ERICSSON Review

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1952

ERICSSON REVIEW

Vol. XXIX 1952

RESPONSIBLE PUBLISHER: HEMMING JOHANSSON
EDITOR: SIGVARD EKLUND, DHS
EDITOR'S OFFICE: STOCKHOLM 32
SUBSCRIPTIONS: ONE YEAR $ 1.50; ONE COPY $ 0.50

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CONTENTS

On cover: Exterior view of the L M Ericsson main factory at Midsommarkransen, Stockholm, seen by night.

High-Tension Protection Equipments for Telephone Instruments

Connected to Conductors Mounted on Power Line Poles

A HENCKEL, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

U.D.C. 621.316.91: 621.395.721

In cases where it is desired to establish telephone connections between a power station and its substations it is frequently found most economical to mount the telephone conductors on the poles which carry the power lines. To protect persons using telephone instruments connected to such lines, special high-tension protective apparatus must be connected in the circuit which furthermore serves the purpose of reducing disturbances in the transmission. The following article describes some new types of such protective equipment.

It is often found desirable to establish a local telephone line between a power station and one or more substations. In many cases the distance between the stations is considerable, and in order to eliminate the heavy costs, which a separate pole line might entail, resort must be made to one of the three following alternatives:

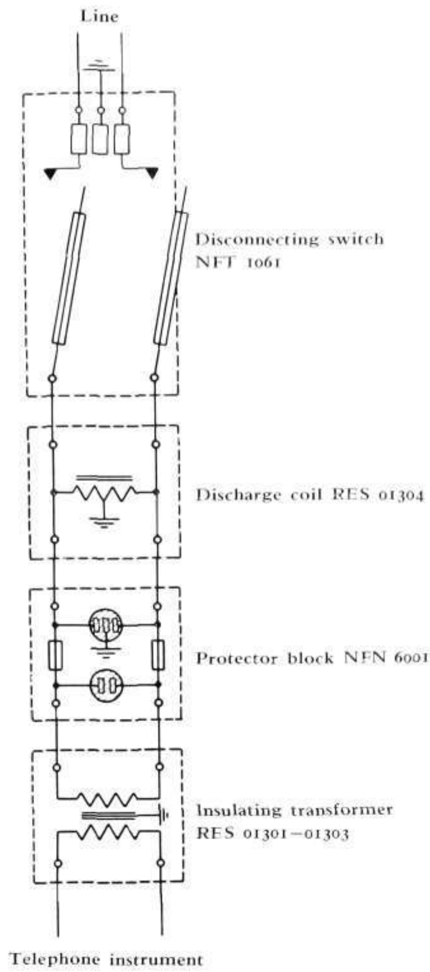
1) carrier frequency over the power line, *2)* placing the telephone conductors on the high-tension poles and *3)* radio (VHF) communication. The question as to which of these alternatives will prove most economical is decided by the distance between the stations. Carrier frequency over power lines is most frequently employed for lines exceeding 50 km in length and is not as a rule found remunerative for distances shorter than 20 km, for which it is preferable to mount the telephone conductors on the power line poles. If measuring facilities are required a radio link is usually preferred.

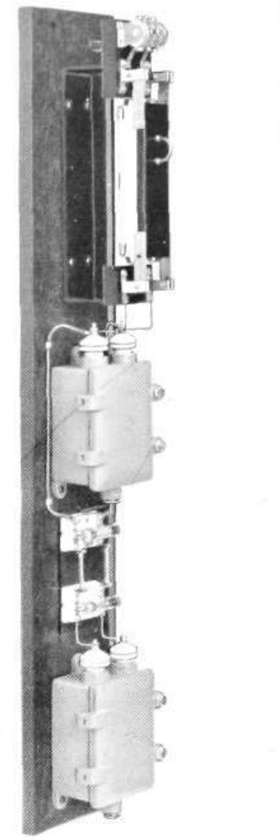
In the second case the telephone lines are exposed to dangerous voltages set up by induction from the power lines and also to direct contact with the latter (catastrophe). To protect the person using the telephone against these voltages which are dangerous to life the telephone instrument must be equipped with effective high-tension protection. L M Ericsson has designed a series of protective equipments for this purpose, which bear the designations *NFT 1001—1013* and *NFT 2001*.

Direct contact between the power lines and telephone conductors which may result in the transmission of the full voltage from the high-tension line to the telephone line is, of course, the most dangerous case encountered. Catastrophes of this kind are not of frequent occurrence; nevertheless the protective equipment must be dimensioned to meet such cases. Overvoltages due to switching operations, earths, etc., on the power line set up voltage waves in the telephone line by induction. Under stationary conditions of the power line, voltages are induced in the telephone conductors having the same frequency as that of the high-tension lines. By way of example it may be mentioned that these voltages may exceed 1 kV with a 20 kV high-tension line transmitting a power output of 200 kVA. (For the calculations relating to this example, see the appendix.)

Thus, owing to its proximity to the high-tension line, the telephone line has itself become a high-tension line!

What measures can be taken to protect the personnel against dangerous voltages in the telephone line? The first precaution to be adopted consists in placing the telephone conductors at as great a distance as possible from the high-tension lines and thus decreasing the induced voltage. If in the





X 4753
X 4765

Fig. 1

High-tension protection equipment NFT 1011—1013

foregoing example the telephone conductors were moved down 2 metres the induced voltages would be decreased to half their value (see appendix). The telephone conductors can carry a voltage dangerous to life in whatever position they are mounted, however. Consequently, the personnel must be effectively protected, and this requirement is met by L M Ericsson's high-tension protective equipment which is constructed both in a stationary and portable form.

Stationary High-Tension Protection Equipments

The NFT 1001—1003 high-tension protection equipments consist of a disconnecting switch, a protector block and an insulating transformer. The equipments NFT 1011—1013 also include a discharge coil. The following table shows the various parts from which the protective equipments are built up.

Table I

High-tension protection equipment	Disconnecting switch	Discharge coil	Protector block	Insulating transformer
NFT 1001	NFT 1061	None	NFN 6001	RES 01301
NFT 1002	NFT 1061	None	NFN 6001	RES 01302
NFT 1003	NFT 1061	None	NFN 6001	RES 01303
NFT 1011	NFT 1061	RES 01304	NFN 6001	RES 01301
NFT 1012	NFT 1061	RES 01304	NFN 6001	RES 01302
NFT 1013	NFT 1061	RES 01304	NFN 6001	RES 01303

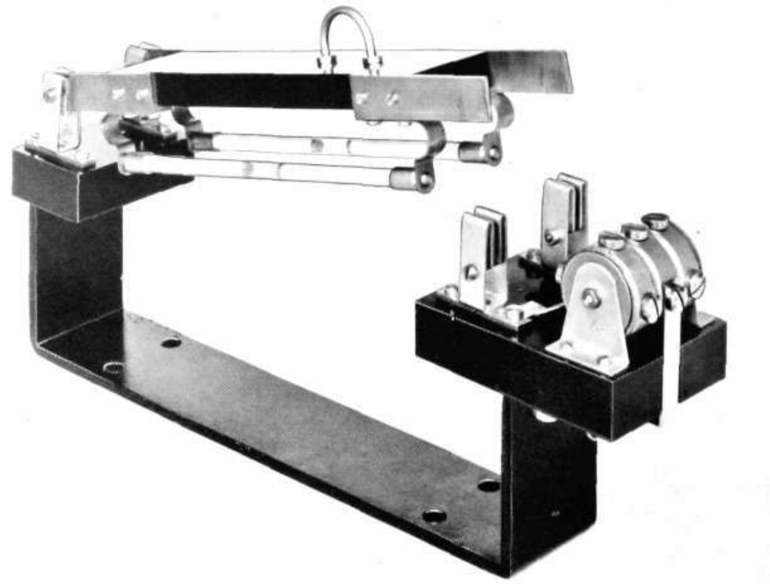


Fig. 2 X 6644

Disconnecting switch NFT 1061

The protective apparatus is a modernized form of the construction described in Ericsson Review No. 3, 1935 (under the designation *ND 20800*).

The high-tension protection equipments are designed for indoor installation. They are supplied with teak mounting panels which can withstand the attack of termites, and the equipment may be employed in tropical countries even under severe climatic conditions. With a relative humidity of 95—100 % and +40° C the insulation resistance will not fall below 4 megohms, which must be regarded as fully adequate for an installation not intended for commercial use. The insulation resistance normally amounts to about 7,000 megohms.

The high-tension protection equipments are designed for alternating voltages up to 66 kV with power outputs up to 1 MVA and voltage surges transmitting quantities of electricity of about 1 coulomb.[1] Voltage surges transmitting larger quantities of electricity are of such rare occurrence that they can be ignored.

Disconnecting Switch

The *NFT 1061* disconnecting switch consists of the disconnecting switch *NFT 1060* itself, an air gap arrester *NFT 1051* and two high-tension fuses *NGH 2901*. The air gap arrester, which is an improved form of the type employed in ND 20800, has an operating voltage of 1,000—1,100 V. Its life is practically unlimited provided that no catastrophe occurs, that is to say, direct metallic contact between the high-tension lines and telephone conductors whereby the electrodes are welded together and keep the telephone line constantly earthed. Fig. 3 shows the time from the occurrence of contact to the welding together of the conductors at different alternating current loads.

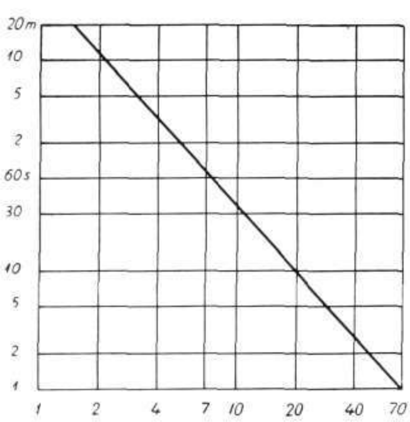


Fig. 3 X 4776

Time from moment of contact up to welding as a *function* of the load on air gap arrester NFT 1051

Hitherto reference has only been made to voltages induced in the telephone conductors by the high-tension line. An overhead line is always exposed to induction from lightning discharges in the vicinity of the line however. These *atmospheric over-voltages* may sometimes attain very high values; 60 kV is not uncommon. The atmospheric over-voltages run along the conductors in the form of waves with a very steep wave front (about 1 μs) and a half-period time of about 50 μs, see Fig. 4. It is extremely important, therefore, that the air gap arrester should function rapidly in order to prevent

[1] L M Ericsson has designed another form of construction for medium D.C. voltages.

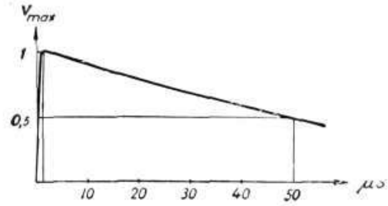


Fig. 4 X 4754
Voltage wave 1/50

the voltage wave from passing before the flash-over takes place. NFT 1051 is designed to prevent this. The surge factor is as low as 1.2 with a wave-front time of 0.1 μs, that is to say, the delay in operation is the smallest possible. The air gap arrester is also connected to the telephone line when the disconnecting switch is in the open position, which implies that dangerous over-voltages are also discharged when the remaining equipment is disconnected.

Protector Block

The protector block *NFN 6001* consists of the actual protector block *NFN 6000*, a three-pole rare-gas tube *NGC 3303*, a two-pole rare-gas tube *NGC 3203* or *NGC 3204* and two fuses *NGH 2001*. The rare-gas tubes are over-voltage arresters intended for operating voltages below those of air gap arrester *NFT 1051*.

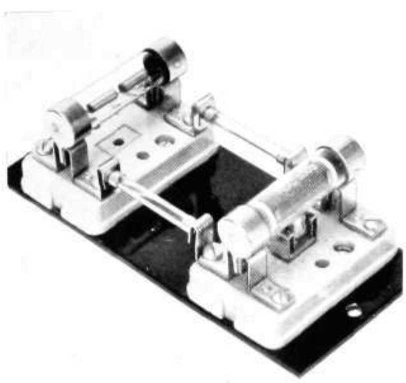


Fig. 5 X 4777
Protector block NFN 6001

Insulating Transformer

The purpose of the insulating transformer, as its name implies, is primarily to insulate the telephone instrument from the line galvanically. Consequently, D.C. voltages cannot be transmitted from the line to the telephone instrument.

The second purpose of the transformer relates to transmission. As is well-known, telephone currents are attenuated on their passage along the line from one instrument to another. Attenuation cannot be prevented entirely, but it should be reduced as much as possible in order to obtain the best transmission. Amongst other steps, reflection attenuation should be reduced to a minimum. Reflection attenuation is caused, for example, when the impedance of a telephone conductor is not the same as that of the telephone instrument. If the impedance of the conductor is denoted as Z_l and that of the instrument as Z_a, then the reflection attenuation will be

$$d_r = 0.5 \cdot \ln 0.25 \left(\frac{Z_l}{Z_a} + \frac{Z_a}{Z_l} + 2 \cos \varphi \right)$$

where φ is the difference between the phase angles of the impedances. Where $\varphi = 0$, then $d_r = 0$ if $Z_l = Z_a$. Thus, it will be seen that an endeavour should be made to match the impedances. The impedance of a telephone instrument lies between 600 and 800 ohms, whereas the impedance of the telephone conductor depends upon the dimensions of the wires and the material. In order to match the impedances, therefore, the impedance of the transformer on the instrument side must be equal to the instrument's impedance, and on the line side it must be equal to the line's impedance. L M Ericsson has designed three different transformers for this purpose, with the type designations *RES 01301—01303*. When the correct type of transformer is employed, the attenuation from the whole protective equipment will not exceed 0.09 N. The following table gives general particulars of the form of high-tension protection to be employed with different types of conductors.

