have been proved their worth as a robust form of switch which makes little demands on care and maintenance. What the 500-line selector needs is to be cleaned and lubricated at intervals that may vary from 1½ to 3 years, depending on the external conditions. (Cf. Ericsson Review No. 1, 1951, "Maintenance of Automatic Telephone Exchanges with 500-line Selectors", and No. 3, 1954, "Maintenance Work and Reliability for Automatic Telephone Exchanges with the L M Ericsson 500-line Selector in Stockholm".) No general adjustment of the selector should be made at the time of cleaning and lubrication, but merely a check of the position of the wiper shaft and of the functioning of certain springsets. Adjustments should otherwise only be made when actual faults have to be put right.

As a means of further prolonging the interval for cleaning of selectors and multiple frames, selectors will in future be supplied with a contact cleaning appliance (fig. 1). The cleaner consists of a holder for attachment to the selector plate. The holder carries two boxes, each containing a plastic sponge that is moderately drenched with oil, roughly ¼ millilitre per sponge. The sponges will be placed on each side of the wiper shaft. Every time the wiper performs a radial movement or leaves the multiple to return to normal, its sliding contacts will be cleaned and lightly oiled. Any dirt which the contacts might pick up from the multiple will thus be effectively removed, whereas the oiling of the contacts practically eliminates all wear both of the contacts themselves and of the multiple wires. Previously the sliding contacts of the wiper were cleaned and oiled by hand in the intervals between the main overhauls of the switch. This process will be performed automatically by the cleaner, so eliminating the human factor with its attendant risks.

By the use of a contact cleaner, which can also be very simply fitted to selectors already in service, the intervals for inspection of the selectors can be generally extended to 2—3 years, and for cleaning of multiple frames to 8—10 years.

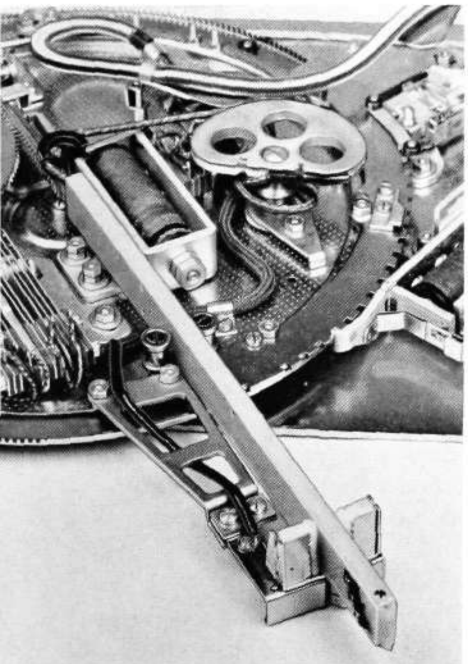

Fig. 1 X 2067
500-line selector type RVA fitted with contact cleaner

The crossbar switch

The crossbar switch (fig. 2) has become a growingly important component in L M Ericsson's automatic exchanges. It forms the chief switching element in the by-path systems *ARF 10*, *ARF 50* and *ARM 20*, and in rural exchanges type *ARK 30*. In the 500-line selector systems it is used in the register and in the connecting equipments between register and link circuits. Its rapid operation and good contact properties have made it excellently adapted to the complicated circuitry and traffic-handling requirements of modern telephone systems. Its mechanical construction is similar to that of a telephone relay so that, in normal service, wear is virtually negligible. (Cf. Ericsson Review No. 2, 1949, "Crossbar Switch—its Design and Manufacture".)

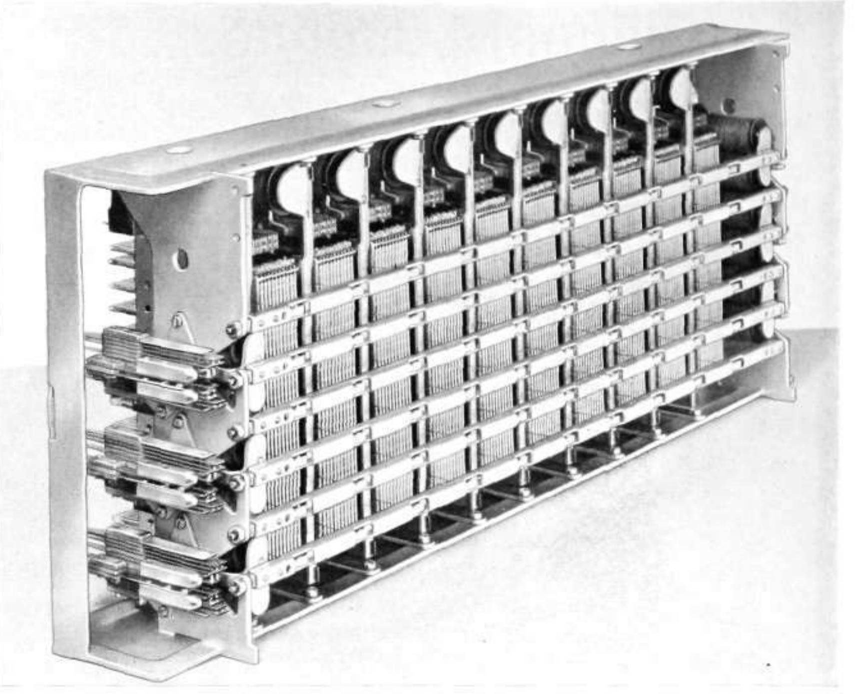

Fig. 2 X 6934
Crossbar switch type RVD

In the light of practical experience the maintenance requirements of the crossbar switch may be regarded as practically nil. No regular inspection is required, and the switch should not be interfered with except for the rectification of service faults.

Relays

Telephone relays in different forms constitute the great majority of switching elements in an automatic exchange. Crossbar exchange equipment consists exclusively of crossbar switches and relays, and large numbers of relays are used likewise in 500-line selector systems. The following types of relays are encountered:

Normal relays, line relays, miniature relays, multicoil relays, and polarized relays.

The miniature, or midget, relay is described in Ericsson Review No. 4, 1950, and the multicoil relay in No. 3, 1954.

The normal relay, which represents the absolute majority of telephone relays in an exchange, is now standardized to type *RAF*, with cards instead of spring-lifting studs, and with a simplified armature system. A nylon residual plate is used in place of the brass residual stud, so entirely eliminating the risk of sticking between armature and core. The springs have precious metal twin contacts, and the whole mechanical construction of the relay is a guarantee of extreme dependability and length of life. The same applies to the other above-mentioned types of relay.

The relays do not require inspection at determined intervals. There is overwhelming evidence from operating exchanges that more harm than good is usually done by unnecessary interference with relays. After the adjustments made to the relays in the factory they generally work for very long periods without attention. All relays have dust covers, and even after some degree of contamination their contact action is guaranteed by the twin contacts.

The general rule to be observed with relays is to interfere with them only when service faults occur or when marginal tests show that adjustment is necessary. Furthermore, adjustments must be done by competent persons and in accordance with the specifications. Much trouble and error will be avoided, moreover, by ensuring that the individual or common dust covers are always in position. In the first place the relays will be protected against dirt but, even more important, they will be safeguarded from involuntary damage by persons passing by or working in the exchange.

External conditions

It has already been stated that the equipment of an automatic telephone exchange requires little or no attention. This can only hold true, however, provided that the equipment is not made to work under unreasonable conditions inherent to the building in which it is housed, in abnormal dust conditions, or in unduly high or low humidity and temperature.

What are the conditions under which an automatic system works best, and what demands should be placed in respect to humidity and freedom from dust?

The question may be answered in general terms by saying that the best assumptions for reliability and long life of the equipment are that air in the switchrooms is kept free from dust and other contaminating substances and that the relative humidity is maintained constant at a figure between 50 and 80 %. The ideal switchroom should be hermetically sealed which, for obvious reasons, is difficult to accomplish.

The layout of the exchange should preferably be such that all extraneous work is done outside the switchrooms and that there is no unnecessary coming and going in them. The windows should be non-openable, and as few and small as possible, in order to exclude the rays of the sun and the entry of dust. Glass blocks or transparent plastic sheets between double windows are an admirable solution. Especially in hot climates the building should run north and south to avoid sunshine on the longitudinal walls. If the architecture of the building requires large windows, they should not be placed in the direct rays of the sun.

The switchroom should preferably have only one entrance leading, for example, form a control or repair room. This arrangement provides an air lock and at the same time affords a check of persons entering the switchroom. The portions of the plant which require most work, and do not form part of the main switching equipment, should be located outside the switchrooms.

Such parts of the plant are the following:

Maintenance control, e.g. service observation desk in 500-line selector system or fault indicating apparatus in crossbar systems
M.D.F.
Power plant
Subscribers' meters
Work benches and test desks
Staff lockers and off-duty accommodation

If these latter departments are made sufficiently attractive and comfortable by the provision of air conditioning, daylight, constant temperature etc., it should be possible to cut down unnecessary visits to the switchrooms to a very great extent.

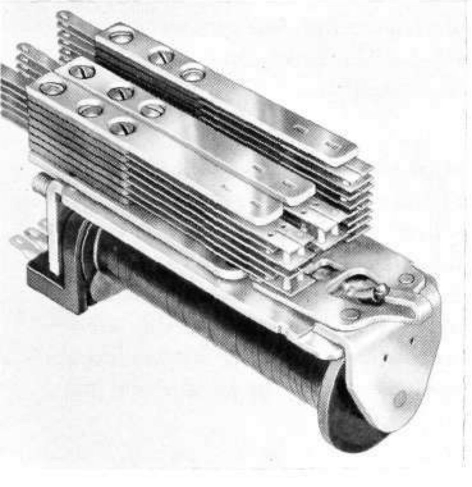

Fig. 3 X 2065
Normal telephone relay type RAF

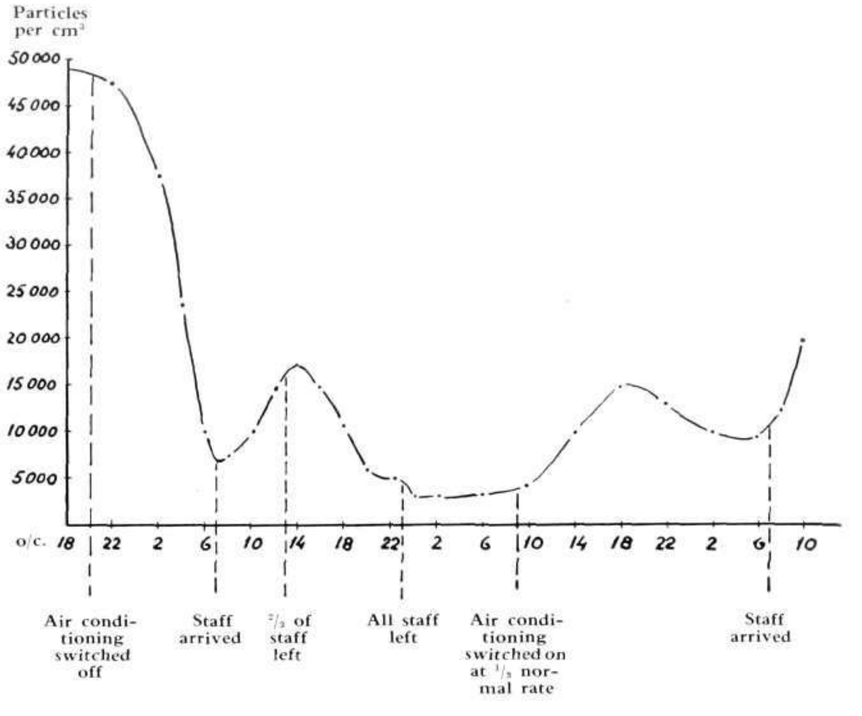

Fig. 4 X 6935

Variations in dust concentration

during two days in a 20 000-line exchange

Air conditioning
normal rate = change of air 9 times per hour
1/3 normal rate = change of air 3 times per hour

Variation of humidity
at point of measurement 57—63 % R.H.