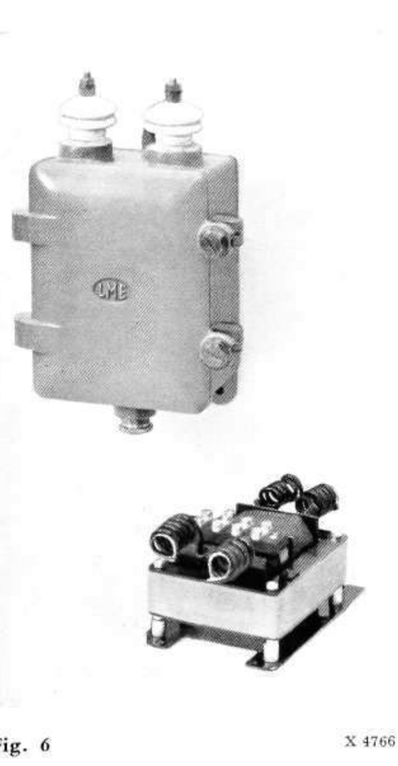


Fig. 6 X 4766
Insulating transformer RES 01301—01303

Table II. Suitable High-Tension Protection Equipment for Different Types of Conductors

Types of telephone wire			Correct high-tension protection equipment
Copper			NFT 1001 or NFT 1011
»Copperweld»			NFT 1001 » NFT 1011
Aluminium			NFT 1001 » NFT 1011
Bronze	diameter	≧ 1.8 mm	NFT 1001 » NFT 1011
»	»	1.1 — 1.8 mm	NFT 1002 » NFT 1012
»	»	≦ 1.1 mm	NFT 1003 » NFT 1013
Iron (steel)	»	≧ 3.0 mm	NFT 1002 » NFT 1012
»	»	≦ 3.0 mm	NFT 1003 » NFT 1013

Discharge Coil

Up to the present reference has only been made to the *danger* resulting from the induced voltages. These induced voltages may also set up disturbing currents which may render telephone conversations impossible on the line. Such disturbing currents are produced owing to the fact that the induced voltages in the two branches of the line are not of the same magnitude. Compensation must therefore be obtained through the telephone instruments. The task of the rare-gas tubes is to equalize the induced voltages; in troublesome cases, however, a discharge coil must be employed. This coil which presents the same appearance as the transformer, see Fig. 6, and bears the type designation *RES 01304*, is included in the high tension protective apparatus NFT 1011—1013.

It is difficult to specify the cases that may be regarded as troublesome in general terms, since this depends on the power line data, the location of the lines, transpositions or twists if any, geological and climatic conditions, etc. On the other hand, it is possible to give certain rules which should be followed:

1) Single-wire telephone connections (with earth as the return) should not be employed.

2) The telephone wires should be laid as far from the high-tension lines and as close to one another as possible. For reasons of safety the distance between the lowest power line and the highest telephone conductor should be at least 100 cm for system voltages up to 600 V, 150 cm for system voltages above 600 V up to 22 kV and 250 cm for system voltages above 22 kV up to 66 kV.

3) The telephone conductors must be transposed at each pole or twisted in the space between each pair of poles.

4) The power lines should be transposed in such a way that a transposition section does not exceed 36 km, that is to say, the distance between the transposition points should not exceed 12 km when the power line wires are placed symmetrically. If the lines are placed unsymmetrically these distances should not exceed 18 km and 6 km respectively.

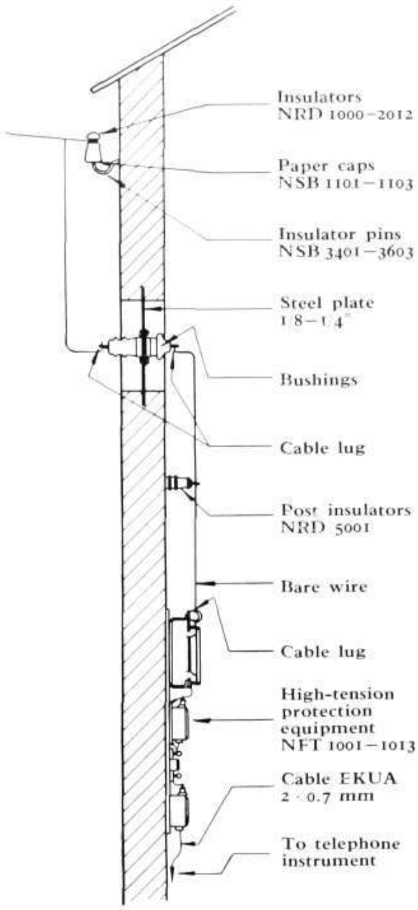


Fig. 7 X 4755

Example of the installation of a high-tension protection equipment in a telephone exchange

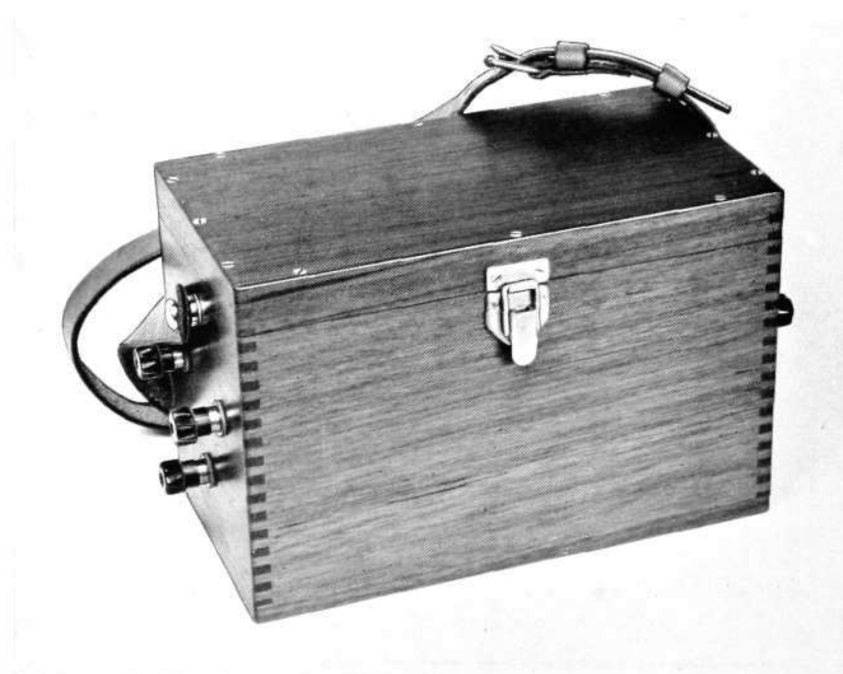


Fig. 8 X 6645

Portable high-tension protection equipment NFT 2001

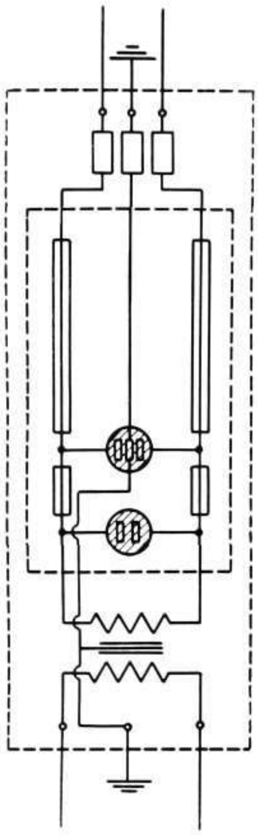


Fig. 9 X 4756

Schematic diagram for high-tension protection equipment NFT 2001

Installation

Fig. 7 shows one example of the manner in which the high-tension protection equipment can be installed in a telephone exchange. The bare wires are led to two bushings from which bare wires of the same dimensions and material are led to the high-tension protection equipment which is mounted on the wall as close to the bushings as possible. The earth electrode on the air gap arrester should be effectively earthed so that the earth resistance is as low as possible. It should not exceed 10 ohms.

Portable High-Tension Protection Equipment

It is frequently necessary for linesmen working out on the line to call up some telephone station. It is obvious that in order to do this on telephone lines located in the vicinity of high-tension lines it is first necessary to take special protective measures. A portable high-tension protection equipment, type *NFT 2001*, has been designed and is employed for this purpose in conjunction with portable telephone instruments *DPA 1152* or *DPC 1001*. This protective equipment NFT 2001 is also capable of withstanding voltages up to 66 kV with outputs up to 1 MVA.

Fig. 9 is a schematic diagram of the portable high-tension protection equipment which includes the same over-voltage protectors and fuses as the other protective sets. The insulating transformer is the same as that employed in NFT 1001 and NFT 1011.

NFT 2001 has the following dimensions: length 250 mm, width 130 mm, height 170 mm, and it weighs approximately 6 kgs.

Fig. 10 illustrates how connection to the line is carried out. The high-tension protective equipment is connected to the portable telephone instrument by a rubber-insulated, screened cable and is effectively earthed. A suitable number of line rod sections *NMA 2011* are fitted together and terminate in a connecting hook *NMA 2601*. The rubber-insulated screened cable is attached to the connecting hooks and connected to the high-tension protection equipment. The line rods are then suspended on the telephone wires and telephoning can take place.

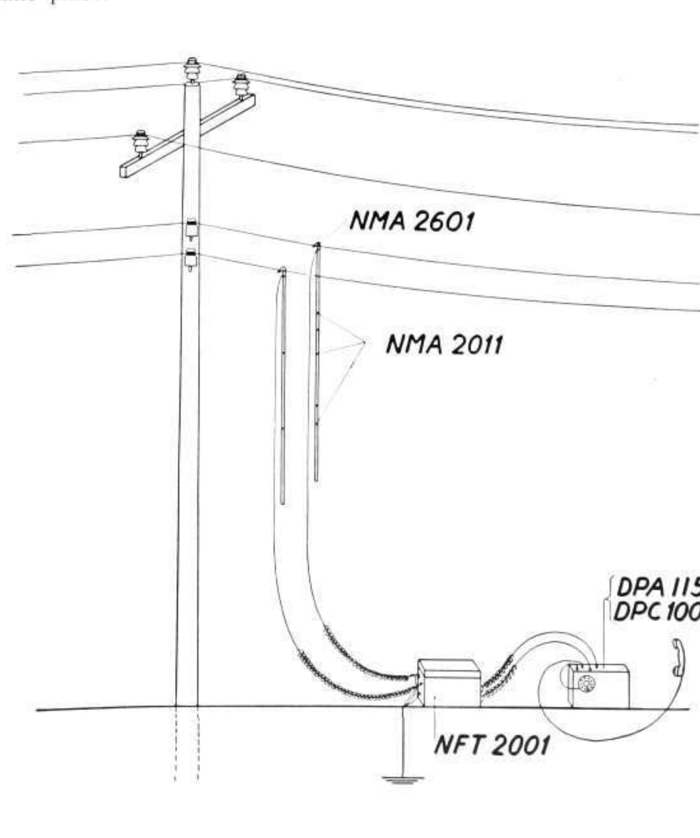


Fig. 10 X 6638

Schematic diagram for field telephony

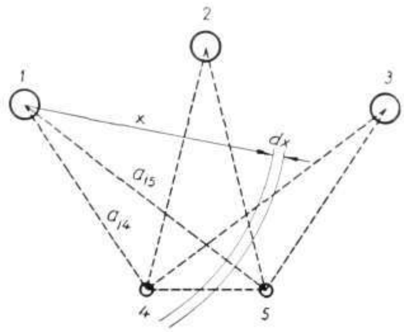


Fig. 11 X 4757

Diagram for calculating the electromagnetic field

Appendix

A calculation is given below relating to the voltages induced in telephone conductors by power lines in a stationary condition, for the case which is of most common occurrence, namely, where a telephone line (double line) is placed parallel to a three-phase symmetrical high-tension line.

In the space surrounding the high-tension conductors electromagnetic and electrostatic fields are generated which induce voltages in adjacent telephone lines, these voltages being primarily dependent on the frequency of the high-tension line, the operating voltage and the power transmitted, as well as the length of the line, the position of the conductors in relation to each other and their height above the ground.

The Electromagnetic Field

Electromagnetic induction is set up by the mutual induction between the conductors.

If it is assumed that the cross-section of the conductors is so small that the latter do not give rise to a mutual skin effect, the field around the conductor *1*, see Fig. 11, per cm length will be determined from the equation:

$$d\Phi_1 = 0.2 \cdot I_1 \cdot \frac{dx}{x}$$

where I_1 is the current (in amps) flowing in the conductor *1*. The field from the conductor *1* which passes between the conductors *4* and *5* (the telephone wires) will then be:

$$\Phi_1 = \int_{a_{14}}^{a_{15}} 0.2 \cdot I_1 \cdot \frac{dx}{x} \text{ maxwells}$$

If, therefore, I_1 indicates the momentary value of the current in conductor *1*, the momentary value of the field will be:

$$\left.\begin{aligned} \Phi_1 &= 0.2 \cdot I_1 \cdot \ln \frac{a_{15}}{a_{14}} \\ &\text{and analogously for the fields from conductors 2 and 3} \\ \Phi_2 &= 0.2 \cdot I_2 \cdot \ln \frac{a_{25}}{a_{24}} \\ \Phi_3 &= 0.2 \cdot I_3 \cdot \ln \frac{a_{35}}{a_{34}} \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots (1)$$

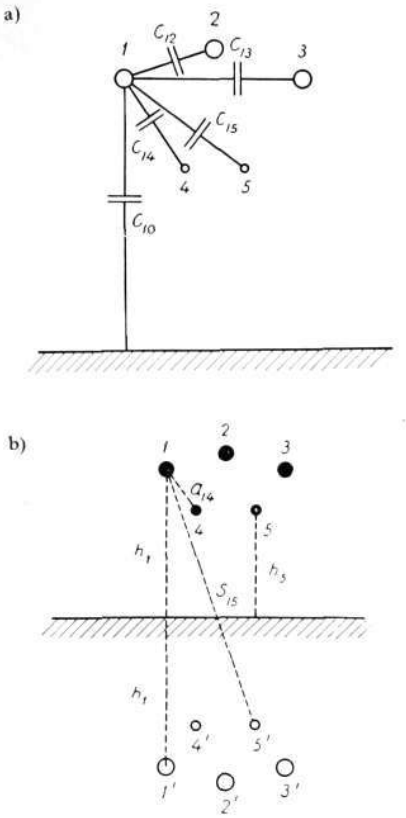
where a_{n4} and a_{n5} denote the distance between the conductors *n (1, 2, 3)* and the conductors *4* and *5* respectively.

Variation in the current intensity $[I = I_{\max} \sin (\omega t + \beta)]$ sets up an induced voltage in the telephone conductors, having the magnitude:

$$E = 10^{-8} \cdot \frac{d(\Phi_1 + \Phi_2 + \Phi_3)}{dt} \quad \ldots\ldots\ldots\ldots (2)$$

If the phase sequence is assumed to be 1, 2, 3, the currents I_2 and I_3 will be displaced in phase 120° and 240° respectively behind I_1:

$$\left.\begin{aligned} I_1 &= I_{\max} \sin (\omega t + \alpha) \\ I_2 &= I_{\max} \sin \left(\omega t + \alpha - \frac{2}{3}\pi\right) \\ I_3 &= I_{\max} \sin \left(\omega t + \alpha - \frac{4}{3}\pi\right) \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots (3)$$



X 4758
X 4759

Fig. 12

Diagram for calculating the electrostatic field

Thus, on deriving (2), if the length of the parallel lines is l km and it is possible to calculate with the same sag for all conductors:

$$E = 2 \cdot 10^{-4} \cdot l \cdot I_{\max} \cdot \omega \cdot \left[\left(\ln \frac{a_{15}}{a_{11}}\right) \cos\left(\omega t + \alpha\right) + \right.$$

$$\left. + \left(\ln \frac{a_{25}}{a_{24}}\right) \cos\left(\omega t + \alpha - \frac{2}{3}\pi\right) + \left(\ln \frac{a_{35}}{a_{34}}\right) \cos\left(\omega t + \alpha - \frac{4}{3}\pi\right) \right] \quad \ldots (4)$$

The Electrostatic Field

Electrostatic induction is set up as a result of the partial capacitances between the conductors and between the conductors and earth.