Variation of temperature
at point of measurement + 25.6—26.2 °C

Walls and ceilings of switchrooms should be painted with light-coloured, turpentine-free paint leaving a smooth surface. Floors should be covered with linoleum or other material that can be polished. If curtains or other textiles are used in the switchrooms, they should be of a material, such as plastic fibre, which does not produce dust.

It is now a known fact that the accumulation of dust, especially on sliding and single contacts, is a cause of contact trouble and an important factor in the shortening of contact life. Twin contacts are considerably more resistant to dirt, but even with twin contacts it is naturally sound economy to pay attention to the dust problem.

The particles of dust in the air are in constant movement. Although switching equipment is usually protected by covers, the dust does penetrate within the covers and collects on the contacts. The greatest quantities of dust, however, accumulate on the floor and other horizontal surfaces and is set in motion by passers-by, by a window being opened, or by the draught set up by an air conditioning plant. Fig. 4 shows the variations in dust concentration in a 20,000-line automatic exchange type *ARF 10*. The curve clearly reveals the relation between dust concentration and air movement.

At low humidity the phenomenon arises that particles of dust on the contacts become electrostatically charged and stand straight out like bristles, with the consequent risk of contact fault. The first step in prevention of dust accumulation in an exchange is the removal of as much dust as possible from the rooms and from the equipment. This should be done with a vacuum cleaner and not with a broom or duster which merely results in moving the dust from one position to another. An excellent plan is to have a central vacuum plant with conduits leading to various points in the exchange so as to avoid the exhaust currents set up by portable vacuum cleaners.

Large automatic exchanges should preferably be equipped with an air conditioning plant, operating on the lowest possible rate of air flow. The air should not be changed more than two to three times an hour. At low air speeds the air can be efficiently filtered by means of mechanical filters at small cost. It will not, of course, be possible to separate the smallest particles, at least not below 5—8 μ in size, but, apart from certain rare types of chemically active carbon, such small particles seem to have no demonstrable effect on the functioning of the contacts. Electric filters are more efficient than mechanical, but should not be used owing to the damage caused by the small particles which pass through the filter and become electrostatically charged. If there is reason to suppose that local factories are generating soot of a kind to cause undesirable coating of contacts, a thorough analysis should be made of the atmosphere before deciding on the type of filtering plant to be used. Air inlets and outlets should be so located that the main air movements are in the parts of the exchange where dust can do little damage. The air conditioning plant should also maintain an overpressure of fresh air in the exchange and so prevent the entry of unfiltered air.

At places where the humidity varies greatly from one season to another, it may be necessary to install humidifying equipment.

In exchanges with circulating air the humidifying process can be most simply arranged by passing the air stream through a tube or chamber in which it is sprayed with water under high pressure. The spray must be virtually in the form of vapour (about 0.5 μ), as otherwise drops of water may be deposited on the equipment. If the exchange has no permanent air circulation plant, use may be made of small portable sprayers.

Moisture removal is now mostly done by absorption with some form of gel, which can likewise be combined with the air conditioning plant.

Air conditioning plants of these types may also be made to heat the air at the same time. When deciding upon the amount of heat required from the air conditioning plant, consideration should be given to the heat already developed by the exchange equipment. Heating of the exchange by air circulation is definitely to be preferred to central heating by radiators, which are the cause of considerable spreading of dust.

As the staff requirements of exchanges become successively less, so will the need of complete air conditioning and cooling plants become less acute. The extremely high temperatures of tropical climates, however, may in themselves cause trouble in exchanges in which the air is stationary, so that for this reason consideration should be given to cooling systems.

As regards power and charging plants, it should be ensured that the losses from rectifiers are led off by means of adequate air circulation in order to prevent damage to ventilators. Quick change of air should also be provided for in large battery rooms.

Staff qualifications

The telephone systems manufactured by L M Ericsson are called upon to meet complex technical requirements. They generally incorporate equipment for subscriber-dialled local and long distance calls, for multi-metering, for intricate signal transmission and reception, and so on. The switching functions are consequently of a fairly complicated nature, and a certain competence is required in the exchange staff. In view of the reliable switching equipment

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of which exchanges are made up, serious trouble is very seldom encountered in a well-trimmed exchange; but when faults occur, it is essential that they be rapidly and correctly located and remedied.

The number of staff required in an exchange is usually small, but it is imperative that the switchman or maintenance personnel who will be in charge of the equipment are fully acquainted with its circuit design, with the switches and switching processes, and that they can readily find their way about in the maze of racks, distribution frames and traffic routes. Maintenance personnel obtain valuable training by partaking in installation and testing work. L M Ericsson also arranges training courses for maintenance men.

An administration is thus making a good investment in securing staff with the highest qualifications and, furthermore, in adhering to a staff policy which ensures that the best men stay in its service.

Maintenance Methods

The principles on which the majority of administrations have hitherto organized their maintenance of automatic telephone exchanges have been based on periodical overhauls, routine preventive tests, inspections and similar measures. A consistent programme of maintenance has been followed, and perhaps not much thought has been spent on whether certain procedures were really warranted or whether some routine operations might be simplified or, in fact, altogether discarded.

The greater efficiency of the modern telephone systems, however, suggests the possibility of a radical change in maintenance methods, particularly if the requirements in regard to buildings and staff are fulfilled. It was in order to examine these possibilities that L M Ericsson instituted investigations and tests of plants operating on the crossbar system *ARF 10*.

Fig. 5
Maintenance plan
based on statistics

X 7689

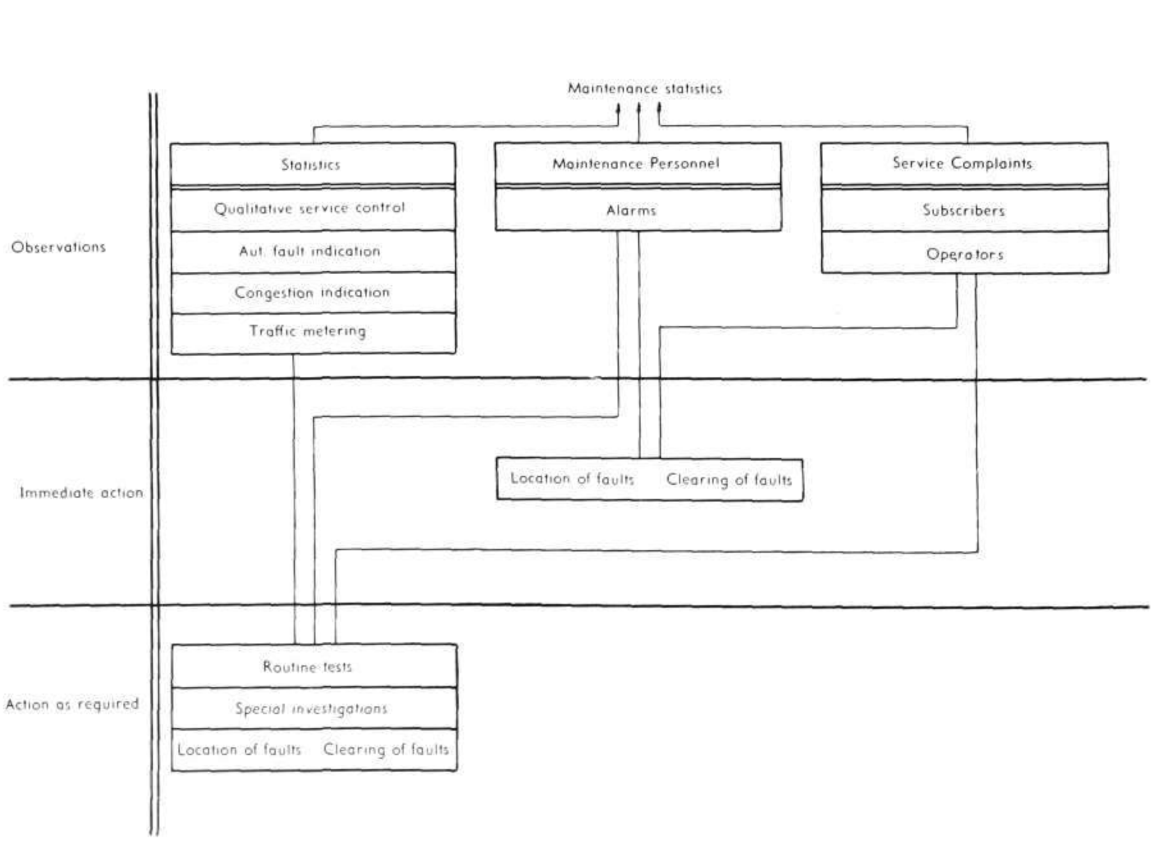

Fig. 6 X 2066

Traffic route tester

with portable receiver unit placed on top of transmitter unit

The underlying principles in these investigations were as follows:

a. Every routine test in which a fault is not encountered is superfluous.

b. Every form of inspection which cannot be proved to raise the grade of service or increase the life of the plant is valueless.

The investigations produced interesting results. By applying the above-mentioned principles, one after the other form of routine testing and overhaul was discarded, until none remained. Despite, or perhaps thanks to, this action the fault rate at the exchanges investigated fell during the period from 1 % to 0.08 %. The fault statistics were obtained by carrying out a number of end-to-end test connections at the exchanges.

There are thus factual reasons for the introduction of a maintenance programme based on statistics from qualitative service measurements, fault records provided by centralographs and counters, indications from congestion meters, and traffic measurements. These statistics will be the gauge of the service offered by the telephone exchange, and they will indicate when certain types of fault exceed a given limit and action must be taken to remedy them. Apart from the statistics, certain information regarding the operation of the exchange may be obtained from alarm panels and from complaints reported by subscribers and operators.

A general plan of this maintenance programme is shown in fig. 5. It will be seen that immediate action is only called for when faults are indicated by alarm panels or complaints. Such faults will be due to blown fuses, cable trouble or the like. Other faults should be dealt with as required.

Qualitative service statistics

The qualitative service control is the cornerstone on which the maintenance programme is built up. It consists of the simulation of traffic conditions by end-to-end tests of connections between two test numbers, corresponding to normal subscriber numbers, and affords a fully adequate appreciation of how the exchange is functioning.

Test connections may be set up manually, but quicker, cheaper and more reliable results are obtainable with automatic equipment. To this end L M Ericsson has constructed an automatic traffic route tester (fig. 6), consisting of transmitting and receiving units; the receiving unit may be located either in the home exchange or at other exchanges in the area.

Test connections consist of calls from 10 test numbers to 10 other test numbers, known as A and B numbers respectively. Thus a complete testing programme comprises 100 connections.

The traffic route tester may be used either for qualitative service control or as a fault indicator. For purposes of qualitative service control it records any faults discovered on meters and also indicates the types of fault, but does not block the connections. After the necessary number of connections have been tested, the number of correct connections, of faulty connections, and of types of fault can be read off on the meters. The meters therefore supply direct data for the statistics.

When used as a fault indicator, the tester stops when a fault is encountered, indicates the nature of the fault on a lamp panel, and gives an alarm. The tester must then be started again by hand.

This form of qualitative service testing is fully dependable and conclusive, especially for L M Ericsson's crossbar systems. These systems are arranged for rotating occupation of the various switches, and thus, if the tester is set to the correct programme, all equipment in the exchange will be effectively tested in turn.

Fig. 7 X 2068

Reading the centralograph fault record in a trunk exchange ARM 20

The traffic route tester may also be employed for 500-line selector systems. By carrying out the tests in the daytime, a sufficient coverage of the switching routes will be obtained to provide representative statistics.

The automatic fault records obtained from, for example, centralographs connected to markers (fig. 7), or from counters, form a valuable complement to the qualitative service statistics. A quick conception of whether congestion is normal or is caused by service failure can be formed by the reading of congestion meters on different outlets and switching stages and comparing them with the load on the same units obtained from traffic measurements.

Preparation and analysis of statistics

If a statistical method of maintenance is to render the desired result and to provide an accurate gauge of the condition of the automatic exchange, in the first place the programme of qualitative service control must be properly prepared and, secondly, the statistical material obtained from the tests and from other observations must be analysed on a rational basis.

For purposes of qualitative service control all routes in a full-automatic exchange or full-automatic area must be completely tested to a definite programme. This programme should be based on a study of the traffic distribution, so that the test traffic applied on every route will be in direct proportion to the actual traffic handled on that route. This will guarantee that the statistics are based on a representative number of test connections via different routes.

Action as required

When the qualitative service statistics reveal that the threshold value of fault liability initially established by the administration has been exceeded, measures must be taken to locate and clear the faults.

Full instructions and appliances must be available for this purpose. The maintenance plan for the exchange must specify the routine tests and inspections to be made, in the same way as is done in the method based on preventive maintenance. The only difference—but an important one—is that the maintenance plan in this case must specify for each routine test and inspection: "Action as required".

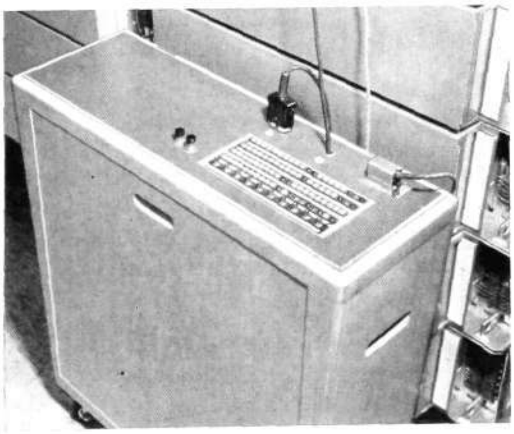

Fig. 8 X 2069

Register tester for system ARF 10

Two test equipments have been constructed for crossbar exchanges, and together they cover all routine tests for locating and clearing of faults.

One is a register tester (fig. 8) for system *ARF 10*, which automatically supervises the work of the register on 10 different types of traffic. On every type the tester transmits dial impulses to the register, sets in motion the code transmission from the register, receives and checks the code signals and returns the necessary acknowledgements back to the register. If the register transmits a wrong code or reacts incorrectly after the transmission of signals, the test is stopped and the tester indicates the location of the fault on a lamp panel.

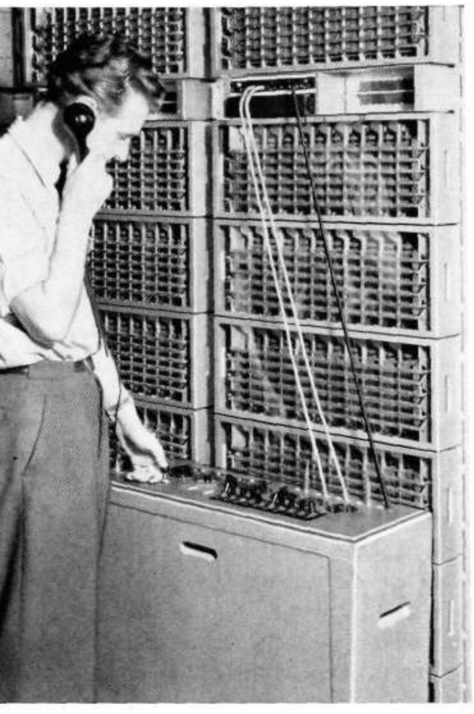

Fig. 9 X 2070

Automatic device tester

plugged for testing the IGV stage of an ARF 10 exchange

In the programme of tests for the register, the tester allows a narrower than normal time margin for transmission of signals. By altering the register's operating voltage to the upper or lower limit, a complete series of marginal tests of its functions can be carried out.

The second test set consists of an automatic device tester (fig. 9). This is used for systematic tests of the GV and SL stages or for setting up single test connections through those stages. The tester may be plugged into a group selector inlet, trunk or link circuit, whereupon it completes the connection to a test number or operator's line.

The tester can repeat connections automatically, so that a correct connection to a test line is immediately cleared and the same connection is set up again. Owing to the rotating occupation of the switching stages it is possible to test all routes in the group or groups in which a fault has been shown to exist by the qualitative service statistics. If the distributer is locked in any position during a low traffic period, a particular route may be subjected to repeated tests. On encountering a fault the tester stops and indicates the position of the fault on a lamp panel.

Automatic testers of this type are available both for system *ARF 10* and *ARF 50*.

As mentioned earlier, the exchange equipment contains fixed appliances for automatic indication of faults in addition to these mobile test sets. The fixed appliances provide a continuous indication, on meters or on lamp or alarm panels, of irregularities in important switching functions, such as failure to meter a call, missing selecting finger in a crossbar switch, and so on. Apart from the statistical value of such indications, they are of inestimable help in locating faults by routine tests.

L M Ericsson's crossbar exchanges type *ARF 10* are also supplied with special control registers. These fulfil the functions of a normal register but are equipped with additional strips in the crossbar switch for marking a dialled number on a lamp panel. There are also facilities for a supervising operator to follow a connection through to the B subscriber. The primary object of the register, which is usually graded to permit access to it from all subscribers in a 10,000's group, is to give the administration a picture of the subscribers' telephone habits, but it can also be used to advantage for maintenance purposes.

Conclusion

Both in their circuitry and in the mechanical design of the switching units, L M Ericsson's automatic telephone systems are admirably adapted for economic maintenance. An account has been given of the standards required in exchange buildings and in maintenance staff if these benefits are to be made best use of.

Having regard to these facts and to the methods of maintenance outlined above, an automatic exchange may be likened to a machine which produces connections between subscribers linked to it. Such a machine must be protected from human contact to the greatest possible extent, and the quality of its output must be supervised by a process of production control. The rational planning of exchange buildings will enable an administration, at no extra cost or even at a lower cost than otherwise, to attain to the ideal condition in which the connection-producing machine can be both operated and supervised from a control room outside the machine hall.

The control room constitutes the maintenance centre for the automatic exchange or group of exchanges. All equipment for the compiling of statistics and for supervision will be concentrated in it. From this centre all traffic metering and automatic fault locating equipment will be controlled. Fault reports from subscribers and operators will be received at the centre, and from it will issue orders for action to be taken on the automatic equipment or directives to the outside plant maintenance section regarding tests or inspection of the external plant.

Control rooms should be provided at main exchanges or at individual exchanges with an initial or anticipated capacity of at least 5,000 lines. Satellite exchanges can generally be left attended.

The control room should be manned from 7 a.m. to 5 p.m. every weekday by one responsible maintenance foreman. If the capacity of the exchange or group of exchanges exceeds 25,000 lines, or if there is any considerable quantity of equipment for full-automatic junction or trunk traffic, the hours of attendance should probably be extended to 7 a.m.—10 p.m., covered by two men, both being on duty during the busy hours of the day. One additional man for exchanges up to 15,000 lines, two additional men for 25,000 lines, etc., should be available for the tracing and clearing of faults. In assessing the staff requirements, however, a number of factors, such as the call rate, must be taken into consideration.

Exchanges may be left unattended at night and on Sundays and public holidays. At these times the duty operator or night watchman will be responsible for the supervision of major alarms and the receipt of complaints from subscribers and, when necessary, should call upon the duty officer at the administration.

With this maintenance force, and based on a fault liability up to 0.1 %, experience shows that L M Ericsson's crossbar systems *ARF 10* or *ARF 50* do not require a greater maintenance effort than 0.3 man-hours per line per annum. The corresponding figure for the 500-line selector systems is about 0.6 man-hours per line per annum, since the 500-line selector and its power drive require periodic inspection. This work, on the other hand, can generally be done by less qualified labour.

LM Ericsson's Subsidiary Automatic System AML 10

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U.D.C. 621.395.722.002.52

The subsidiary automatic system described in this article is used to supplement the equipment of a telephone exchange in order to reduce the number of lines to remote subscribers. It provides administrations with a more economical means of supplying a complete service to subscribers on the fringe of an exchange area.