Using the notation for partial capacitances employed in Fig. 12 a, the charge on conductor 1 will be:

$Q_1 = C_{10}\,U_1 + C_{12}\,(U_1 - U_2) + C_{13}\,(U_1 - U_3) + C_{14}\,(U_1 - U_4) + C_{15}\,(U_1 - U_5)$
and analogously for the other conductors (U_n denotes the potential on conductor n).

Since the formulae for the capacitances are somewhat troublesome to use, it is more convenient to resort to a system of equations including the capacitances in a reciprocal form:

$$\left.\begin{aligned} U_1 &= k_{11}\,q_1 + k_{12}\,q_2 + k_{13}\,q_3 + k_{14}\,q_4 + k_{15}\,q_5 \\ U_2 &= k_{12}\,q_1 + k_{22}\,q_2 + k_{23}\,q_3 + k_{24}\,q_4 + k_{25}\,q_5 \\ U_3 &= k_{13}\,q_1 + k_{23}\,q_2 + k_{33}\,q_3 + k_{34}\,q_4 + k_{35}\,q_5 \\ U_4 &= k_{14}\,q_1 + k_{24}\,q_2 + k_{34}\,q_3 + k_{44}\,q_4 + k_{45}\,q_5 \\ U_5 &= k_{15}\,q_1 + k_{25}\,q_2 + k_{35}\,q_3 + k_{45}\,q_4 + k_{55}\,q_5 \end{aligned}\right\} \quad \ldots\ldots\ldots (5)$$

U_n denotes the potential in volts in conductor n, q_n denotes the charge in microcoulombs per km in conductor n, whilst the ks are constants the magnitude of which may be seen from the following:

If it is assumed that the length of the conductors is great in relation to the distance between them and to their height above the ground and that these distances in turn are great in relation to the wire radii, then the constants may be expressed as follows:

$$\left.\begin{aligned} k_{nn} &= 18 \cdot \ln \frac{2\,h_n}{r_n}\ \text{km}/\mu\text{F} \\ k_{xy} &= 18 \cdot \ln \frac{s_{xy}}{a_{xy}}\ \text{km}/\mu F\ (x \neq y) \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots\ldots (6)$$

where r_n denotes the radius of conductor n
h_n » conductor n's height above the ground
a_{xy} » distance between conductor x and conductor y
s_{xy} » » » » x » » y's reflection with respect to the ground ($s_{xy} = s_{yx}$), see Fig. 12 b.

The formulae (6) actually assume that the conductive capacity of the ground is infinitely great which is never the case in practice, but the error thus resulting in the calculations is negligible in most cases.

We now return to equation system (5). Since the voltages induced in the power lines by the telephone conductors may be entirely ignored, q_4 and q_5 may be inserted as equal to o in the formulae for U_1, U_2 and U_3. If it is further assumed that the telephone conductors are completely insulated from one another and from earth, then $q_4 = q_5 = 0$. Equation system (5) can thus be simplified as follows:

$$\left.\begin{aligned} U_1 &= k_{11}\,q_1 + k_{12}\,q_2 + k_{13}\,q_3 \\ U_2 &= k_{12}\,q_1 + k_{22}\,q_2 + k_{23}\,q_3 \\ U_3 &= k_{13}\,q_1 + k_{23}\,q_2 + k_{33}\,q_3 \\ U_4 &= k_{14}\,q_1 + k_{24}\,q_2 + k_{34}\,q_3 \\ U_5 &= k_{15}\,q_1 + k_{25}\,q_2 + k_{35}\,q_3 \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots\ldots (7)$$

*—200003

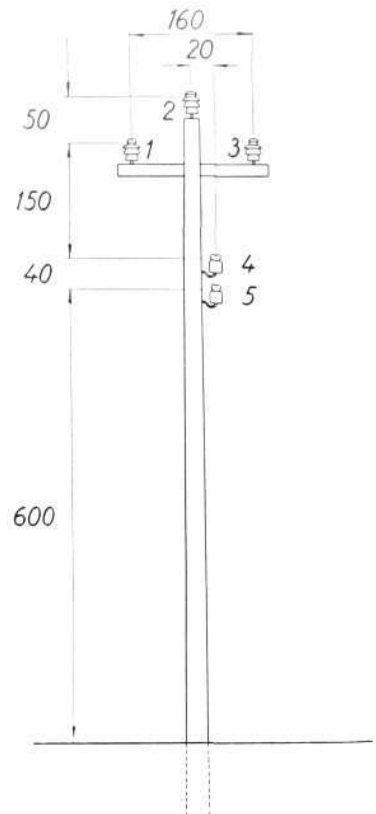


Fig. 13 X 4760
Example of a pole head configuration

In this system of equations U_1, U_2 and U_3 therefore represent the voltages in the 3 high-tension lines, whilst U_4 and U_5 represent the induced voltages in the telephone conductors. In order to calculate the induced voltages, q_1, q_2 and q_3 must be known, and these can be calculated with the help of the three first equations in (7):

$$\left.\begin{aligned} q_1 &= \frac{\begin{vmatrix} U_1 & k_{12} & k_{13} \\ U_2 & k_{22} & k_{23} \\ U_3 & k_{23} & k_{33} \end{vmatrix}}{\begin{vmatrix} k_{11} & k_{12} & k_{13} \\ k_{12} & k_{22} & k_{23} \\ k_{13} & k_{23} & k_{33} \end{vmatrix}} \\ q_2 &= \frac{\begin{vmatrix} k_{11} & U_1 & k_{13} \\ k_{12} & U_2 & k_{23} \\ k_{13} & U_3 & k_{33} \end{vmatrix}}{\begin{vmatrix} k_{11} & k_{12} & k_{13} \\ k_{12} & k_{22} & k_{23} \\ k_{13} & k_{23} & k_{33} \end{vmatrix}} \\ q_3 &= \frac{\begin{vmatrix} k_{11} & k_{12} & U_1 \\ k_{12} & k_{22} & U_2 \\ k_{13} & k_{23} & U_3 \end{vmatrix}}{\begin{vmatrix} k_{11} & k_{12} & k_{13} \\ k_{12} & k_{22} & k_{23} \\ k_{13} & k_{23} & k_{33} \end{vmatrix}} \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (8)$$

If it is assumed that the phase sequence is 1, 2, 3, the voltages U_2 and U_3 will be displaced in phase by 120° and 240° respectively in relation to U_1.

The voltages may therefore be written:

$$\left.\begin{aligned} U_1 &= U_{max} \cdot \sin\ (\omega t + \alpha) \\ U_2 &= U_{max} \cdot \sin\left(\omega t + \alpha - \frac{2}{3}\pi\right) \\ U_3 &= U_{max} \cdot \sin\left(\omega t + \alpha - \frac{4}{3}\pi\right) \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots \quad (9)$$

Example

A telephone line (double line) is mounted on the same poles as a high-tension line having the following data: 3 phases, operating voltage 20 kV, frequency 60 c/s, transmitted power 200 kVA, wire diameter 5 mm, distance between poles 100 m, maximum sag 2.1 m. The pole head configuration may be seen from Fig. 13 in which all dimensions are indicated in cm.

The electromagnetic induction is first calculated. The distance between the power lines and the telephone conductors can best be determined geometrically. It is found that:

$$\begin{aligned} a_{14} &= 180 \text{ cm} \quad & a_{24} &= 201 \text{ cm} \quad & a_{34} &= 162 \text{ cm} \\ a_{15} &= 214 \text{ cm} \quad & a_{25} &= 241 \text{ cm} \quad & a_{35} &= 199 \text{ cm} \end{aligned}$$

If these values are inserted in (4) and $l = 20$ km, $I_{max} = 10\sqrt{2} = 14.14$ A, $\omega = 2\pi \cdot 60 = 377$, then:

$$E = 3.72 \cos(\omega t + \alpha) + 3.86 \cos\left(\omega t + \alpha - \frac{2}{3}\pi\right) + $$
$$+ 4.42 \cos\left(\omega t + \alpha - \frac{4}{3}\pi\right) \text{ volts.}$$

By vectorial addition it is found that the effective value $E = 0.68$ V.

If the ratios $\frac{a_{15}}{a_{14}} = \frac{a_{25}}{a_{24}} = \frac{a_{35}}{a_{34}} = 1$ could be obtained, it would then be found that $E = 0$, see (4). But even in this practical case in which the ratios are ≈ 1.2, only an insignificant induced voltage is obtained on account of the electromagnetic induction. This voltage may nevertheless give rise to interference, which has been dealt with in the text.

The conditions are different in the case of electrostatic induction, the calculations for which now follow. The formulae evolved assume that the conductors run parallel with the ground, which they cannot do, however, owing to the sag. Already, when calculating the electromagnetic induction the same line curves have been assumed for all 5 conductors. Since the distance between poles is several times greater than the maximum sag, the line curve may be regarded with satisfactory approximation as a very flat parabolic arc, the distance of the centre of gravity of which from the straight line between the conductors' fixing points is equal to $\frac{2}{3}$ of the maximum sag. Hereafter, therefore, each conductor will be reckoned as having a constant height above the ground, equal to $h_n - 140$ cm.

Thus, the values already known are:

$h_1 = h_3 = 650$ cm, $h_2 = 700$ cm, $a_{13} = 160$ cm, and $r_1 = r_2 = r_3 = 0.25$ cm.

The distances between the high-tension lines and the telephone conductors have been determined previously. The remaining distances may best be determined geometrically, and it is then found that:

$$a_{12} = a_{23} = 94 \text{ cm} \qquad s_{14} = 1156 \text{ cm} \qquad s_{25} = 1161 \text{ cm}$$
$$s_{12} = s_{23} = 1355 \text{ cm} \qquad s_{15} = 1116 \text{ cm} \qquad s_{34} = 1153 \text{ cm}$$
$$s_{13} = 1310 \text{ cm} \qquad s_{24} = 1203 \text{ cm} \qquad s_{35} = 1113 \text{ cm}$$

Inserting these values in (6) we obtain:

$$k_{11} = 154.0 \qquad k_{12} = 48.0 \qquad k_{14} = 33.5 \qquad k_{15} = 29.8$$
$$k_{22} = 155.3 \qquad k_{23} = 48.0 \qquad k_{24} = 32.2 \qquad k_{25} = 28.3$$
$$k_{33} = 154.0 \qquad k_{13} = 37.8 \qquad k_{34} = 35.4 \qquad k_{35} = 31.0$$

which on insertion in (8) give:

$$q_1 = 10^{-3} \,(7.40\, U_1 - 1.92\, U_2 - 1.23\, U_3)\ \mu\text{C/km}$$
$$q_2 = 10^{-3} \,(-1.92\, U_1 + 7.64\, U_2 - 1.92\, U_3)\ \mu\text{C/km}$$
$$q_3 = 10^{-3} \,(-1.23\, U_1 - 1.92\, U_2 + 7.40\, U_3)\ \mu\text{C/km}$$

On now inserting $U_{\max} = 20 \cdot 10^3 \cdot \sqrt{2} = 28.3 \cdot 10^3$ in (9), together with the values found for k and q in the two last equations in (7) we get:

$$U_4 = 4.07 \sin(\omega t + \alpha) + 3.21 \sin\left(\omega t + \alpha - \frac{2}{3}\pi\right) + 4.52 \sin\left(\omega t + \alpha - \frac{4}{3}\pi\right) \text{kV}$$

$$U_5 = 3.56 \sin(\omega t + \alpha) + 2.81 \sin\left(\omega t + \alpha - \frac{2}{3}\pi\right) + 3.94 \sin\left(\omega t + \alpha - \frac{4}{3}\pi\right) \text{kV}$$

The effective values can then be found by vectorial addition, and we get:

$$U_4 = 1.1 \text{ kV} \qquad U_5 = 1.0 \text{ kV}$$

If it is assumed that the telephone conductors are moved down 2 m, induced voltages of 510 and 455 V respectively would be obtained.

Modern Water Level Indicators

A TRÄGÅRDH, TELEFON AB L M ERICSSON, TELESIGNAL WORKS, STOCKHOLM

U.D.C. 654.942

L M Ericsson have been supplying water level indicator systems for more than 60 years, and the experiences gained during this time have been taken fully advantage of in the periodical revisions of the equipment. The following article will illustrate the design and function of the equipment which is at present available after a recent redesign.

The water level indicator is a valuable and essential piece of equipment for remote supervision of the water level in reservoirs and receptacles of different kinds. The rise and fall of the levels in different places may be ascertained from a central position enabling the control personnel to prevent supply failures and to compensate exceptionally high or low levels. In hydro-electric plants and waterworks the water level indicator is, of course, essential but it is also finding applications in other industrial plants where remote supervision of liquid levels is required.

A transmitter, installed at the control point, contains a magneto generator transmitting electrical impulses in a certain relation to the changes in the water level. The impulses are transmitted to a receiver in the central control room. The receiver has an indicating dial and may contain a recording mechanism for continuous registration of the water level on a diagram paper. No batteries are required which is a considerable advantage as no battery supervision will be required. Two wires only are required for the transmission of the impulses and if suitable conductors are selected the distance between the transmitter and the receiver may be considerable, for instance in case of reservoirs for hydro-electric plants.

The wires used for the transmission of the impulses may also be utilized for telephony. With the use of special telephone instruments a telephonic connection may be obtained betwen the transmitter and the receiver without wiring cost.