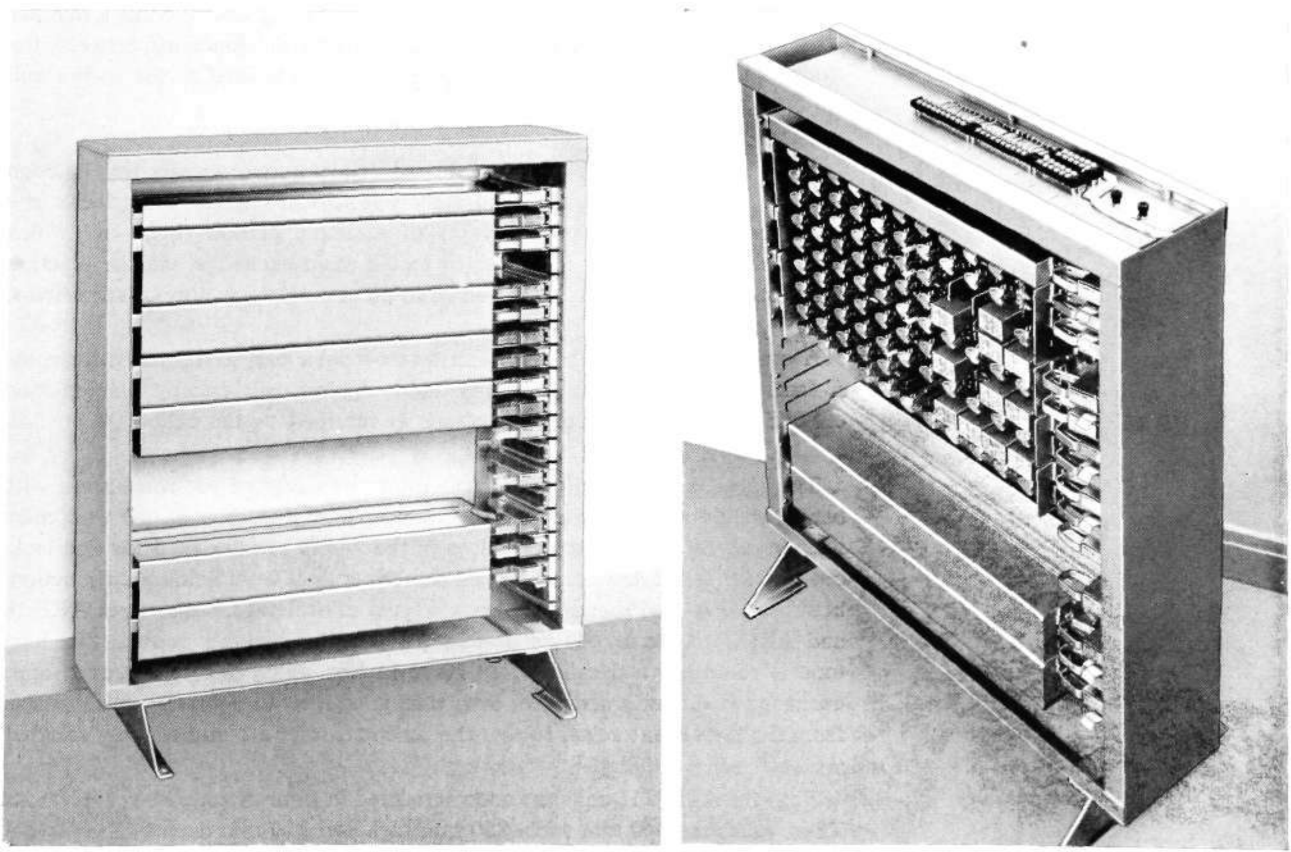
Applications

A large proportion of the total cost of a telephone exchange is taken up by the local line plant, and the heaviest outlay is naturally borne by the lines to the most remote stations. Indeed the point at which some form of cable-saving arrangement becomes profitable is not so far distant from the exchange. The most common solution hitherto has been either a party line or a smaller independent exchange with junctions to the main exchange. When there is no alternative to party lines, L M Ericsson recommends solely two-party lines in order to preserve the important secrecy facility. The disadvantage of the first solution is the high initial outlay on an automatic switchboard, while a manual switchboard incurs heavy operating costs on telephonist's salaries. The service offered to subscribers by a small manual exchange, moreover, is limited by the fact of its not being permanently attended. L M Ericsson has therefore sought for a solution which will satisfy the requirements of economy, both in initial outlay and in running costs, where more than two remote subscribers form a natural group. The result has been the subsidiary automatic system AML 10.

Fig. 1 X 6930 X 6933

Subsidiary automatic system AML 10

composed of relay sets for subscriber and junction lines. (Right) The same switchboard viewed from above and with certain relay sets removed.



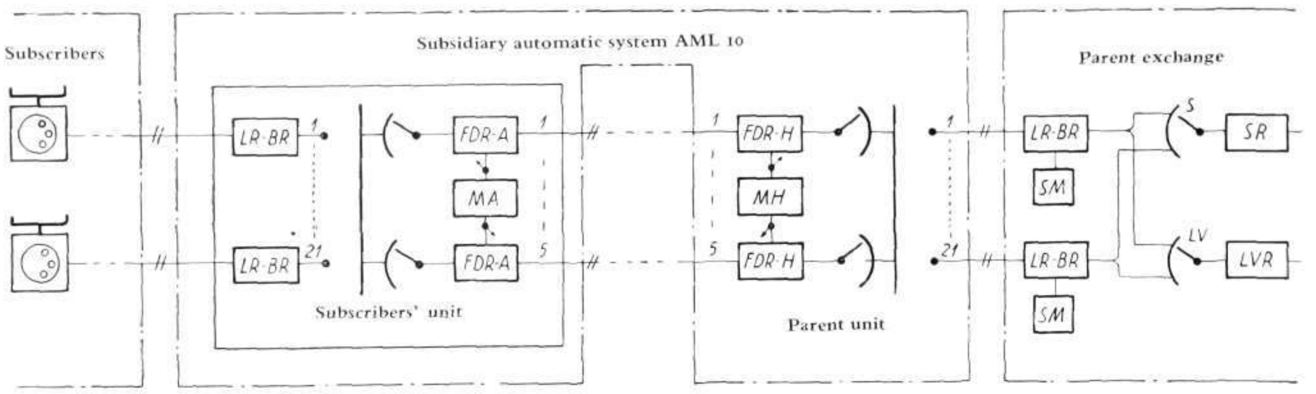


Fig. 2 X 7680

Trunking scheme for subsidiary automatic system with junctions to auto main exchange.

LR-BR	line and cut-off relay
FDR-A	junction relay set, subscribers' unit
FDR-H	junction relay set, parent unit
MA	marker, subscribers' unit
MH	marker, parent unit
SM	subscriber's meter
S	linefinder
SR	linefinder relay set
LV	final selector
LVR	final selector relay set

Design and Operation

The purpose of the subsidiary automatic system is to reduce the number of lines from a small isolated group of subscribers to a main exchange. It can be connected to automatic or manual exchanges of either magneto or C.B. type.

The subsidiary automatic system consists of two units, of which one (the H-unit) is located in the main exchange, and the other (the A-unit) in the centre of the group of subscribers. The two units are interconnected by 2-wire junctions.

Subscribers connected to a subsidiary automatic system can be given numbers from the ordinary main exchange scheme and occupy the corresponding positions in the main exchange multiple. Their meters are also located in the main exchange, and they can thus be treated in every way as ordinary subscribers of that exchange.

The subsidiary automatic system may be most simply described as a number of relay selectors which are connected in pairs to the junctions between the A-unit and the H-unit. One selector of each pair is located in the A-unit and the other in the H-unit.

A call to or from a subscriber on the subsidiary system seizes a free junction between the A- and H-units. The relay selectors are set to subscriber's line in the respective multiples by means of a simple marker (M), after which the subsidiary subscriber is connected to the main exchange, via the junction relay sets (FDR) in the A- and H-units, in the same way as normal subscribers.

A call between two remote subscribers occupies two junctions between the A- and H-units, whereas incoming and outgoing calls occupy one junction only. If no junction is free, busy tone is returned to the caller.

The subsidiary automatic system is primarily designed for rural areas with bare wire lines; to reduce the effect of atmospheric disturbances, the equipment includes no rectifiers. The line relays in the A-unit are designed for line lock-out in order to prevent shortcircuited subscriber lines from holding the junctions between the A- and H-units. On certain types of exchange, such as our ARF 10 and ARF 50 systems, the arrangement of the line lock-out is such that busy tone is returned to a caller from his own line relay. Where the auto main exchange is similarly arranged, busy tone is emitted to a subsidiary subscriber from the A-unit line relay, so that the junctions, too, are immediately released.

Both the A- and H-units are accommodated in floor-mounted box type racks. These racks are 840 mm wide, 860 mm high and 210 mm deep.

Marker (MA)
Junction relay set (FDR-A)
Junction relay set (FDR-A)
Junction relay set (FDR-A)
Junction relay set (FDR-A)
Junction relay set (FDR-A)
Line and cut-off relays (LR-BR)
Line and cut-off relays (LR-BR)

Fig. 3
Mounting plan for A-unit

The selectors used in the subsidiary automatic system consist solely of ordinary telephone relays, which means that all switching units can be assembled into relay sets and connected to the racks by plug and jack.

The racks are cabled from the outset for the final capacity (no. 5 capacity below), but the number of relay sets can be varied to provide the following capacities:

1. 11 subscriber lines and 3 junctions
2. 11 » » » 4 »
3. 21 » » » 3 »
4. 21 » » » 4 »
5. 21 » » » 5 »

As is seen from the adjoining mounting plan (fig. 3), a fully installed subsidiary automatic system contains the following relay sets.

1 marker relay set MH or MA
5 junction relay sets FDR-H or FDR-A
2 line relay sets LR-BR (only in A-unit)
1 matching relay set (only in H-unit). This relay set is used only in certain cases for matching the subsidiary system to the parent exchange.

The subscriber and junction lines connect to the permanent cabling of the A-unit via the terminal blocks on the top of the rack. Screw terminals for the two battery leads are placed immediately beside the terminal blocks.

The weight of a fully mounted rack is about 120 kg.

Power Supply

The A-unit operates on 24 V or within the tolerances 20 V—30 V. A main supply is not required at the location of the A-unit, which is fed from a 10 Ah Nife battery charged from the H-unit via free junction lines. After every call via the subsidiary system, incoming or outgoing, the battery voltage in the A-unit is governed from the marker in the H-unit, and the battery is supplied with charging current as required.

If line lock-out were not incorporated, no source of power would be required at the A-unit; but the extra cost involved in the Ni-Fe battery is more than compensated by the better utilization of the junction lines. The particular advantage gained is in the cases when some part of the subsidiary line plant is out of order, for instance as a result of storm damage. Owing to the line lock-out the damaged subscriber lines are isolated and do not prevent the use of the junctions by other subscribers connected to the A-unit.

Since the A-unit battery is charged from the H-unit, the power plant in the latter section must supply a higher voltage to compensate for the drop in the junction lines. The normal operating voltage of the H-unit is therefore 48 V, but satisfactory operation is guaranteed within the limits 40—70 V. If the battery supply from the main exchange is 48 (or 60) V, this voltage can be used as feed voltage in the subsidiary system as well; but if the main exchange is of magneto type, or if the operating and feed voltage is 24 V, a separate 48 V power plant will be needed for the subsidiary system. In the event of a high voltage drop on the junction lines, however, the feed voltage in the H-unit can be further increased.

The power consumption in the H-unit during a call is about 100 mA per junction, or about 0.5 A for five junctions. A further quantity of energy will be consumed by the H-unit for transmitter feed, depending on the line resistance, type of telephone instrument, etc.

Telephone Instruments

If the parent exchange is of C.B. type—manual or automatic—the same type of telephone is normally used for the subsidiary and parent exchange subscribers. In some cases, however, it may be more economical—in view of the cost of line plant—to employ an instrument with another transmitter inset. The relation between length of line and type of telephone will be seen in the table below.

Even with a magneto type of parent exchange, the subsidiary subscribers must, of course, be supplied with C.B. instruments. These instruments may be manual or automatic, depending on the likely date of conversion of the main exchange to automatic working.

Transmission Data

As was stated in the introduction, the subsidiary automatic system is primarily intended to serve subscribers on the fringe of an exchange area. It will be as well, therefore, to say a few words about the maximum permissible length of line for satisfactory battery supply and transmission conditions. If we consider merely the supply requirements, the subsidiary system may be connected to any junction or subscriber's line with a total maximum line resistance of 2,000 Ω and minimum insulation resistance of 20,000 Ω owing to the possibility of increasing the voltage on the H-unit to the required value. The question of prime importance, however, as with every other type of telephone exchange, is that the general stipulations in respect to the quality of transmission are fulfilled.

The following table presents some general data in regard to length of line and line resistance. They will only hold good for certain specified conditions, however, and if exact data are desired a calculation must be made for each particular case, taking into consideration the maximum permissible attenuation, type of conductor and type of telephone instrument.

Supply voltage in H-unit	Resistance of feed coils	Type of telephone	Resistance of transmitter inset	Type of conductor	Max. length of junction + subscriber's line
48 V	2 × 400 Ω	48 V	100 Ω	Bare wire (bronze, ⌀ 2 mm)	40 km (= 720 Ω)
48 V	2 × 400 Ω	24 V	200 Ω	"	60 km (= 1 080 Ω[1])
60 V	2 × 400 Ω	48 V	100 Ω	"	56 km (= 1 010 Ω)

[1] To avoid too high a voltage drop across the transmitter, the line resistance must be at least 250 Ω.

As will be seen from the table, an improvement in the transmission conditions can be obtained by:

1. improving the line plant
2. raising the supply voltage
3. employing more sensitive type of telephone for the particular supply

Traffic Capacity

The subsidiary subscribers receive as good a service as other subscribers, with the exception that the congestion increases on calls to and from subsidiary stations owing to the additional congestion involved in common junctions. If the initiated and terminating traffic are each assumed to be 0.03 Erlang per subscriber, the additional congestion will be as follows, calculated from the Erlang Loss Formula:

Size of system sub./junc. lines	Both-way traffic in Erlangs	Extra congestion
11/3	11 × 0.06 = 0.66	2.50 %
11/3	11 × 0.06 = 0.67	0.41 %
21/3	21 × 0.06 = 1.26	9.25 %
21/4	21 × 0.06 = 1.26	2.75 %
21/5	21 × 0.06 = 1.26	0.67 %

Maintenance

The subsidiary automatic system requires a minimum of maintenance since it is composed solely of relays and capacitors. Observation of the A-unit, moreover, can be maintained from the H-unit, which means that an alarm is given in the parent exchange when a fault occurs in the A-unit. A major alarm is given for a fault on a marker in the subsidiary system or affecting all junctions. Minor alarm conditions are set up by a fault on a line relay in the A-unit or on an individual junction. If three to five subscribers are on line lock-out simultaneously, a line lock-out alarm is signalled at the parent exchange. Calls can also be made on the first two junction lines for testing the subscriber lines and instruments.

Maintenance of the A-unit may be limited to occasional routine visits—for instance twice a year—to test the level of the battery.

The A-unit is guaranteed to function reliably within as wide a temperature range as + 40° C to — 20° C and thus places little demands on the nature of the premises in which it is installed.

Slave Clocks for Outdoor Use

F AHLBERG, TELEFONAKTIEBOLAGET LM ERICSSON, STOCKHOLM

U.D.C. 681.116.2

Telefonaktiebolaget L M Ericsson, Erga Division, recently completed the design of a series of slave clocks with 600 mm (24") and 800 mm (32") dials, chiefly for outdoor use. The majority of present clock designs are based on hand production methods and, moreover, are attended by difficulties of transport, installation and maintenance. This article briefly describes the principles of design of the new slave clocks.

Outdoor clocks were originally made by hand to the customer's specifications, as they still are to some extent today. In the course of time electric clocks of certain sizes and types came to be produced on a factory scale, but they largely followed the same pattern as the earlier hand-made models. It therefore proved difficult to effect any improvement in the methods of production, and for this reason the prices of such clocks have remained relatively high, particularly in view of the necessity to maintain quality standards in respect to corrosion resistance, strength, reliability and appearance.

The outdoor clocks that have been available hitherto have proved troublesome to transport owing to the fragility of the dial and glass front. If the dials were attached at only a few points, they became liable to damage by impact; while, with a greater number of points of attachment, it was no longer possible to maintain the planeness tolerances and stresses arose which often caused the dials to crack. The weight of the clocks further increased their lability to damage during transport and added to the difficulty of installation. The fitting of a clock required certainly two, and usually three, men.

Slave clocks of this type have usually been made with steel frames. In spite of scrupulous attention to the finish, the frames were liable to rust, particularly round the edges and at the hinges. Their construction generally involved the use of rather narrow weatherstrips which did not afford a satisfactory seal. The trouble arose not so much from moisture as, especially at railway stations and similar locations, through the penetration of dirt which spoilt the appearance of the glass and dial. Cleaning of the mechanism was also a troublesome procedure. The entire clock had to be dismounted and taken to pieces.

In view of this and similar experiences the Erga Division of L M Ericsson designed a new series of slave clocks that is now ready for marketing. The clocks have 600 mm and 800 mm dials and are primarily intended for outdoor use. As regards their operation, installation, and the appearance of the dial and hands, they are identical to earlier types KA 550/630—KA 565/833.

The basic material in the new clocks is aluminium. They are thus light and highly rustproof.

The dial, glass, movement and hands are mounted in a ring of lathe-formed aluminium sheet and make up a self-contained unit, the slave clock unit (fig. 1). The ring has three flanges; the front flange serves to hold the glass,

Fig. 1 X 2058
Slave clock unit KAC 1301/1

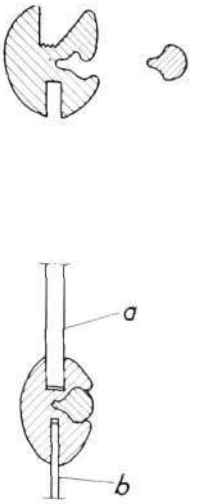


Fig. 2 X 2056

Self-sealing rubber strip

(above) before mounting, (below) mounted
a glass
b flange

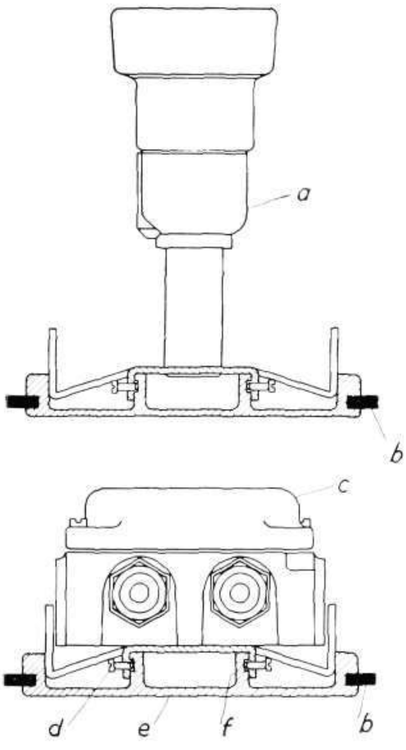


Fig. 3 X 2057

Assembly of components in frame
a lamp holder
b self-sealing rubber strip
c terminal box
d grub screw
e frame section
f rail

the centre flange to hold the dial, and the rear flange provides a backing to fit against the mounting frame. The glass and dial are fixed in position by means of a self-sealing rubber strip of the type used in the windows of motor vehicles (fig. 2). The glass is thus elastically mounted round its entire rim, and the strip at the same time provides an excellent seal. The method of forming the flanges ensures perfect flatness and procludes all risk of stress in the glass.

The dial is made either of metal or of opal glass. In the former case the movement is mounted in the centre hole of the dial; in the latter case it is supported by an aluminium bar attached to the rear flange of the ring.

The slave clock unit may either be used alone (with metal dial), mounted on a wall, or may be mounted in a frame for single faced clocks with internal illumination or for double faced clocks with or without internal illumination.

The frame for single faced clocks has an aluminium back plate. The standard model frame for double faced clocks has an aluminium bracket which is hollow to allow passage for cables. The bracket is attached to the frame by means of four screws.

The frame consists of a rolled and welded aluminium section. The frame has a rectangular groove running around its rim to carry the rubber strip and two internal rails which serve for the fitting of lamp holders, terminal boxes and suspension bracket. These components are held in position by grub screws which engage in slots in the sides of the rails (fig. 3). It is thus easy to alter the positions of the components, a desirable feature if a double faced clock is to be changed to wall-mounting instead of being suspended from a ceiling.

The internal illumination is provided by three parallel-connected 15 or 25 watt lamps operating off the mains. The wiring consists of P.V.C. insulated cables terminating in an aluminium box. The cables are held in position by spring clips between the rails.

The slave clock unit is suspended on a bracket in the frame and is held tightly against the frame by three screws. The seal between unit and frame, as also between back plate and frame in the case of single faced clocks, is provided by a sponge-rubber strip which is glued into the groove around the frame.

For installation of the clock, the unit or units are removed from the frame. The frame is set up in position, the incoming cables are wired to their boxes, and the lamps are placed in their holders. The slave clock units are then suspended on their brackets, the movements are connected, and the clocks are set to the correct time. Finally, the three fixing screws for each unit are tightened.

To change a lamp or correct the timing, the three fixing screws on one unit are loosened and the unit is swung forwards and upwards far enough to allow access to the inside of the clock (fig. 4). This arrangement precludes the need for the doors which must otherwise be provided on the underside of the clock.

An old type of 600 mm double faced clock with internal illumination weighed between 45 and 50 kg (100—110 lbs). The same clock in the new design weighs 24 kg (53 lbs), and installation is further assisted by its division into three parts. The frame and bracket weigh only 6 kg (13 lbs), and each of the slave clock units 9 kg (20 lbs).

Fig. 4 X 2059

Insertion of slave clock unit in its frame

The new slave clocks are designed for connection to master clock systems with reversed 1/1 minute or 1/2 minute impulses, and the standard impulsing voltage is 24 V. The impulse motors are of the same type as in the corresponding older models of clock. These motors have proved extremely durable and reliable. The torque on the minute hand spindle is 300 gcm at 80 % of nominal voltage despite the low consumption of 20 mA at 24 V.

The sturdy construction of these clocks makes them well suited to railway and bus stations, airfields, schools, factories, and for show purposes in combination with advertising signs.

Remote Control of Lighthouse and Fog Signal Installations

BENGT HOLM, ROYAL BOARD of SHIPPING and NAVIGATION, STOCKHOLM

U.D.C. 621.398:627.92
621.398:627.932

L M Ericssons Signalaktiebolag, in cooperation with the Swedish Board of Shipping and Navigation, has introduced a system of remote control for electric lighthouse and fog signal installations. The system complies with all requirements of reliability and economy, and calls for little maintenance; it has been recently installed at the Djursten Lighthouse station on an important shipping route north of the Stockholm Archipelago.

Remote Controlled Lighthouses

During the past ten years and more a number of remote control plants have been installed at Swedish lighthouses. The development of lighthouse control systems has been linked to the technique of building lighthouses upon submerged foundations. Such types of wave-swept lighthouse have been built in Sweden in up to 6—7 fathoms of water.

The remote control technique has enabled electric lighthouses and fog signal installations to be left entirely unmanned. But it has also been employed as a means of mechanizing the work at lighthouses where some attendance is required for security reasons.

The equipment of a remote controlled lighthouse generally consists of:

1. Light apparatus with automatic lamp changer for electric lamps and stand-by gas burner
2. Fog signal equipment (with electrodynamic or pneumatic sound emitter)
3. Radio beacon
4. Stand-by power plant with full-automatic starting and stopping
5. Control and indication apparatus
6. Storage battery with charger.

It is imperative that lighthouses shall operate with complete reliability, and full provision must therefore be made for various kinds of stand-by equipment. A basic principle is that there should be twin sets of the most important units. As regards the light, it should be taken as a general rule not to place undue expectation on the electric power supply system, whether consisting of a cable from the mainland or of a local supply in the lighthouse itself. The most dependable source of light as "last resort" is still considered to be the open acetylene flame or the brighter, but a little more complicated, incandescent mantle burner.