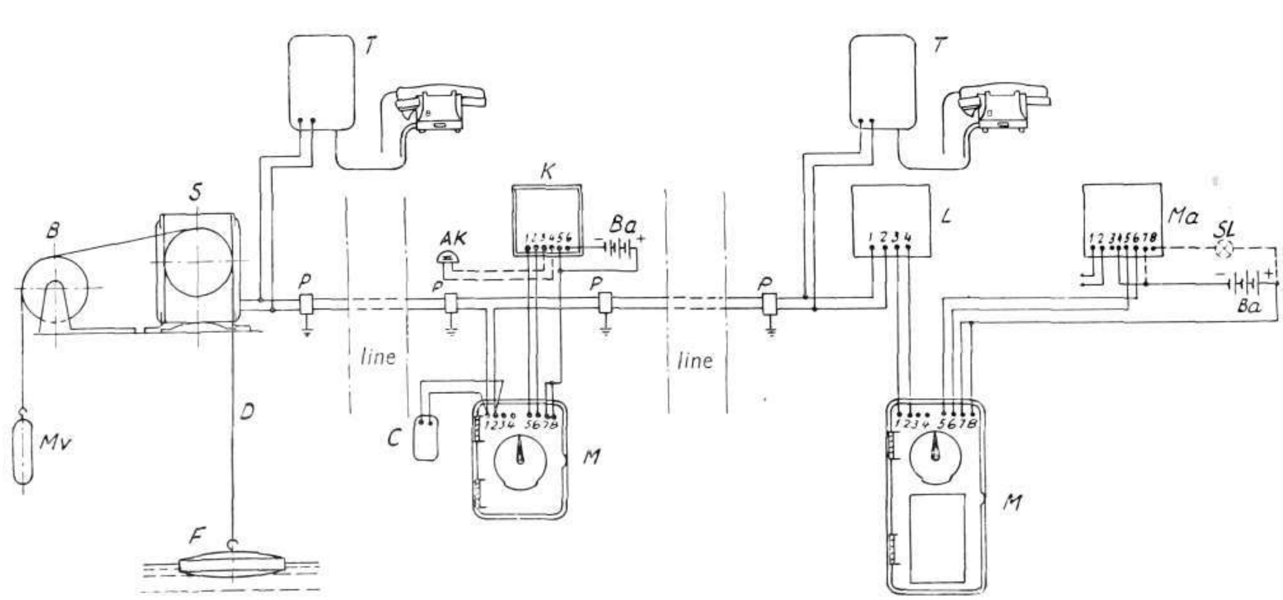


Fig. 1 X 7609

Circuit diagram for a water level indicator system

AK alarm bell
B pulley
C capacitor box
D driving belt
F float
K alarm set
L low pass filter
M receiver
Ma control set
Mv counter weight
P fuses
S transmitter
SL signal lamp
T telephone

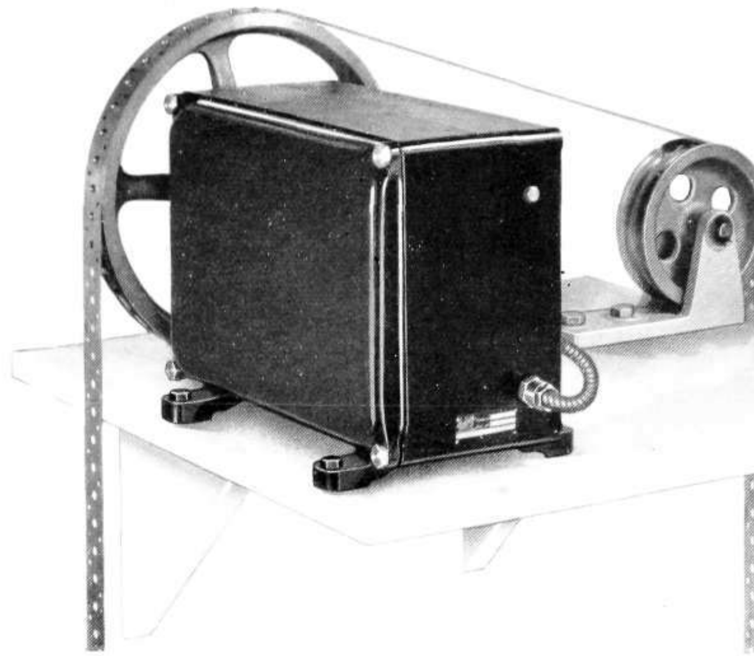


Fig. 2 X 6653

Transmitter KET 1002—KET 1005

with driving belt and pulley, for different impulse intervals

Design

A water level indicator system contains in principle a transmitter and one or two receivers and wiring between these. The equipment on the transmitter side includes a *float*, a *driving belt*, a *pulley* and a *counter weight* which are required to transfer the motive power from the varying water level to the transmitter. The receiver side may be equipped with a control unit issuing an alarm signal, when a certain level has been reached, to call the attention of the control staff. Certain systems have in addition a repeater set containing a relay for automatic control of motors for pumps, sluice gates and other devices. If the transmitting line is used for telephony, telephone instruments are added on the transmitter and the receiver side. Fig. 1 illustrates how the lay-out may be arranged for such a system.

The transmitters and the receivers are supplied in several variations enabling transmission of different rates of intervals and ranges. There are instruments for transmission of 1 impulse per 2.5 cm and 5 cm level change and corresponding types for 1 impulse per 1″ and 2″. The ranges, *i.e.*, the distance between highest and lowest level, are 5, 10 or 20 metres and 15 or 30 feet respectively. A system for 2.5 cm impulse interval may be supplied for 5 or 10 metres range and a 5 cm system for 10 or 20 metres. For 1″ impulse interval the range is 15 or 30 feet and for 2″ interval 30 feet.

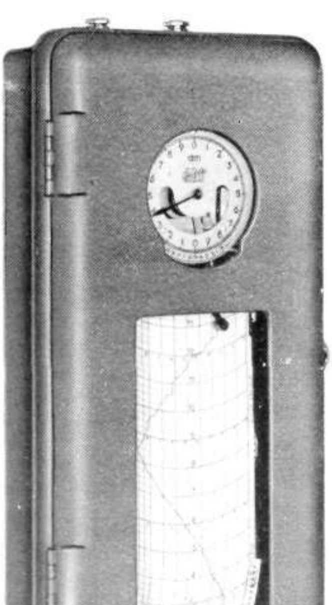
The *transmitter*, Fig. 2, consists of a magneto generator with five magnets and tripping gear, enclosed in a water tight black enamelled cover of cast brass. The generator is coupled to a driving wheel outside the cover the diameter of which varies for different impulse intervals. The electrical impulses generated by the magneto generator are transmitted over the line to the receiver and have a polarity which is depending on the direction of rotation of the generator, *i.e.* whether the level is rising of falling.

The *float* is made of hot-galvanized mild steel and is provided with a loop in which the driving belt is secured. The left portion of Fig. 1 shows how the phosphor bronze driving belt runs from the float to the driving wheel on the transmitter and over a pulley to a cast iron counter weight. The periphery of the driving wheel is provided with a number of pegs engaging a line of holes in the driving belt and preventing the belt from slipping on the wheel. In this way the movements of the float are transferred over the driving belt to the transmitter. The driving belts are supplied in lengths of 8, 13 and 23 metres and 26 and 40 feet respectively, the length of the belt being selected so as to suit the distance between the lowest level and position of the transmitter.

Fig. 3 X 4773
Indicating receiver KCT 2011—KCT 2017
for different impulse intervals and ranges

The *receiver* is supplied in two types, the indicating type, Fig. 3, and the indicating and recording type, Fig. 4. Both types are fitted in grey enamelled die-cast cases and may be mounted projecting or flush in an instrument board. In the latter case the receiver is fixed in the board by means of mounting brackets.

The indicating receiver contains a dial movement driven by two driving magnets operated by the impulses from the transmitter. The driving magnets receive the transmitter impulses over two rectifiers, identifying the direction of the impulses. »Rising» impulses will operate one magnet and »falling» impulses the other one. The case is provided with a glass covered aperture in front of the dial which has two scales and two pointers. The upper circular scale carries divisions corresponding one impulse interval. The lower shorter scale segment covers the complete range. The full range pointer operates limit signal contacts for critical high or low levels. The signal contacts are adjustable on a curved bar and can be adjusted in any position within the range. Usually two signal contacts only are used but there is space available for a further two contacts in case signals are required for several levels. The contacts are rated for max. 0.2 A at 24 V or 0.8 A at 6 V.



The combined indicating and recording receiver contains in its upper position an instrument movement identical with that in the indicating receiver. The lower position contains a clock driven recording unit with an eight day spring movement. The rate of the paper feed is 20 mm/h. The diagram is read through a glass covered aperture in the lower part of the case. The level variations are drawn on the diagram paper by a pen provided with an ink container. The pen is fixed to the lower pointer in the indicating movement and is pressed against the paper by a spring. A blue special slow drying ink is used. The diagram paper is time referenced and has a length of 25 metres corresponding to roughly 50 days. Replacement of diagram paper and refilling of ink is easy to carry out.

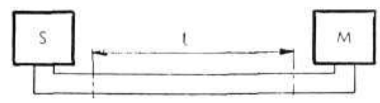
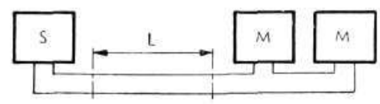
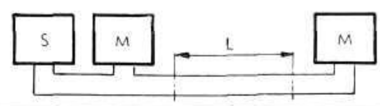
When an alarm signal is required for critical high or low levels the receiver is supplemented with an *alarm set*, Fig. 5. The alarm set contains two relays, a bell and two lamps under lenses marked »MAX» and »MIN». It is connected to the signal contacts on the full range scale in the receiver.

Automatic starting and stopping at certain levels is often required for pump motors etc. For this purpose the receiver is supplemented with a repeater set containing a relay with a power contact for 10 A at 250 V. The relay also carries a signal contact for the operation of a signal lamp. The signal lamp is mounted in a convenient position indicating whether the motor operated from the repeater set is running or not.

Fig. 4 X 4774
Indicating and recording receiver KCT 2101—KCT 2107
for different impulse intervals and ranges

The control unit and the repeater set are enclosed in grey lacquered mild steel covers. They are supplied in two variations for 6 V and 24 V operating voltage. These two sets consequently require a separate battery.

The line between the transmitter and the receiver consists of two conductors, either as overhead wires or as telephone ground cable. The following table indicates the line distances permissible for different systems and line constructions.

System	Permissible line distance	
	Bare 2 mm Copper wire km	Ground cable 0.6 mm telephone cable (paper insulated) km
	575	55
	508	49
	508	49

For long distances between the control point and the control room it is very advantageous to use the transmitting line also for telephony. The telephone instrument, Fig. 6, used in that case, is provided with a separate calling set. The instrument is a table set made in black moulding material and is provided with a calling button and a D.C. bell. The separate calling set, also serving as wall terminal box, contains equipment for transmission and reception of calling signals. A vibrator unit is used as signal generator and consists of a vibrator with a frequency of 110 cycles and a transformer. The calling set has space for three dry cell batteries of 3 V each and 85 mm height, 67 mm width, 35 mm depth. Two of the batteries are feeding the vibrator and one is used as microphone supply.

A low pass filter is connected between the line and the receiver, which is furthest away from the transmitter. The filter, wich consists of an induction coil and a capacitor, blocks the ringing frequencies whereas the system impulses

Fig. 5 X 6652

Alarm set KER 2101 for 6 V or KER 2102 for 24 V

right: with cover removed

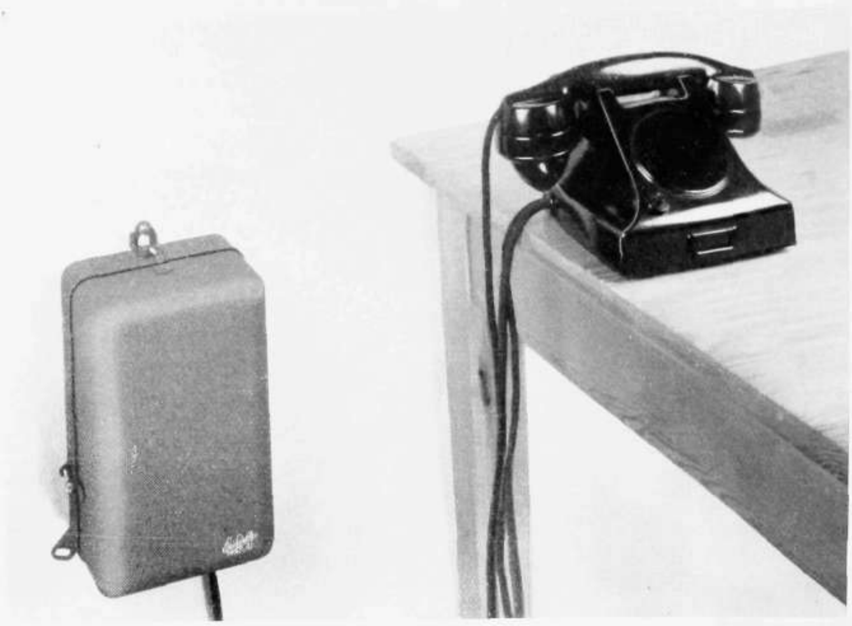


Fig. 6 X 6651

Telephone instrument with calling set DGH 1611

are passed. An intermediate receiver is provided with a parallel capacitor allowing speech and signal currents to by-pass the receiver but blocking the system impulses.

Function

When the level is changing, the movements of the float are transferred to the transmitter by the driving belt. When the wheel has been rotated an angle corresponding to an impulse interval the armature in the generator is released and is rotated half a revolution transmitting an impulse to the receiver. One of the driving magnets in the receiver is operated depending on the polarity of the impulse and the two pointers are moved one step. If an indicating-recording receiver is used in the system, the level change is also recorded on the diagram paper.

If by the level change the maximum limit has been reached, the corresponding signal contact in the receiver is closed operating the bell in the control unit and the »MAX» or »MIN» lamp indicating that the upper or lower limit has been reached. The bell is silenced by pressing a button, but the lamp signal remains operated until the signal contact in the receiver is opened when the level has been restored to normal.

If a pump is to be started or stopped at a certain level or a sluice gate opened or closed, the signal contact in the receiver is closing a circuit to a relay in the repeater set.

The motor is started over the power contact on the relay and will be running until the receiver has reached the opposite contact cutting out the motor.

If telephone sets are connected on the transmitting line, the ringing signal is transmitted from a set by pressing the calling button. When the call has been answered conversation can be carried out in the usual way. If an alteration in the level takes place at the same time as a ringing signal is being issued or a call is in progress, this does not interfere with the reception and recording of the impulse in the receiver.

Small Automatic Charging Rectifiers

H BERGSTRÖM, TELEFONAKTIEBOLAGET L M ERICSSON

U.D.C. 621.314.63:621.316.722:621.355

Accumulator batteries for telephone and telesignalling installations are usually charged nowadays by dry rectifiers provided with regulating equipment which automatically supervises charging. L M Ericsson has designed a series of these rectifiers, types BMM 17—19, which are fitted with regulating devices consisting of telephone relays. This series, which has been on the market since 1948, is described in the following article.

Charging rectifiers of the types *BMM 17—19* are intended for the automatic charging of lead- or alkaline batteries having capacities of 6—180 Ah, and are particularly suitable for use in small telephone and telesignalling installations.

The rectifiers can be reconnected for alternating current supply systems at 110, 127 and 220 V, 50 c/s, and are manufactured in sizes from 0.5 to 12 A charging current with a battery voltage of 24 V. Where a higher charging current is required a number of these rectifiers can be connected in parallel.