It may perhaps appear an anachronism not to employ automatic control of the light apparatus, fog signal and radio beacon equipment through the influence of daylight or the transparency of the air. Many unattended lighthouses working on *gas* lighting are automatically lit and extinguished by means of the well-known Dalén's sun valve. But, when using *electric* light, it

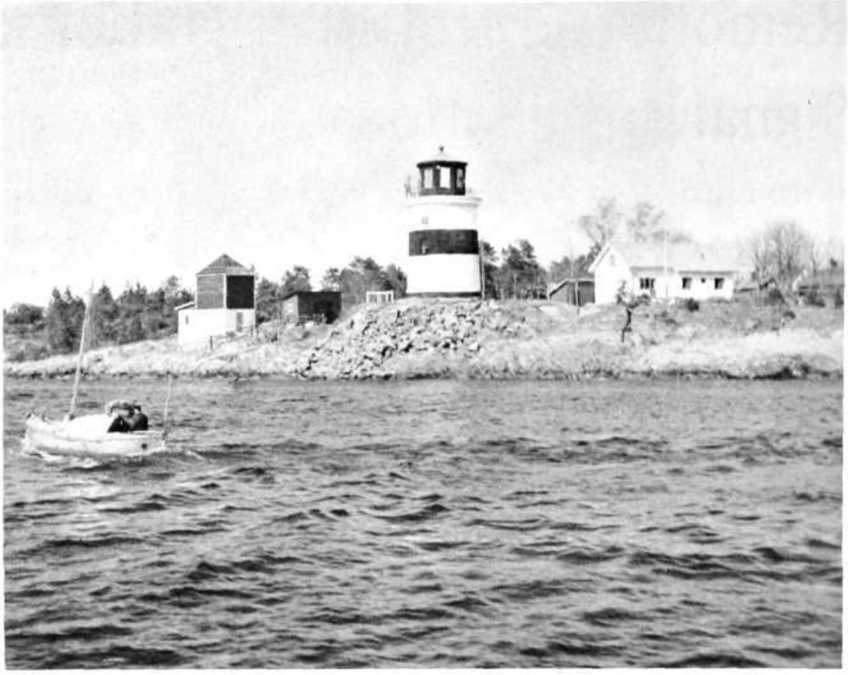


Fig. 1 X 6933
Djursten Lighthouse Station

has so far been found more practicable to have the light switched on and off by a time switch with automatic correction for the changing times of sunrise and sunset. As regards fog signals, there is not yet any widely used equipment that indicates the transparency of air with sufficient reliability and within the range of normal economy. The operation of fog signals and radio beacons in a remote controlled lighthouse is, therefore, always done from the manned lighthouse or pilot station that is responsible for the functioning of the lighthouse.

Remote Control Apparatus

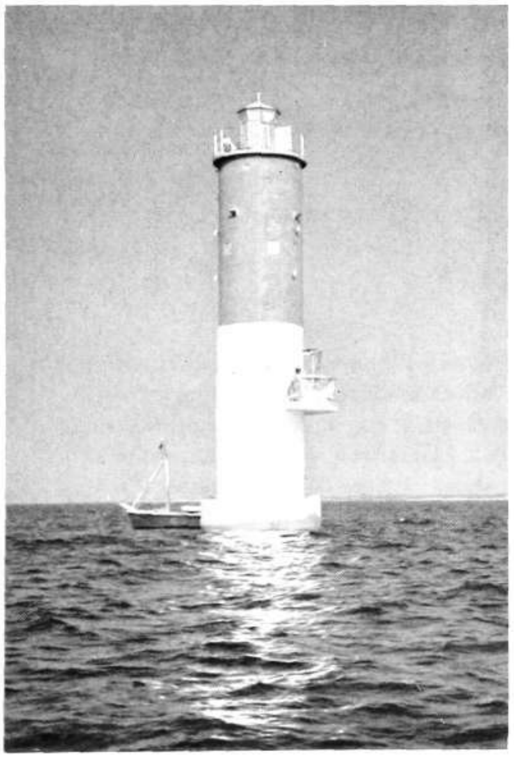


Fig. 2 X 2061
Engelska Grundet Lighthouse

The essential requirements in a system of remote control of lighthouses may be summarized as follows:

First and foremost, the system must be reliable; it should require little attention or maintenance and should operate economically. These may appear trivial points of view, but considering the difficulty of approaching a wave-swept lighthouse to carry out repairs, especially in autumn and winter, it will be recognized that they are factors of supreme importance. Unexpected calls for service are not only troublesome, but often costly, since qualified technicians are not usually available in the neighbourhood of the control equipment. Briefly, it may be said that the end in view should be simple, robust apparatus with not too many parts.

It is a great advantage if the operation of the various units can be observed without disturbing the apparatus, particularly as it is in the charge of people without technical training. In the event of "repair by telephone", which is sometimes necessary, it is essential that the technician should receive the information he needs in order to instruct the control room staff where to look for the fault. This may prove impossible if the equipment is too complicated or if its operation is not of a visible character.

Another desirable property in the equipment is that it shall have adequate operating tolerances, e.g. in respect to voltages, frequencies, pulse lengths, etc. It works very often under difficult conditions owing to fluctuating battery voltages and long cable lines; and for this reason it will often be necessary to utilize the stand-by power plant.

Control and Indication Functions

An important point in the choice of remote control system is the *number* of necessary control and indication functions. As may be seen from the earlier remarks on the lighthouse equipment, a comparatively small number of *control* functions is needed, usually 6 to 10. The *indications* are normally rather more numerous and may be divided into three groups:

1) synchronous indication, i.e. exactly timed images of the light, sound and radio signals,

2) indication of the condition of the more important equipment in the lighthouse, for example the position of the lamp changer, a fault in any sound emitting unit or in the machinery, abnormal temperature, etc.,

3) indication of fault in communication between control room and lighthouse, i.e. on the line wires or in the radio communication equipment.

A New Remote Control System on Wire Lines

A short description will now be given of the remote control system designed by L M Ericsson and recently installed for control of the Djursten Lighthouse from the Öregrund Pilot Station on the mainland. The Djursten Lighthouse is located on the island of Gräsö off Öregrund. An essentially similar equipment will soon be installed for a recently built wave-swept lighthouse, Engelska Grundet in Öregrund Bay. The latter lighthouse, which will replace the present lightship Grepen, will be remote controlled from the manned Örskär Lighthouse Station off the northern tip of Gräsö.

The Engelska Grundet Lighthouse will be the first in Sweden to be controlled both by line and by radio; radio will only be used as stand-by in the event of a fault on the comparatively long telephone line.

The L M Ericsson remote control system for lighthouses is based on the use of *frequency separation.*

Fig. 3 X 2071

Map of the most important lighthouses in Öregrund Bay

Controls are executed by means of alternating currents at low frequencies, viz. 15, 38 and 60 c/s, generated by electromechanical oscillators in the form of polarized relays with tuned circuits.

Alternating current is also employed for the *synchronous indication* of light and fog signals, but in this case generated by static frequency transformers in the lighthouse, which are fed from 50-cycle mains and generate the frequencies 25 or 100 c/s.

Direct current is used for *supervision of the line* between control room and lighthouse, the alternating currents for control and synchronous indication being superimposed on the direct current.

The *indication of failures* in lighthouse and fog signal equipment is arranged by:

1) rapid impulsing of the respective synchronous indication signals: a fluttering light in the indicating lamps shows that the stand-by light has been brought into operation or that a fault has occurred in one of the sound emitting units.

2) impulsing of the d.c. through the line, indicating a serious functional fault in the lighthouse equipment. This type of impulsing is also used for telephone calls.

A great advantage of this system is that no amplification is required either of control or indication signals—provided that the transmission line is not unduly long.

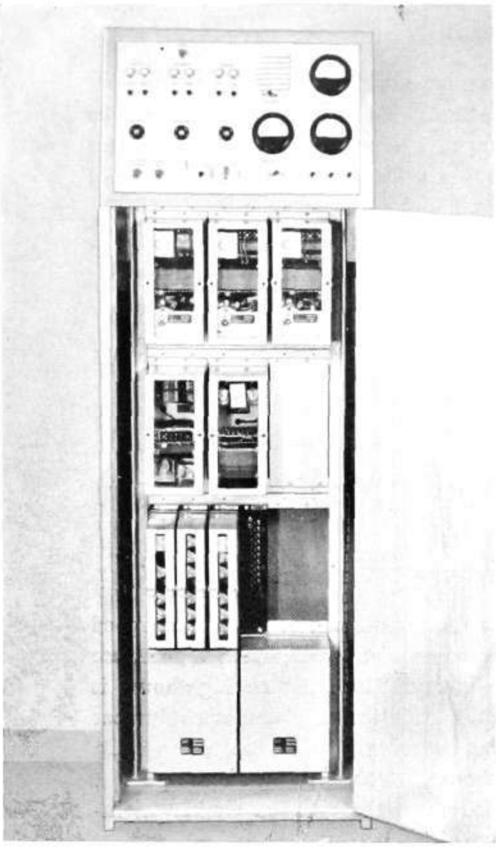


Fig. 4 X 2062

Remote control apparatus at Öregrund

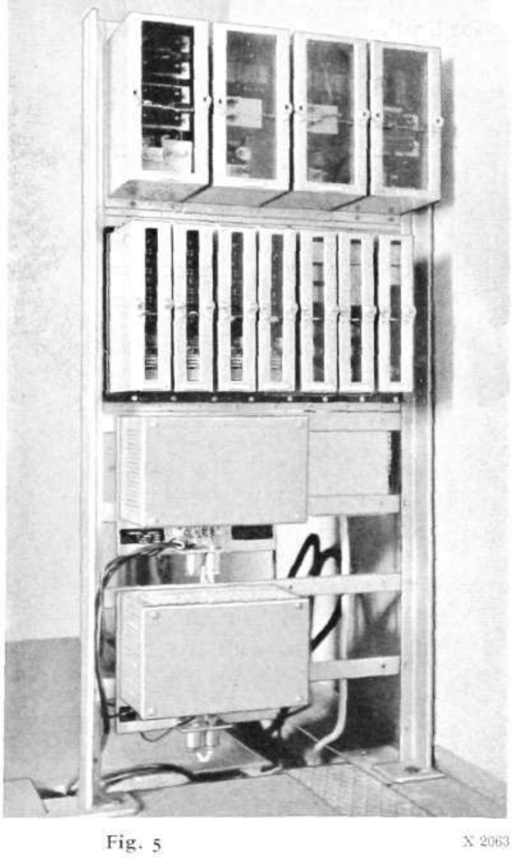


Fig. 5 X 2063

Remote control apparatus at Djursten Lighthouse Station

The separation of the control signal frequencies is arranged by means of conventional LC type low frequency filters at the lighthouse station. After passing the filters, the signals are rectified and fed to the control relays, one relay for each frequency. These relays are of a highly sensitive, but at the same time robust, type known in railway signalling by the name of safety type relays. Combinations of the frequencies are used for certain controls (see below), since only three control frequencies are employed whereas six functions are required.

The separation of the synchronous indication signal frequencies is likewise done in ordinary filters. These signals are not rectified, however, after passing through the filters, but are instead fed directly to neon lamps. Other indications—fluttering of the neon lamps and interruption of the line current—require no other equipment than a few normal telephone relays.

The frequencies used for control and for synchronous indication at the Djursten—Öregrund plants are tabulated below.

Control		*Synchronous Indication*	
Radio beacon	On: 15 c/s	Light	25 c/s
Radio beacon	Off: 15 + 60 c/s	Fog signals	100 c/s
Fog signals	On: 38 c/s		
Fog signals	Off: 38 + 60 c/s		
Telephone	On: 15 + 38 c/s		
Telephone	Off: 60 c/s		

It has already been said that reliability is an essential requirement in a remote control system. But an aim of at least equal importance for the lighthouse engineer—to quote a high official in the U.S. Coast Guard, speaking at a recent international lighthouse conference—is *simplicity*. The goal should be simplicity of design and quality of equipment—together they spell *reliability*.