The principle adopted for controlling battery charging with these rectifiers consists in the employment of a voltage-sensitive relay which is connected to the main terminals of the battery. As is well known, the battery voltage rises during charging in relation to the duration of the charge. On reaching a suitable, adjustable voltage, the relay closes and interrupts the charging current from the rectifier. When the battery is being discharged, its voltage falls until the relay drops out and connects up the rectifier for charging again. Since the relay is directly controlled by the battery voltage the rectifier will always maintain the voltage limits for the battery for which adjustment has been made, even when the mains voltage and frequency fluctuate, or the rectifier element changes due to aging or to temperature conditions. The charging current of the rectifier will change, however, in relation to the fluctuations in the mains voltage. If therefore, the mains voltage is abnormally low during long periods or where breakdowns in the supply are of frequent occurrence a rectifier of larger standard type should be selected to ensure that the battery can be recharged during the time in which the mains voltage is normal again. Fluctuations in the mains voltage of ± 10 % and 40—60 cycles in the frequency have no effect on the operating reliability of the rectifier.

Construction

The charging rectifier, Fig. 1, consists of:

a *charging section* with the transformer *Tr*, the selenium rectifier *L 1*, the choke *Dr* for smoothing the rectifier's pulsating voltage and the transformer tap changer switch *OK 2* for regulating the current intensity for rapid charging;

a *regulating section* with the voltage-controlled relay *R 1*, the charging relay *R 2*, with the contact *31—32* for switching in rapid and trickle charging respectively, the relay *R 3* for connecting up the so-called additional charging and the change-over switch *OK 1* which has two positions marked *MAN* (manual charging) and *AUT* (automatic charging). The regulating equipment also includes the rheostat r_{MIN} provided with a control knob and scale graduated from 22 to 28 V. By means of this resistance adjustment is made for the minimum voltage at the battery. The rheostat r_{MAX} which has a scale graduated from 24—32 V is employed for adjusting the battery's maximum

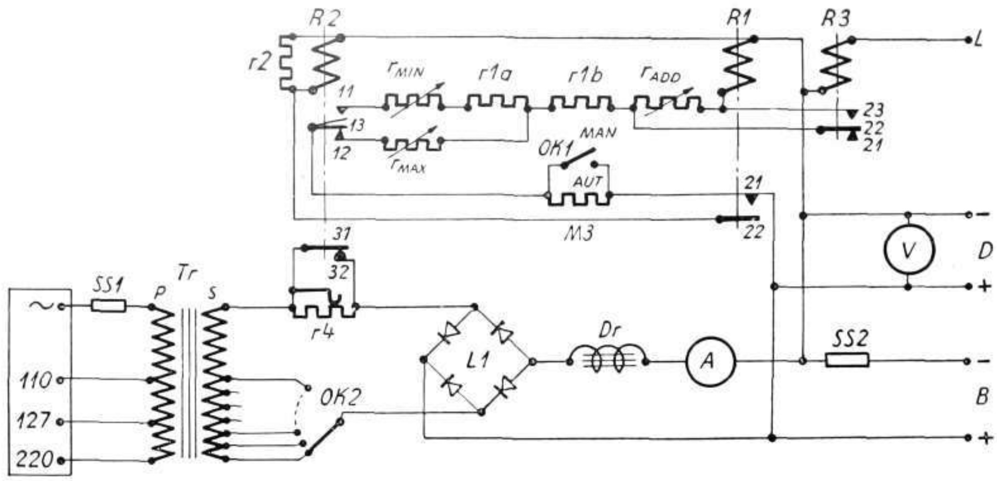


Fig. 1 X 7610

Schematic diagram for automatic charging rectifier

A	ammeter
B	terminals for battery
D	terminals for load
Dr	choke
L	terminal for additional charging
L 1	selenium rectifier
M 3	resistance
OK 1	two-position change-over switch
OK 2	transformer tap-changer switch
R 1	voltage control relay
R 2	charging relay
R 3	relay for additional charging
r 1a	resistance
r 1b	resistance
r 2	resistance
r 4	resistance for trickle charging
r_{ADD}	rheostat
r_{MAX}	rheostat
r_{MIN}	rheostat
SS 1	fuse for supply mains
SS 2	fuse for rectifier
Tr	transformer
V	voltmeter

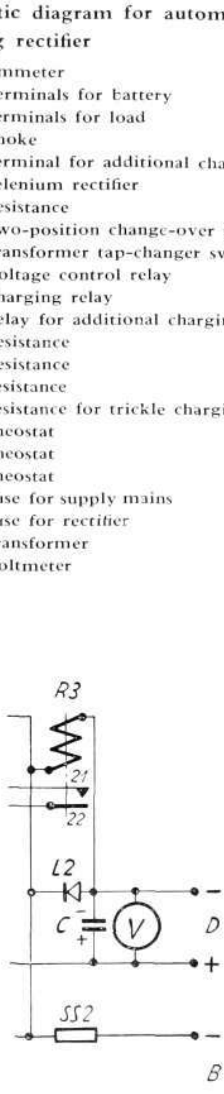


Fig. 2 X 4775

Part of schematic diagram for an automatic charging rectifier with a non-linear shunt

C	electrolytic capacitor
L 2	non-linear shunt of the copper-oxide type
R 3	relay for additional charging

voltage. The rheostat r_{ADD} the scale of which is graduated from 0—4 V, is intended for additional charging. The terminals *B* are connected to the battery and the terminals *D* to the load (telephone exchange).

Functioning

Manual Charging

In certain instances it may be desirable to regulate charging by hand, as for example, when charging the battery for the first time or during routine maintenance when the battery is filled up with distilled water and is fully charged until gassing takes place in the cells. The change-over switch *OK 1*, see Fig. 1, is then set in the position *MAN*. The resistance *M 3* is hereby connected in series with the relay *R 1* so that the latter can no longer hold its armature. The relay *R 2* will then become deenergized and its contact *31—32* is closed, whereupon the rectifier will charge continuously at the full rate. On completing the charge the switch *OK 1* must be returned to the position *AUT*.

Automatic Charging

Rapid charging

In this form of charging the relay *R 3*, the function of which will be described later, is assumed to be closed. When the contact *31—32* is closed, the rectifier charges at its maximum current (rapid charging) until the battery voltage has risen to a value corresponding to the setting of the rheostat r_{MAX} such as 27 V for example. The voltage controlled relay *R 1* then attracts its armature and its contact *21—22* closes, whereupon *R 2* pulls up.

Trickle Charging

A battery when left standing idle for some time loses capacity, and consequently it must be supplied with a certain charging current of approximately 1 mA/Ah in order to prevent the reduction of its capacity. This so-called trickle charging takes place automatically when the relay *R 2* closes. The contact *31—32* then opens and the resistance *r 4* is connected in series with the transformer and the rectifier element. In this way the charging current is not interrupted but is reduced to such a value that adequate compensation is obtained for the consumption of the relays and the internal self-discharging of the battery. The current intensity for trickle charging is adjusted by the resistance *r 4* according to requirements. When current is taken from the battery its voltage will gradually fall to a value corresponding to the setting of the rheostat r_{MIN} such as 24 V for example. The relays *R 1* and *R 2* will then drop out and the rectifier will be connected in circuit again for rapid charging. The breaking capacity of the contact *31—32* is ample since it always opens on alternating current. In addition, the resistance *r 4* serves as an effective spark quench.

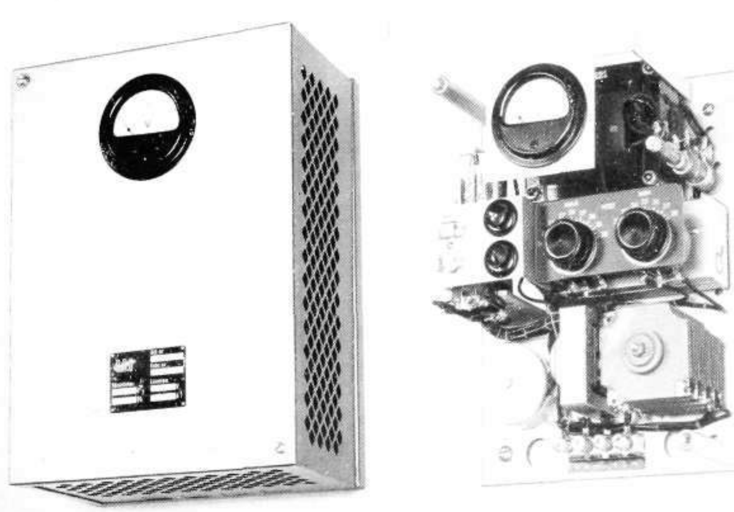
Additional Charging

A telephone exchange normally functions satisfactorily when the battery voltage is maintained within the limits 24—27 V for which the rectifir's regulating equipment is assumed to be set, as described above. In order to ensure its full capacity, however, the battery must be charged at a higher voltage from time to time, namely, at about 30 V. A lower value than this can be chosen if the rectifier's charging current is low in relation to the rated capacity of the battery, or higher if the conditions are reversed. This additional charging takes place automatically with these rectifiers as soon as the drain from the load ceases. The additional charge is switched on and off with the help of the relay *R 3* in two different ways, see Figs 1 and 2.

In Fig. 1 *R 3* is controlled by imparting a plus polarity to the terminal *L* from a contact in the consumption apparatus (the telephone exchange). This contact closes as soon as the exchange is functioning. Automatic telephone exchanges of L M Ericsson's AHD and ALD types are equipped with a contact of this kind.

In installations which are not provided with this contact, such as automatic exchanges of the type OL, manual exchanges and other telesignalling apparatus, the relay *R 3* is operated as show in Fig. 2. Here the relay *R 3* is provided with a low-resistance winding (contrary to Fig. 1 where *R 3* has a high resistance) and is connected in parallel with a non-linear shunt *L 2* of the copper-oxide type which has such a characteristic that the voltage drop across *R 3* is limited to about 0.5 V at the maximum current.

The relay *R 3* drops out when no current is being taken from the terminals *D* and thereby connects the resistance r_{ADD} in series with the relay *R 1* so that its additional voltage is raised to a value corresponding to the adjustment of r_{ADD} such as 3 V for example. The cut-out limit is however also raised by about 30 % of the adjusted value, that is to say, about 1 V in the present case. Consequently, the new voltage limits will be 30 and 25 V respectively. Immediately current is drawn from the terminals *D* the relay *R 3* closes, the additional charge is disconnected and the limits will once more be restored to 27 and 24 V. The purpose of the electrolytic capacitor *C* is to reduce the risk of cross-talk between subscribers owing to the impedance of the relay *R 3*.



X 6655

Fig. 3
Automatic charging rectifier type BMM 17
right: with cover removed

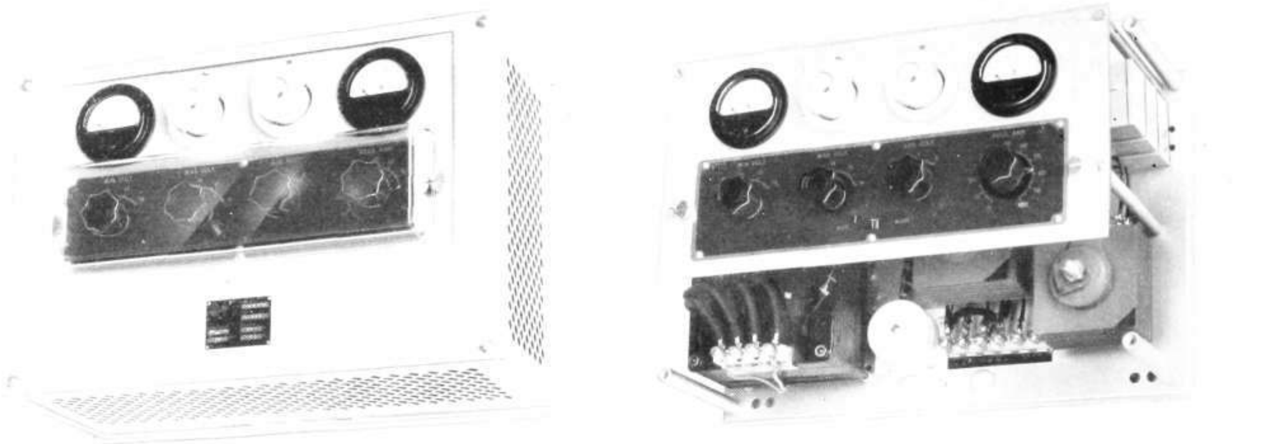


Fig. 4 X 7612
Automatic charging rectifier type BMM 18
right: with cover removed

Automatic Charging Rectifiers, type BMM 17

These rectifiers which are illustrated in Fig. 3, are constructed in the simplest possible form. Thus, they are not equipped with an arrangement for additional charging (relay *R 3*) or a change-over switch for manual charging (*OK 1*) see schematic diagram Fig. 1. Such arrangements are unnecessary for small rectifiers where the charging current is usually low in relation to the capacity of the battery. The transformer switch *OK 2* is replaced by a resistance. In their standard form the rectifiers are manufactured for 24 V and charging currents of 0.5 and 1 A. The current consumption for trickle charging is 8 W (10 VA) and the efficiency on rapid charging is about 55 %.

Automatic Charging Rectifiers, type BMM 18

These rectifiers which are illustrated in Fig. 4, are constructed in accordance with the principle shown in Figs 1 and 2. The tap-changer switch *OK 2* is replaced by a rheostat, however. The various devices for regulating the voltage and current are mounted at the front of the rectifier and are protected against tampering by a detachable cover of transparent cellon. The standard rectifiers are manufactured for 24 V and charging currents of 2 and 4 A. The current consumption for trickle charging is 12 W (22 VA) and the efficiency on rapid charging is about 60 %.

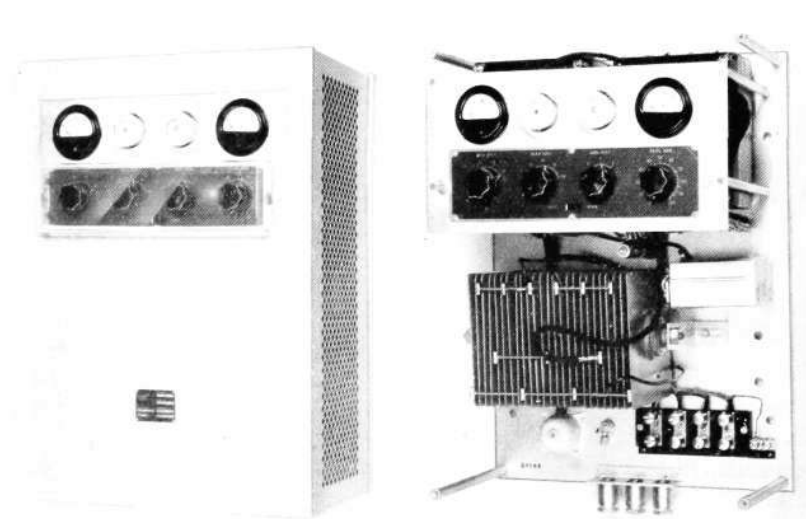


Fig. 5 X 6657
Automatic charging rectifier type BMM 19
right: with cover removed

Automatic Charging Rectifiers, type BMM 19

These rectifiers are constructed on a principle similar to that shown in Figs 1 and 2. The rectifiers, the appearance of which may be seen from Fig. 5, are manufactured in the standard form for 24 V and charging currents of 8 and 12 A. The current consumption for trickle charging is 18 W (66 VA) and the efficiency on rapid charging is about 70 %.

Installation

The rectifier must be mounted vertically on a firm base so that the setting of the controlling relay is not disturbed. It is of the greatest importance for the life of the rectifier element that the set should be located in a dry and cool position and that the air circulation should be unrestricted. The battery and the associated load are connected to the rectifier terminals *B* and *D* respectively. The mains supply is connected to a totally enclosed terminal box in the rectifier.

Table of automatic charging rectifiers, types BMM 17—19 for 24 V

Designation	Rated Current A	Notes	
BMM 1705	0.5		
1706	1		
1715	0.5	With voltmeter	
1716	1		
1805	2		With L-contact as in Fig. 1
1806	4		
1811	2	With volt- and ammeter	
1812	4		
1825	2		With arrangement as in Fig. 2
1826	4		
1831	2	With volt- and ammeter	
1832	4		
1901	8		With L-contact as in Fig. 1
1902	12		
1903	8	With volt- and ammeter	
1904	12		
1921	8		With arrangement as in Fig. 2
1922	12		
1923	8	With volt- and ammeter	
1924	12		

Portable Field Radio Equipment SUF-21 K

K BEHR AND H NORRBY, SVENSKA RADIOAKTIEBOLAGET, STOCKHOLM

U.D.C. 621.396.721

Portable field radio equipment with interesting characteristics has been developed by Svenska Radioaktiebolaget. It is mainly designed for military applications and the requirement for field use has left its mark on the design. The equipment is designed for the mechanical stresses which are encountered in the field and it can be operated by unskilled persons. Although particularly suited for such military applications as fire control and reconnaissance, the equipment is also suitable for use in other civil and military fields such as civil defence, air-raid precautions, forest fire protection, and customs and frontier guard duties.

Frequency bands in the very high frequency (VHF) range are now used for the shorter radio circuits in both military and civil applications. In this way the severe disturbance produced in the short-wave band by strong distant stations is avoided. On the other hand the range of the VHF equipment is very limited. The majority of the portable stations for these frequencies have a range of only a few kms. Often, however, a longer range is of great importance. The new portable field radio equipment, which has type number *SUF-21 K*, is a frequency modulated telephone system of such characteristics that a range of 15—25 km is obtained in spite of the limitations of the ultra-short-wave band. This has been achived by operation on the lower frequencies in the VHF band, 30—50 Mc/s. In addition, the transmitting power is high, about 4 W, and the sensitivity of the receiver is great, about 1 μV. The range can be doubled by a special relay arrangement (see under Operation).

In military operation and sometimes also in civil operation, the radio stations are often arranged in networks which operate on different frequencies but must periodically communicate with each other. Frequency switching must therefore be carried in a simple way, and the radio equipment type *SUF-21 K* satisfies all requirements in this respect. It can be switched to any of 77 different channels.

The equipment derives its power from NiFe accumulators of the non-spillable type having a capacity sufficient for 8 to 10 hours normal traffic.

Fig. 1 X 4745
Portable field radio equipment SUF-21 K

Mechanical Design

General

The equipment consists of four main parts: the apparatus unit, the battery unit, the carrying equipment and the control equipment. The boxes for the apparatus and battery units are made of steel plate with drawn bottoms and covers and welded sides. The front plate of the apparatus unit is made of the same material and in addition is strengthened by welded members. In this way a robust but light construction is obtained.

The units are, as far as possible, sealed so that they cannot be damaged by dust, dirt or rain. Between the cover and the box of the battery unit a rubber seal is fitted and similar sealing is provided between the apparatus box and the front panel. The shafts of the controls and the battery lead are also made watertight.

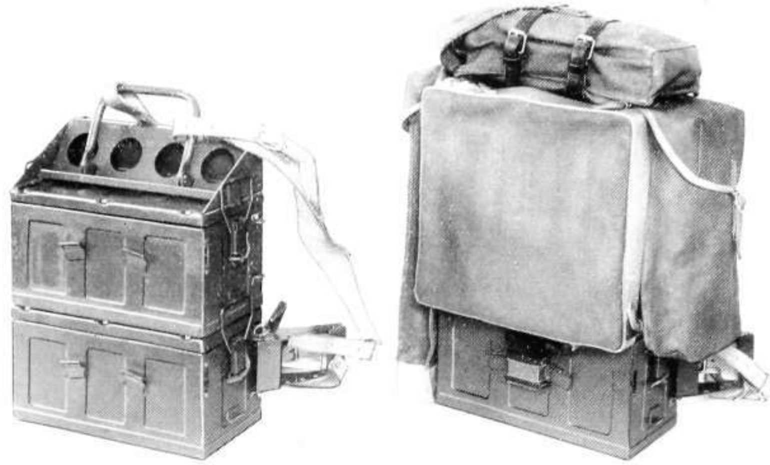


Fig. 2 X 6622
Equipment assembled

To protect the controls as much as possible against external damage a frame is mounted in front of the front panel.

The apparatus box is provided with a mounting in which the battery unit can be fixed by means of clips. Three pockets are also fixed to the apparatus box, containing the control unit, the extension cable for this unit, hand micro-telephone, battery cable, aerials, tool case and, where required, a speech set with throat microphone, Fig. 3.

The Apparatus Unit

In order to save weight, aluminium has been used as much as possible in the design of the components of the apparatus unit.

The common chassis for the transmitter and the receiver high frequency section is fixed to the front panel. The intermediate frequency and low frequency sections of the receiver are built on a separate chassis mounted above the transmitter and the mounting is designed so that the unit can be withdrawn backwards. The transmitter is thus easily accessible for changing valves. The intermediate frequency chassis is electrically connected to the transmitting section and the front panel by means of a flexible cable.

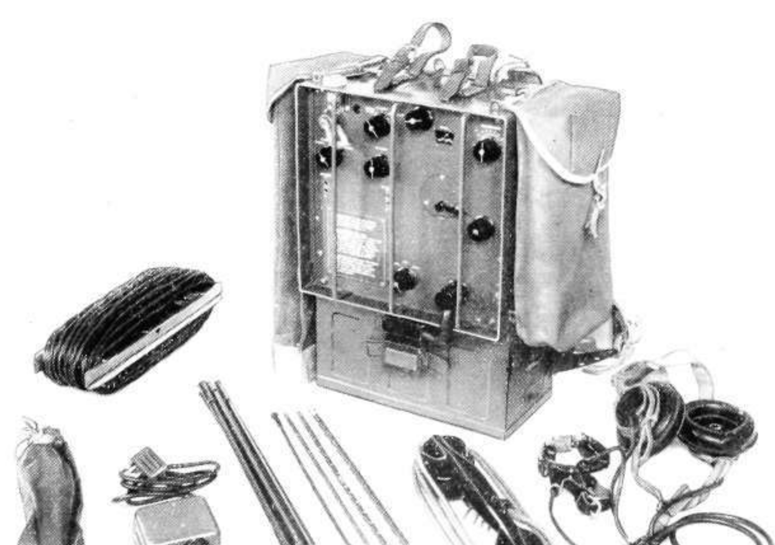


Fig. 3 X 6623
Equipment with accessories

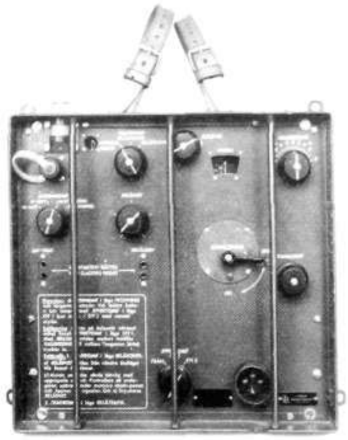


Fig. 4 X 4736
Front panel
with all controls

The power unit which is mounted at the bottom of the apparatus unit is detachable. It slides on twin guides mounted on the front panel, and the supply switch, power switch and battery cable socket are accessible trough openings in the panel. The battery connector, a short rubber-covered cable with moulded contacts connects to a socket in the battery box which is also moulded in rubber and it is so arranged that charging can take place while the equipment is in use. The connectors are non-reversible.

The power unit is connected electrically to the other units by a ten-pole contact on the inside of the front panel which fits the corresponding socket in the unit. The contact block on the front panel is detachable without tools so that for maintenance the equipment can be operated with the power unit at one side without any loose extension leads being needed. Fig. 5.

The mechanical design described above leads to exceptionally good accessibility for servicing.

The Battery Unit

One of the most difficult problems in the design of field radio equipments is the choice of power supply. The two requirements of long operating time and low weight are conflicting. When the transmitting power is high and the current consumption correspondingly great it is most convenient to design the equipment for storage battery operation. Dry batteries result in considerably higher operating costs and in addition they are not suitable for use at low temperatures.

Of the two main types of storage battery which are available, lead and nickel-iron cells, the latter have been chosen since they are both mechanically and electrically more robust and require less supervision in store.

The storage battery used for this equipment consists of three double cells in series with a nominal voltage of 7.2 V and 24 Ah capacity.

The battery box is painted inside with chlorinated rubber paint as a protection against battery gases. The cells, which are placed in moulded rubber holders, are held in position by rubber blocks on the box cover.

The equipment may also be mounted in motor vehicles, when the vehicle six volt battery can be used for the supplies. If the equipment is operated as a fixed station, for example as the headquarters station for other portable units, it can be operated from the AC mains by means of a special power supply unit, Fig. 6.

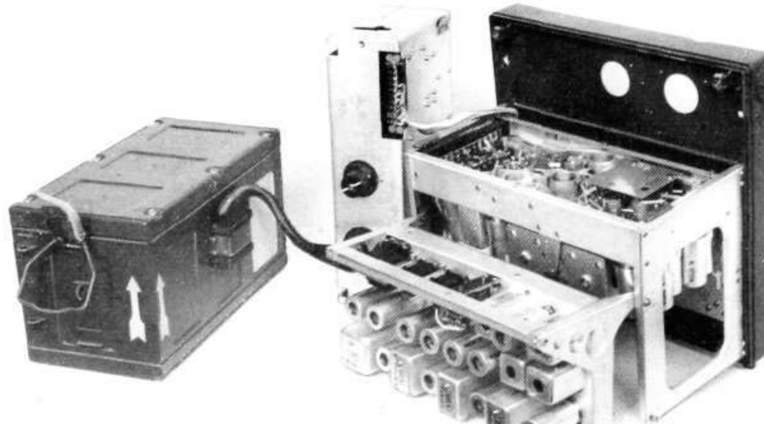


Fig. 5 X 6624
Equipment removed from boxes
but with all units connected

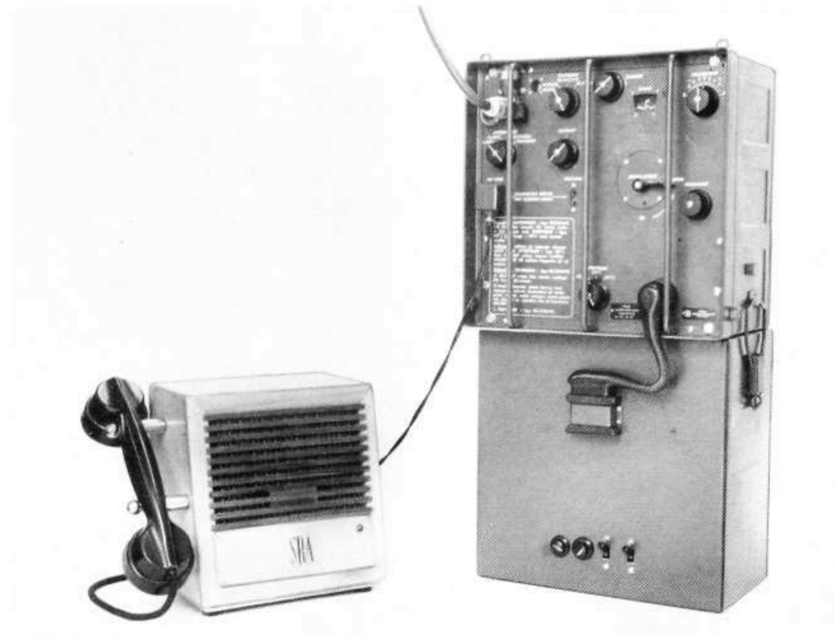


Fig. 6 X 6625

Radio equipment SUF-21 K

with mains supply unit and control unit incorporating loudspeaker

Carrying Equipment

In addition to the catches, plates for the carrying equipment are also placed at the end of the battery box. The carrying equipment consists of two shoulder straps and a supporting strap. This latter extends between two support members which are in turn fixed by pins to the battery box fittings. The shoulder straps are fixed to the support members and to the fittings on the top of the apparatus box.

The same carrying equipment is used for a load consisting of two spare batteries. By means of clips this battery unit is connected to a support plate with a handle, to which the shoulder straps are fixed as shown in Fig. 2, left.

Electrical Design

As was stated in the introduction the equipment can be set to 77 different channels. This is made possible by the use on the tuning knob of a positioning disk having a V-shaped notch in the edge for each channel. An indexing arm drops into the selected notch and holds the tuning locked, Fig. 7. Each notch is marked by an engraved number which appears in the scale window and shows to which channel the station is set.

The receiver is a superheterodyne with double frequency-changing. The aerial frequency is amplified in two high frequency stages, after which it is mixed with a signal from the variable oscillator. The second oscillator of the receiver is crystal-controlled and its frequency is chosen so that there are no harmonics within the frequency range of the equipment. For the second intermediate frequency there are three stages of amplification, the last of which is designed as a limiter and feeds the discriminator. From this the low frequency is taken to the output stage.

The transmitter frequency is obtained by taking a signal from the receiver variable oscillator and mixing it with a crystal-controlled frequency equal to the receiver first intermediate frequency. To avoid unwanted terms this mixing is carried out at low level. The sum frequency is filtered by tuned circuits and then amplified in a driver stage and a power stage.