Ericsson LM NEWS *from* All Quarters of the World

(Left) The telephone factory at São José dos Campos during the inauguration, with the Brazilian and Swedish flags fluttering merrily in the breeze. In the right foreground are the busses which carried the persons invited to the opening ceremony.

Inauguration of LME Factory in Brazil

Ericsson do Brazil Comércio e Industria, S.A., the Brazilian subsidiary of Telefonaktiebolaget L M Ericsson, opened its telephone factory at São José dos Campos on Saturday, November 5. Representatives of the President of Brazil and the Governor of the State of São Paulo were present at the inaugural ceremony. Among the 500 persons invited were also the Swedish Minister, C J Stenström, and representatives of different telephone operating companies from the whole country, including Companhia Telefônica Brasileira, the largest in Brazil.

Ericsson do Brazil was represented by its president, Sven Oskar Englund, and works manager, Alvar Olsson, and the parent company by its president, Sven Ture Åberg, Olof Hult and John Zoetterman.

The Brazilian and Swedish flags were flown in honour of the occasion. The factory was designed by the well-known Brazilian architect, Oscar Niemeyer, and the constructional work was undertaken by Svenska Entreprenad AB, the Brazilian subsidiary of AB Sentab. The first stage of building was completed at the end of last year, comprising about 30,000 sq.ft., and the manufacture of telephone instruments started on a small scale at that time. An extension of the premises to 50,000 sq.ft. is practically complete. It is anticipated that the 1955 production will be about 25,000 telephone instruments. When the new extension is ready, the annual capacity should be some 70,000 instruments with, in addition, a certain quantity of automatic exchange and transmission equipment. Some 160 persons are at present employed.

São José dos Campos, situated about 60 miles from São Paulo on the super-highway to Rio de Janeiro, has a population of 54,000 and is fast becoming an industrial city of distinction.

Apart from L M Ericsson, several other large firms have purchased factory sites there, including General Motors and Firestone.

Brazil is a very large market for telephone equipment, not only due to its size and rapid development but also because telecommunications have not been able to keep pace with developments in other directions. L M Ericsson's ability to take part in the extension of telecommunications will be greatly strengthened by the addition of the Brazilian factory.

L M Exchanges in 70 Towns

The first of L M Ericsson's automatic telephone exchanges in Brazil was installed in 1931. Today automatic exchanges for above 100,000 lines are in service or on order for some 70 towns, from Manáos in the heart of the Amazon area in the north to Pelotas near the Uruguayan border in the south. No other automatic telephone system is so widespread in Brazil as L M Ericsson's.

Cont. on next page

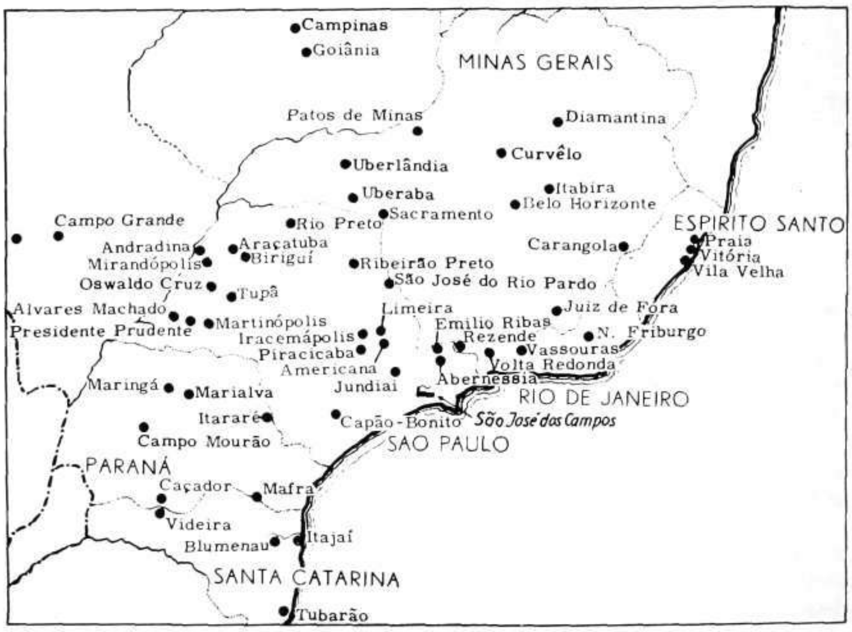
The solemn act of consecration was performed by S. Excia. Revma. D. Gabriel Bueno Conto, Assistant Bishop of Curitiba. To his immediate right is seen in the front row the president of Telefonaktiebolaget L M Ericsson, Sven T. Åberg, and beside him the president of Ericsson do Brasil Comércio e Indústria S. A., Sven Oscar Englund.

Cont. from preceding page

But L M Ericsson's deliveries to Brazil are not limited to public telephone exchanges and external plant. An important part of the sales is comprised of manual and automatic private branch exchanges and of trunk equipments. Constructional work is at present proceeding on coaxial cable equipments for the São Paulo–Santos telephone line, including the supply of coaxial cable, and terminal equipments for the São Paulo–Campinas and São Paulo–Rio de Janeiro radio links.

(Above) The visitors on a tour of the plant at São José dos Campos after the opening ceremony.

Map of part of Brazil showing the majority of the L M E automatic exchanges in the country and the telephone factory at São José dos Campos.



Automatic Exchanges Opened at Nyköping . . .

An important extension of the Swedish full-automatic trunk network was brought about by the opening of the new automatic exchange at Nyköping on November 27. About 750,000 subscribers in the Nyköping, Linköping, Norrköping, Stockholm, Eskilstuna and Örebro areas are now in dial communication with one another.

The automatic exchange is an ART 204 crossbar system built to the circuit designs of the Swedish Telecommunications Administration; it has rack accommodation for 8,000 local lines and switches for 7,000 lines. It also possesses a toll section with about 400 outgoing and incoming lines.

The automatic equipment was manufactured and installed by L M Ericsson. The installation work started in March 1955.

The Minister of Communications, Sven Andersson, officiated at the inauguration of the exchange; he was accompanied by the Director General of the Telecommunications Administration, Håkan Sterky, and the Norrköping District Superintendent, Gösta Sjögren; the Lord Lieutenant of the County, Bo Hammarskjöld; and, from L M Ericsson, Hans Thorelli, Malte Patricks, Eric Ledin and K G Hansson.

(Left) View from Nyköpings automatic exchange.

. . . and at Norberg

The Norberg automatic exchange –a junction centre with 1,200 lines within the Fagersta zone–was cut over on December 29. The automatic equipment was manufactured and installed by L M Ericsson, and the exchange is built on the Telecommunications Administration's crossbar system ART 204. The installation work has taken just over six months.

When the service is opened in the near future, the Norberg exchange will be the most northerly central office supplied by L M Ericsson to have subscriber-dialled trunk connections with Stockholm.

Prime Minister U Nu is presented with the gift of a private automatic exchange. In the centre is seen Mr. Hans Thorelli, and to the right Consul General Måns Hallberg.

A building exhibition was held in Mexico City in November, at which the L M Ericsson company, Teléfonos de Mexico, S.A., was represented. The company's stand was designed with the object of introducing visitors to the telephone and telesignal equipments that are installed by the company. The photograph above shows the eagerly frequented stand.

U Nu Visits LM Ericsson

U Nu, the Burmese Prime Minister, paid a visit to the Midsommarkransen plant of L M Ericsson during his stay in Sweden in November. In company with his wife Daw Mya Yi, the Secretary of State, U Thant, the Vice Chief of the Defence Staff, Aung Gyi, the wife of the Indian Minister to Sweden, Mrs. Chopra, and the Swedish Consul General in Rangoon, Måns Hallberg, the Burmese Prime Minister made a tour of laboratories and workshops and also showed interest in the firm's social welfare arrangements. Following a review of the company's organization and manufactures and a demonstration of some of the products, a private automatic exchange was donated to U Nu in memory of his visit.

New LM Automatic Exchanges in Denmark and Finland

The Fyn Communal Telephone Corporation has placed an order with L M Ericsson for a 23,000-line local exchange at Odense. The same corporation, jointly with the Danish P.T.T., has ordered an automatic trunk exchange with 1,910 trunk lines, also to be installed at Odense.

L M Ericsson is to build a new automatic trunk exchange in Copenhagen, comprising 3,860 trunk lines, for the joint account of the Copenhagen Telephone Company and the P.T.T. The Odense as well as Copenhagen exchanges are to be built on L M Ericsson's crossbar system.

The Helsinki Telephone Administration has placed orders during 1955 for a total of 15,000 lines–comprising two new exchanges and extensions of existing exchanges in Helsinki.

The Åland Telephone Company has ordered a further number of automatic rural exchanges for a total of 1,220 lines, which will bring the total number of lines up to 2,210, spread over 20 exchanges. This means that practically the whole of the Åland archipelago will have automatic telephone facilities.

The twelfth award of L M Ericsson Gold Medals to veterans of the company took place this year at a banquet at Restaurant Gillet in Stockholm. Of the 50 "old faithfuls" who received the distinction, Mr. Elov Johansson, with his 43 years of service, had been longest in the company's employment. Among the nine women medallists Mrs. Herti Blomqvist, employed since 1919, had the greatest number of years of service. Vice-President Hans Thorelli was among the medallists, being the eldest of those receiving awards this year. The trio in the photograph are, from the left, Mrs. Iva Linck, Vice-President Hans Thorelli and Mrs. Herti Blomqvist.

L M Ericsson has commissioned the artist, MasOlle, to paint a portrait of Director General Waldemar Borgquist, Chairman of the Board from 1933—1952. The portrait was unveiled by the present Chairman, Mr. Marcus Wallenberg, at a ceremony at Midsommarkransen in the presence of Mr. and Mrs. Borgquist, the artist, and members of the Board and Management.

Beyrouth Exchange Doubled

The 15,000-line automatic exchange at Beyrouth, capital of Lebanon, which L M Ericsson started to build in the spring of 1952 and which was cut over at the beginning of 1953, will be doubled in size within the near future. An order for extension of the exchange by 7,500 lines was received by L M Ericsson in July 1954, and this work is now under way; an order for a further extension by 7,500 lines has now been received. The Beyrouth exchange will thus have a capacity of 30,000 lines.

L M Ericsson has received further orders for six new exchanges totalling 17,500 lines, including an 8,000-line exchange for Tripoli, Lebanon's second city.

LME Extends Automatic Network in Columbia and Brazil

A total of 10,500 lines have been ordered for Bogotá, capital of Columbia, including new exchanges and extensions of existing exchanges. In Medellín–the country's largest industrial city–the number of lines will be increased by 13,000, of which 6,000 for four new exchanges and 7,000 for extensions of three exchanges.

First LM Exchange in Ireland at Limerick

The first L M Ericsson exchange in Ireland will be situated at Limerick. It will be a 2,000-line automatic exchange built on LME's crossbar system.

L M Ericsson has also had orders for three new crossbar switch exchanges in Holland, 10,000 lines at Dortdrecht, 5,000 lines at Gonda, and 1,200 lines at Sliedrecht.–The 500-line selector exchanges in Rotterdam will also be extended by 15,000 lines.