The transmitter output frequency can be checked at three points on the scale by comparison with the harmonics from a crystal-controlled calibrating oscil-

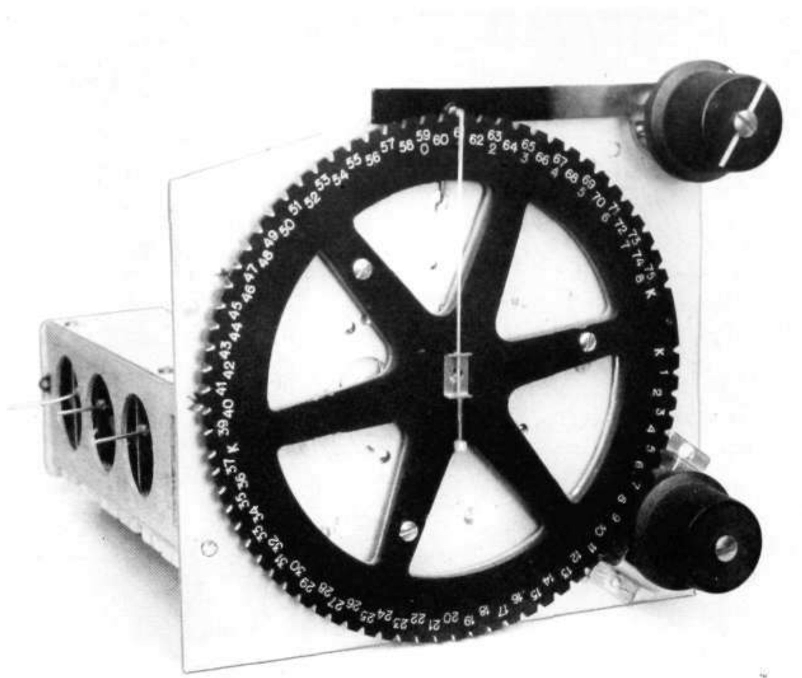


Fig. 7
Tuning scale and indexing

X 6626

lator. This is arranged so that when the scale is set to the wanted calibration point and locked, the transmitter and receiver output stage are set in operation and the calibration knob is used to adjust for zero beat.

The transmitter is modulated by a reactance valve which controls the variable oscillator and is fed with the speech currents from the microphone. During reception the reactance valve is controlled from the discriminator and thus gives automatic frequency control.

The transmitter can be switched between two powers, 0.7 and 4 W. The power stage operates in push-pull with four valves, parallel connected two and two. For the low power only two of these are in operation. Switching to the higher power lights the filaments of the other two valves and at the same time increases the anode voltage. This is done by the power switch in the power unit.

All valves used in the equipment have directly heated cathodes. When switching between transmitting and receiving the filament current is disconnected from the valves which are not in use.

The power unit is provided with a vibrator which produces the anode voltages. The vibrator uses separate transformers for reception and transmission. For reception a selenium rectifier is used, while for transmission the synchronous contacts of the vibrator are used for rectification. The control relays for the equipment are also mounted in the power unit.

Aerials

The equipment is provided with two aerials, one for use when in movement and a longer standard aerial. The smaller aerial consists of four sections of spiral duralumin strip. To simplify the assembly of the aerial the joints are each marked in colour. The standard aerial consists of eight sections of drawn steel tubing, electrolytically galvanized as a protection against rust. The aerial is supported by a steel wire which passes through all the sections. The wire is held stretched by a spiral string in the lowest section.

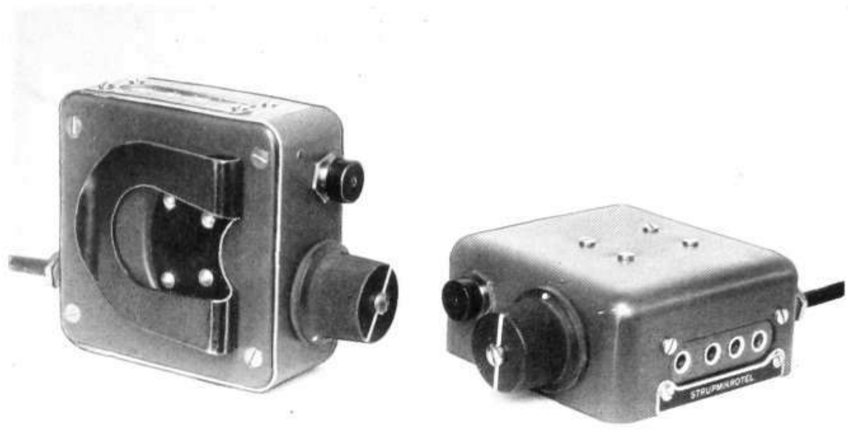


Fig. 8 X 6627
Control unit
(TR switch)

The aerial mounting is in one corner of the front panel and the threaded support is moulded in a polythene insulator. A coaxial socket is also provided on the panel for connecting a feeder to a separate aerial. This of value when the equipment is used indoors, for example in a shelter, or when the equipment is mounted in a vehicle.

The matching networks for the different aerials are connected by a switch which in its fourth position connects a built-in artificial aerial. This contains a lamp which is visible behind a window on the right of the aerial mounting. The transmitter can be checked and the condition of the battery observed with the aid of this artificial aerial.

Operation

The control box is a separate unit to which either a hand micro-telephone and switch or a speech set with a throat microphone can be connected. A volume control and a push switch are mounted on the box. The switch is used to start the transmitter when the speech set is used. As will be seen from Fig. 8 the control box is designed for fastening to a belt.

The box is normally connected to the equipment by a short twin cable but this can be extended using a 40 m remote control lead.

In relay operation the two equipments which are to form the relay station should be set up, as much in the open and as high as circumstances permit, and at a distance of about 80 m from each other. They are connected together by a twin lead (the two remote control leads for the equipments) and set for relay traffic, Fig. 10. Relay traffic is arranged so that one terminal station *I* transmits on a channel *A* to its relay station *II*. A relay in the receiver of this equipment switches on the transmitter in relay station *III* over the twin lead, and this station transmits to the other terminal *IV* on a second channel *B*. The transmitter of equipment *III* is modulated via the twin lead from the receiver in *II*. Before relay traffic can begin the relay stations must be in touch with their respective terminals and must be set for relay operation. Once this is done

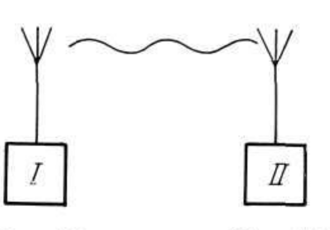


Fig. 9 X 7605
Normal traffic

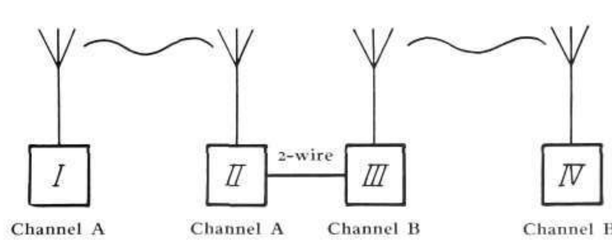


Fig. 10 X 7605
Relay traffic

no switching is required at the relay stations and they operate fully automatically. The traffic can, however, be monitored in the relay station telephones. The switch on the hand micro-telephone is disconnected.

When the equipment is used in the normal traffic arrangement, Fig. 9, the relay equipment can be used as a squelch circuit (noise suppression).

Technical Data

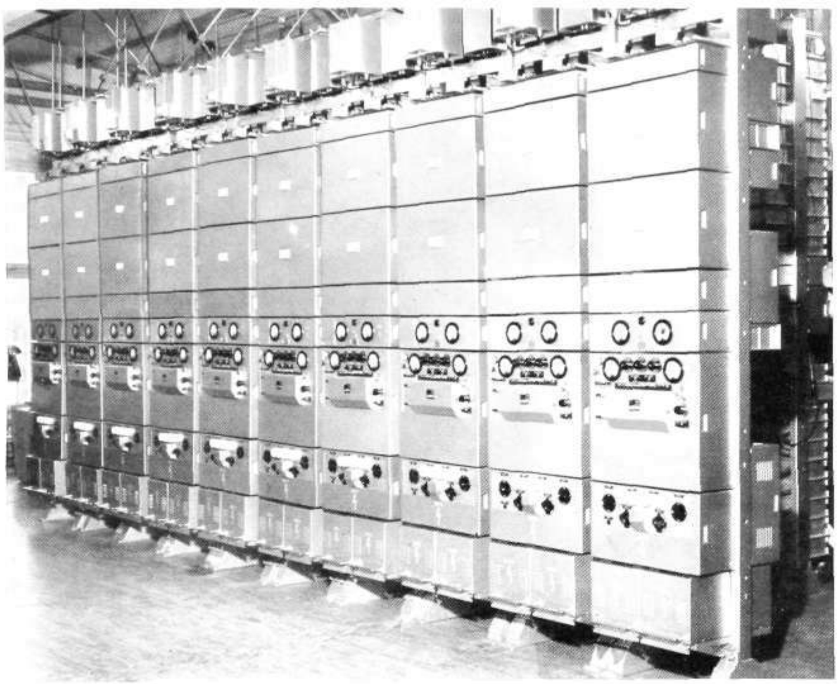
Type of Transmission:	Telephony, simplex.
Aerial Power:	Position 1, about 0.7 W. Position 2, about 4 W.
Aerials:	Standard aerial 3.27 m long or march aerial 1.34 m long. A fixed elevated aerial with feeder can be connected.
Frequency Range:	About 8 Mc/s in the band 30—50 Mc/s, 77 channels including 3 calibration points.
Modulation:	Frequency modulation.
Receiver Sensitivity:	A signal of 1 μV reduces the noise by 16 dB.
Spurious Radiation:	Less than —65 dB for both transmitter and receiver.
Valves:	5 off 3A4, 10 off 3V4 and 10 off 1L4.
Supplies:	Battery unit containing 3 nickel-iron cells, capacity 24 Ah. Alternatively power supply unit for 110, 127, 190 and 220 V, AC, 50 c/s.
Current Consumption:	Receiving, normal traffic: 0.85 A Receiving, relay traffic: 1.0 A Transmitting, position 1: 2.5 A Transmitting, position 2: 6.0 A

Size and Weight:	Height mm	Width mm	Depth mm	Weight kg
Apparatus Unit............	265	275	176	8.6 (18.9 lbs)
Battery Unit	145	275	136	9.2 (20.3 lbs)

The weight of the equipment complete with pockets, carrying frame and one battery unit = 22.2 kg (49.0 lbs).

Load with two extra battery units complete with carrying equipment = 19.8 kg (43.0 lbs).

NEWS *from* *All Quarters of the World*



Top left: Equipment for 10 attended repeater stations prior to its despatch from the testroom.

L M Ericsson Equipment for the Stockholm—Gothenburg Coaxial Cable

»L M Ericsson has the distinction of being the first company in the world to offer coaxial cable equipment for 960 simultaneous calls on one coaxial pair». These words are quoted from a speech made by Mr Håkan Sterky when opening the new Stockholm—Gothenburg coaxial cable system in January this year. Mr Sterky is the president of the Swedish Royal Board of Telegraphs.

L M Ericsson started the development of carrier telephony as late as 1946. At that time considerable progress had already been made in USA where a trial installation was in existence transmitting frequencies up to one million cycles per second. Within this frequency range a maximum of 240 simultaneous calls can be transmitted.

The ultimate objective for the L M Ericsson development was a system for 960 channels. This was considered the limit for the technical resources available in the form of electronic and magnetic materials and other components. The initial trials of the L M Ericsson coaxial system were started by the end of 1950 and in April 1951 a number of channels were put into service.

The Stockholm—Gothenburg cable has so far been equipped for 360 channels but orders are already in hand for substantial extensions.

One telephone connection between Stockholm and Gothenburg requires the operation of no fewer than 700 electronic valves. These are mainly located in the 49 intermediate repeater stations which are installed along the cable route at an average distance of 9 km ($5^1/_2$ miles) apart. Most of the repeater stations are unattended and only every ninth or tenth station is attended.

The First »Speaking Clock» in South America

L M Ericsson is shortly putting into service the first speaking clock in South America. It is being installed in Bogotá, Colombia, and will be connected to the automatic exhanges which just now cover 40,000 lines.

The recorded voice belongs to Swedish Miss Inger Chilberg, born and brought up in Colombia and now on the staff of L M Ericsson. The illustration above shows her listening to her own voice together with Mr Gunnar Lindblom of L M Ericsson Telesignal Works.

The first L M Ericsson speaking clocks were installed 1934, in the summer, at Warsaw and Lodz in Poland. The first speaking clock in Sweden was put in service in Stockholm on October 7th of the same year.

The L M Ericsson speaking clock will now be found in all four quarters of the globe telling the time in 17 different languages over the telephone as well as over wireless. Some sixty clock systems have up to now been installed and two more for Lebanon are in the process of completion. From the latter the Beyrouth inhabitants will be able to get the exact hour, minute and second in French as well as in Arabic.

The L M Ericsson speaking clock will shortly be introduced in Italy. The equipment, which is going to be installed in Naples, was exhibited at the recent Milan Fair.

Some Aspects of the New Indonesia

—An acquaintance with the new Indonesia is a wholly pleasant experience, says Mr Nils Sundevall of L M Ericsson's staff, who resumed his connection with that country at the end of the last year. He was L M Ericsson's representative in Java from 1921 to 1930 when he directed the installation of a number of telephone exchanges. Indonesia, which became an independent state in 1949, is one of the richest countries in the world as regards natural resources. The system of communications has been very highly developed, an entirely modern telephone network being available in Indonesia, which will bear comparison with similar networks in most countries. It is connected up by radio with telephone networks in Europe and numerous Asiatic countries. Long distance calls are made chiefly with the help of carrier wave telephony.

The Indonesian LM-office is situated in Bandung which is reached after a flight of 40 minutes from the capital, Jakarta. Bandung lies on a plateau 800 metres above sea level, and the air route to it passes over numerous volcanoes with peaks rising to 3,000 metres.

— Much has happened in Indonesia during my absence of more than twenty years, continues Mr Sundevall. A considerable part of this time has been filled by war, occupation and revolution, and consequently it was with feelings of eager anticipation that I looked forward to my return. Generally speaking, however, everything had remained very much the same as in former times. In Bandung, as in many other places I visited during my six-months stay in Indonesia, I found that the revolutionary changes that had taken place had not left any noticeable scars. The work of development is being carried on animatedly in most directions and the authorities show great willingness to co-operate with other countries and their specialists. The new Indonesia places particular importance on education. The number of schools has been increased considerably and numerous opportunities are available for secondary education. Great interest is shown for books, and long queues may be seen in front of the booksellers' windows, inspecting the new books offered for sale.