Companhia Telefônica da Borda do Campo in Brazil has ordered five new automatic exchanges–Santo André, São Caetano, São Bernardo do Campo, Manã, and Ribeirão Pires. These exchanges, which are all in the neighbourhood of São Paulo, will cater for a total of 7,500 lines.

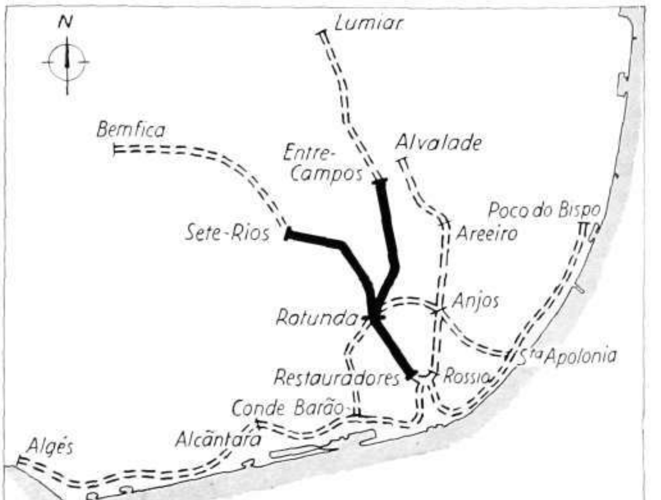
Signalling Material for New Lisbon Underground

L M Ericssons Signalaktiebolag has signed a contract with Metropolitano de Lisboa for the supply of signalling material for the first stage of the underground to be built in Lisbon.

The planned system is shown below, the first stage being drawn in full lines. The railway will be two-track, and the first stage will comprise about 7 kilometres of line with 11 stations. According to present plans, the final underground system should comprise about 40 kilometres of line. At the start it will have 2-car trains, and later 4-car trains. It is estimated that the future headway will be 40 trains per hour in each direction.

The contract with L M Ericsson covers the supply of signalling material and its installation. The signalling equipment comprises an automatic block signal system, four small interlocking plants and a train identification system. Mechanical train stops will also be provided at the signals to arrange for automatic emergency braking of trains which pass signals showing the stop aspect.

The excavation work on the new underground has already started, and it is estimated that the first stage will be open to traffic by the beginning of 1958.



U. D. C. 621.395.722.004.5

HANSSON, K G: *The Assumptions for Economic Maintenance of L M Ericsson's Automatic Telephone Exchanges.* Ericsson Rev. *32* (1955) No. 4 pp. 96—106.

The organization of maintenance in an automatic telephone exchange is a matter of prime importance to the telephone administration. A well managed exchange means that subscribers are satisfield with the service offered them, that the number of subscriptions rises, and that the administration can operate on a more efficient basis. The article discusses the assumptions for economic maintenance of L M Ericsson's 500-line selector and crossbar systems, and puts forward certain new viewpoints in regard to maintenance methods.

U. D. C. 621.395.722.002.52

LÖNNSTRÖM, S: *L M Ericsson's Subsidiary Automatic System AML 10.* Ericsson Rev. *32* (1955) No. 4 pp. 107—111.

The subsidiary automatic system described in this article is used to supplement the equipment of a telephone exchange in order to reduce the number of lines to remote subscribers. It provides administrations with a more economical means of supplying a complete service to subscribers on the fringe of the exchange area.

U. D. C. 681.116.2

AHLBERG, F: *Slave Clocks for Outdoor Use.* Ericsson Rev. *32* (1955) nr 4 pp. 112—114.

Telefonaktiebolaget L M Ericsson, Erga Division, recently completed the design of a series of slave clocks with 600 mm (24″) and 800 mm (32″) dials, chiefly for outdoor use. The majority of present clock designs are based on hand production methods and, moreover, are attended by difficulties of transport, installation and maintenance. This article briefly describes the principles of design of the new slave clocks.

U. D. C. 621.398.: 627.92
621.398: 627.932

HOLM, B: *Remote Control of Lighthouse and Fog Signal Installations.* Ericsson Rev. 32 (1955) nr 4 pp. 115—118.

L M Ericssons Signalaktiebolag, in cooperation with the Swedish Board of Shipping and Navigation, has introduced a system of remote control for electric lighthouse and fog signal installations. The system complies with all requirements of reliability and economy, and calls for little maintenance; it has been recently installed at the Djursten Lighthouse station on an important shipping route north of the Stockholm Arcipelago.

The Ericsson Group

Associated and co-operating enterprises

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L M Ericsson A/S *København F*, Finsens Vej 78, Tel: Fa 6868, tgm: ericsson

Telefon Fabrik Automatic A/S *København K*, Amaliegade 7, tel: C 5188, tgm: automatic

Dansk Signal Industri A/S *København F*, Finsens Vej 78, tel: Fa 6767, tgm: signaler

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Ericsson Verkaufsgesellschaft m. b. H. *Düsseldorf 1*, Worringer Strasse 109, tel: 16 488, tgm: erictel

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Cía Española Ericsson, S. A. *Madrid*, Conde de Xiquena 13, el: 31 53 03, tgm: ericsson

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Société des Téléphones Ericsson *Colombes (Seine)*, Boulevard de la Finlande, tel: CHA 35-00, tgm: ericsson

Paris 17e, 147 Rue de Courcelles, tel: Carnot 95-30, tgm: eric

Société Cinéric *Paris 20e*, 111 Rue Villiers de l'Isle Adam, tel: Ménilmontant 87-51, tgm: cinericsson

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Swedish Ericsson Company Ltd. *London, W. C. 1*, 329 High Holborn, tel: Holborn 1092, tgm: teleric

Production Control (Ericsson) Ltd. *London, W. C. 1*, 329 High Holborn, tel: Holborn 1092, tgm: productrol holb

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SIELTE, Soc. per Az. — Società Impianti Elettrici e Telefonici Sistema Ericsson *Roma*, C. P. 4024 Appio, tel: 78 02 21, tgm: sielte

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den Haag—Scheveningen, Gevers Deynootplein 30, Kurhaus, tel: 55 55 00, tgm: erictel-haag

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A/S Industrikontroll *Oslo*, Teatergaten 12, tel: Centralbord 335085, tgm: indtroll

A/S Norsk Kabelfabrik *Drammen*, P. B. 205, tel: 12 85, tgm: kabel

A/S Norsk Signalindustri *Oslo*, P.B. Mj 2214, tel: Centralbord 46 18 20

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Sverige

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AB Alpha *Sundbyberg*, tel: 28 26 00, tgm: aktiealpha-stockholm

AB Ermex *Solna*, tel: 82 01 00, tgm: elock-stockholm

AB Ermi *Ulvsunda 1*, tel: 26 26 00, tgm: ermibolag-stockholm

AB Rifa *Ulvsunda*, tel: 26 26 10, tgm: elrifa-stockholm

AB Svenska Elektronrör *Stockholm 20*, tel: 44 03 05, tgm: electronics

L M Ericssons Driftkontrollaktiebolag *Solna*, tel: 27 27 25, tgm: powers-stockholm

L M Ericssons Svenska Försäljningsaktiebolag *Stockholm*, Kungsgatan 33, tel: 22 31 00, tgm: ellem

L M Ericssons Signalaktiebolag *Stockholm Sv*, tel: 19 01 20, tgm: signalbolaget

Mexikanska Telefonaktiebolaget Ericsson *Stockholm 32*, tel: 190000, tgm: mexikan

Sieverts Kabelverk *Sundbyberg*, tel: 28 28 60, tgm: sievertsfabrikstockholm

Svenska Radioaktiebolaget *Stockholm*, Alströmergatan 12, tel: 22 31 40, tgm: svenskradio

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New Delhi, 45, Indra Palace, Connaught Place, tel: 44 90, tgm: inderic

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Ericsson Telephone Sales Corporation AB *Bandung*, Djalan Dago 151, tel: 2135, tgm: javeric

Liban

Telefonaktiebolaget L M Ericsson, Technical Office *Beyrouth*, Rue du Parlement, Immeuble Bisharat, tel: 33555, tgm: ellem

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Cía Argentina de Teléfonos S. A. *Buenos Aires*, Perú 263, tel: 305011, tgm: cecea

Cía Entrerriana de Teléfonos S. A. *Buenos Aires*, Perú 263, tel: 305011, tgm: cecea

Cía Comercial de Administración S. A. *Buenos Aires*, Perú 263, tel: 305011, tgm: cecea

Industrias Eléctricas de Quilmes S. A. *Quilmes FCNGR*, Eva Perón 1090, tel: 203-2775, tgm: indelqui-buenosaires

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São Paulo C. P. 5677, tgm: ericsson

Empresa Sul Americana de Telefones S. A. *Rio de Janeiro*, C. P. 4684, tel: 43-0990, tgm: emsulatel

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Teléfonos de México S. A. *México D. F.*, Paseo de la Reforma 107 tel: 21-91-00, tgm: elmex-mexico

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Soc. Telefónica del Perú, S. A. *Arequipa*, Casilla de Correo 112, tgm: telefonica

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North Electric Co. *Galion, Ohio*, P. O. B. 417, tel: 24201, tgm: northphone-galion-ohio

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Cía Ericsson S. A. *Montevideo*, Casilla de Correo 575, tel: 84433, tgm: ericsson

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Cía Anónima Ericsson *Caracas*, Apartado 3548, tel: 57467, tgm: ericsson

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»ETEP», S. A. Commerciale & Technique *Athens*, 1, Stadiou Street, tel: 31 211, tgm: aeter

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Hongkong

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Compagnie Internationale de Commerce *Saïgon*, P. O. B. 204, tel: 20253, tgm: intercom

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Irano Swedish Company AB *Teheran*, Khiaban Sevom Esfand 201-203, tel: 36761, tgm: iranoswede

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Swedish Oriental Company AB *Baghdad*, Mustansir Street, 5 A/38, tel: 848 19, tgm: swedeorient

Israel

Jos. Muller, A. & M. *Haifa*, P.O.B. 243, tel: 3160, tgm: mullerson

Japan

Gadelius Co. Ltd. *Tokyo*, Shiba Park No. 7 Minato-ku, tel: (43)-1847, tgm: goticus

Jordan

H. L. Larsson & Sons Ltd. Levant *Amman*, P. O. B. 647, tgm: larsonhus

Liban

Swedish Levant Trading *Beyrouth*, P. O. B. 931, tel: 31624, tgm: skefko

Malaya

Thoresen & Co. (Malaya) Ltd. *Singapore*, P. O. B. 653, tel: 6818, tgm: thoresenco

North Borneo

Thoresen & Co. (Borneo) Ltd. *Sandakan*, P. O. B. 44, tgm: thoresen

Pakistan

Vulcan Trading Co. (Pakistan) Ltd. *Karachi City*, P. O. B. 4776, tel: 32506, tgm: vulcan

Philippines

Koppel (Philippines) Inc. *Manila, P. R.*, P. O. B. 125, tel: 3-37-53, tgm: koppelrail

Saudi Arabia

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Swedish Ethiopian Company *Addis Abeba*, P. O. B. 264, tel: 1447, tgm: etiocomp

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J. Martins Marques *Lourenço Marques*, P. O. B. 456, tel: 5953, tgm: tinsmarques

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Elcor S. A. *Tangier*, Francisco Vitoria, 4, tel: 2220, tgm: elcor

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Surinam

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