Hygienic measures have been introduced on an extensive scale with excellent results. The DDT-preparation has worked wonders in Indonesia where numerous serious epidemics are spread by insects. In a number of malarial districts the use of mosquito nets is no longer necessary. It may be stated without exaggeration that Indonesia has now become a very healthy country.

The telephone traffic is carried on by the Indonesian PTT. Even before the first world-war L M Ericsson had built a number of large telephone exchanges which are still in operation. The oldest of these was installed as far back as 1908. The Jakarta Kota Exchange was completed in 1912 and was the first to be equipped with the central battery system. Since then it has been extended from time to time by numerous additional lines. The Gambir Exchange followed in 1914, and two years later the exchanges in Surabaya were placed in service. At the same time an exchange was built at Medan on Sumatra. The Gambir Exchange was rebuilt in 1925 and the automatic distribution of incoming calls was introduced.

The L M Ericsson office in Bandung is housed in the building shown above. Seven Indonesians and four Swedes are employed here at the present time, but the staff will be increased shortly.

The telephone exchange Surabaya South installed by L M Ericsson in 1916.

An Indonesian delegation paid a visit to Sweden recently in connection with negotiations concerning a trading agreement, during the course of which they also visited L M Ericsson's factories.

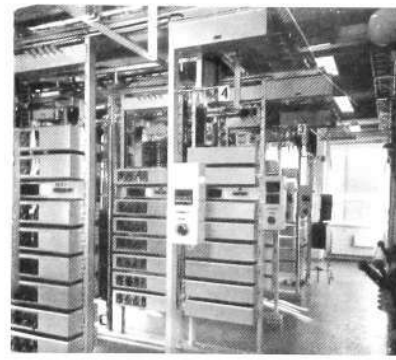
Approximately 90 per cent of all Indonesian telephone calls are connected up through L M E's jacks and plugs. While L M Ericsson was engaged on the construction of certain large exchanges, the PTT themselves constructed several small and medium-sized stations, employing LME material. At the present time it is calculated that there are some 50,000 subscribers connected to the Indonesian telephone network, spread over approximately 350 exchanges.

At the beginning of the present year L M Ericsson started work on the installation of an automatic telephone exchange for 1,000 lines at the capital Jakarta. The exchange is equipped with Ericsson's 500-line selectors and will be employed primarily for the ministeries and the telephone networks of the various authorities.

The Indonesian climate is tropical, and consequently very exacting demands are made on the capacity of the telephone material to withstand moisture and high temperatures. The fact that L M Ericsson's telephone components are capable of meeting the highest requirements in these respects is proved by the large number of old exchanges which are still in service. Tropical insects, chiefly ants, cause numerous difficulties and all equipment must be rendered »ant-proof».

Seven Indonesians and four Swedes are employed in L M Ericsson's office in Bandung at the present time, but the staff will be increased shortly. A service workshop has been set up recently in connection with this office which is housed in a white bungalow from which a wonderful view of the mighty volcano Tankoan Prauw is obtained.

A New Northern Record



L M Ericsson's 500-Line Selector Installed in the World's Most Northerly Telephone Exchange

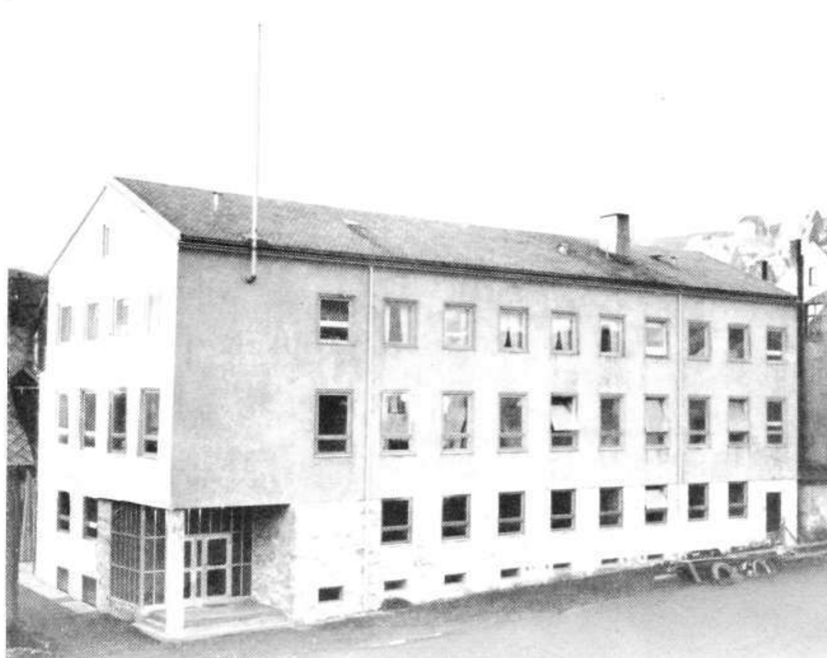
The world's most northerly automatic telephone exchange now lies in Norway since the telephone exchange in the little commercial town and seaport of Harstad was placed in operation during the previous summer. Harstad lies on the coast 50 kilometres to the northwest of Narvik on northern latitude 69° and thus outdistances by several miles the earlier northern record which was held by the town of Kiruna on latitude 67°8'.

The telephone exchange at Harstad was delivered by A/S Elektrisk Bureau of Oslo and is equipped with L M Ericsson's automatic telephone system with 500-line selectors for 2,000 subscribers, of which 1,000 are arranged for connection to private branch exchanges (PABX). The exchange equipment includes apparatus both for local traffic and automatic connection to the State network.

Simultaneously with the placing in service of the Harstad telephone exchange, the exchange at Steinsås and the previously automatized districts of Kasfjord, Oldra, Sørvik and Gausvik in Norway were connected up and now constitute a fully automatic telephone district.

The most southerly automatic station constructed by L M Ericsson is located at Marton in New Zealand on southern latitude 40°. An order for the extension of this exchange by 500 lines has been received recently.

Above: Interior of the Harstad Exchange, the world's most northerly telephone exchange which was placed in service in 1951. Below: An exterior view of the exchange.



Mobile Control Gate

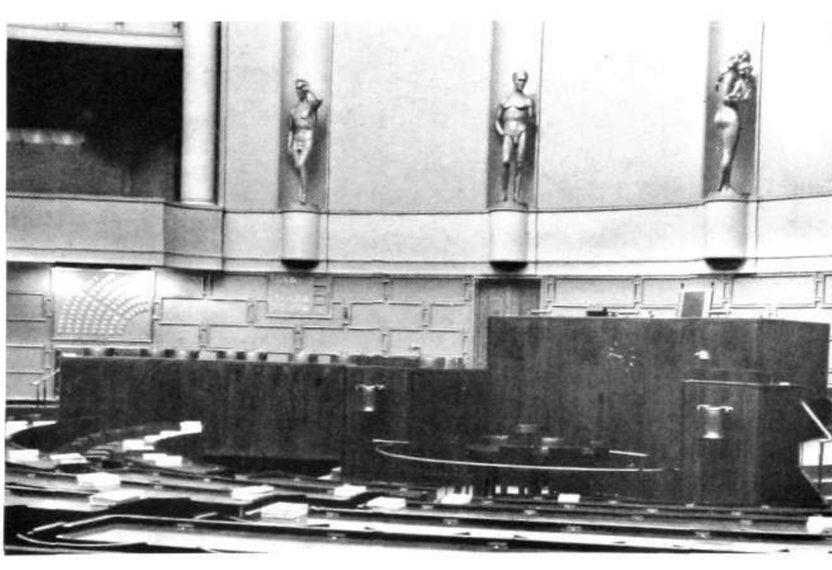
A rather unusual random search system has been supplied to A/S Schou Ravnholm works near Copenhagen. Owing to the very large number of employees leaving the factory at the same time a mobile gate has been designed which in conjunction with four L M Ericsson random search units offers simultaneous exit for two cyclists and two pedestrians. All persons passing the gate have to press a button operating either a white or a red lamp. The red light indicates that the person operating the button must subject himself to an examination. The sequence of the signals is entirely at random and the device may be arranged to give a 4—60 % examination rate.

The framework is moved into position immediately before the conclusion of work, and is rolled away again when all the employees have left the factory. By this means the roadway is left free for the passage of vehicular traffic during working hours.

Reconstruction of the Voting Machine for the Finnish Parliament

L M Ericsson's Telesignal Work has completed the reconstruction of the voting machine for the Finnish Parliament in Helsinki. This apparatus, which was first installed by L M Ericsson in 1927, was originally designed for a secret ballot, and consequently it was not possible to ascertain how each member had voted. In its new form the apparatus can also be employed for open balloting. It thus affords the same possibilities as the equipment installed in the Swedish House of Representatives. The new equipment also includes an apparatus for recording the protocol which, for additional reliability, is fitted with double lamps for each vote. An instantaneous photograph is taken of the lamp panel, the negative of which is firmly attached to a printed templet showing how the individual members have voted. The protocol also includes a panel for results on which the number of votes »for», »against», »abstained» and »absent» are each totalled separately.

Senate Chamber in the Finnish Parliament of Building.
On the left of the picture the panels showing the distribution of the votes may be seen.



A New Catalogue from Sieverts Kabelverk

Sieverts Kabelverk has issued a new catalogue in English, No. 545, on capacitors for overvoltage protection, voltage measurements and carrier transmission for voltages up to $380.000/\sqrt{3}$ V. The special properties of the capacitors are described and the catalogue also contains particulars of their employment and technical construction. This information is followed by a short section on the different routine and type tests to which the capacitors are subjected and the choice of insulation standards. Technical data are given in tabular form, in addition to various particulars and instructions for the handling and transport of the capacitors and their installation, maintenance, etc. The catalogue is completed by a reference list of the large capacitor deliveries carried out during the past twenty years.

U.D.C 621.316.91:621.395.721

HENCKEL, A: *High-Tension Protection Equipments for Telephone Instruments Connected to Conductors Mounted on Power Line Poles.* Ericsson Rev. *29* (1952) No. 1 pp. 2—11.

In the article new types of high-tension protection equipments are presented intended to be connected to conductors which for economic reasons have been mounted on power line poles. For work on the line, portable high-tension protection equipments can be used in conjunction with portable telephone instruments.

In an appendix a calculation is given relating to the voltages induced in telephone conductors by power lines in a stationary condition with a telephone line placed parallel to a high-tension line.

U.D.C. 654.942

TRÄGÅRDH, A: *Modern Water Level Indicators.* Ericsson Rev. *29* (1952) No. 1 pp. 12—16.

L M Ericsson have been supplying water level indicator systems for more than 60 years, and the experiences gained during this time have been taken full advantage of in the periodical revisions of the equipment. The following article illustrates the design and function of the equipment which is at present available after being re-designed recently.

U.D.C. 621.314.63:621.316.722:621.355

BERGSTRÖM, H: *Small Automatic Charging Rectifiers.* Ericsson Rev. *29* (1952) No. 1 pp. 17—21.

Accumulator batteries for telephone and telesignalling installations are usually charged nowadays by dry rectifiers provided with regulating equipment which automatically supervises charging. L M Ericsson have designed a series of these rectifiers, types BMM 17—19, which are fitted with regulating devices consisting of telephone relays. A brief description of this series, which has been on the market since 1948, follows.

U.D.C. 621.396.721

BEHR, K & NORRBY, H: *Portable Field Radio Equipment SUF-21 K.* Ericsson Rev. *29* (1952) No. 1 pp. 22—28.

A portable field radio equipment, mainly designed for military applications, has been developed by Svenska Radioaktiebolaget. The equipment can be handled by unskilled persons and is designed for the mechanical stresses which are encountered in the field. The equipment is particularly suited for military fire control and reconnaissance but is also suitable for use in civil defence, air-raid precautions, forest fire protection, and customs and frontier guard duties.

The Ericsson Group

ASSOCIATED AND CO-OPERATING ENTERPRISES

EUROPE

Danmark

L M Ericsson A/S *København V*, Trommesalen 5, tel: C 3438, tgm: ericsson-københavn

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

Dansk Signal Industri A/S *København-Vanløse*, Skalbakken 10, tel: DA 6346, tgm: signaler-københavn

Deutschland

Ericsson Verkaufsgesellschaft m. b. H. *Kronberg im Taunus*, Parkstrasse 1, tel: Kronberg 450, tgm: ericsson-kronbergtaunus

España

Cía Española Ericsson, S. A. *Madrid*, Conde de Xiquena 13, tel: 31 53 03, tgm: ericsson-madrid

France

Société des Téléphones Ericsson *Colombes* (Seine), Boulevard de la Finlande, tel: CHA. 35-00, tgm: ericsson-colombes-seine
Paris 17e, 147 Rue de Courcelles, tel: Carnot 95-30, tgm: eric-paris

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Esselte, Sthlm 52

ERICSSON Review

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1952

ERICSSON REVIEW

RESPONSIBLE PUBLISHER: HEMMING JOHANSSON
EDITOR: SIGVARD EKLUND, DHS
EDITOR'S OFFICE: STOCKHOLM 32
SUBSCRIPTIONS: ONE YEAR $1.50; ONE COPY $0.50

CONTENTS

On cover: Main entrance doors of the head office of Stockholms Enskilda Bank equipped for photo cell controlled pneumatic door operation.

Modern Telesignal Systems at the Head Office of Stockholms Enskilda Bank

B E:SON SUNDEMAN, STOCKHOLMS ENSKILDA BANK AB, STOCKHOLM
H EKSTRÖM, LM ERICSSON SALES COMPANY, STOCKHOLM

U.D.C. 654.9:925.24

In conjunction with a reorganization of the office routine at the head office of Stockholms Enskilda Bank various kinds of telesignal systems have been installed. A few new features with reference to equipment as well as to wiring methods have been introduced. All systems presented below have been supplied by Telefonaktiebolaget L M Ericsson.

The premises for the head office of Stockholms Enskilda Bank have for the last few years been modernized. The reconstruction work has been carried out in stages in order not to unsettle the normal work in the bank to an appreciable extent. All departments in the bank, almost without exceptions, have been affected by this reconstruction.

As part of the reorganization of the office work in the bank electrical telesignal systems have been installed extensively. A few new features have been introduced with reference to equipment and wiring methods. The most important of the systems will be briefly described below.

Fig. 1 X 6667
Exterior view of the head office of Stockholms Enskilda Bank
Kungsträdgårdsgatan 8, Stockholm

Fig. 2 X 6668
Part view of the large bank hall

Photo Cell Controlled Pneumatic Door Operation

The heavy doors at the main entrance from Kungsträdgårdsgatan have been equipped for automatic operation. About 3 to 4 feet in front of each door the passage is traversed by a light beam from a concealed transmitter, Fig. 3. The beam is directed against a concealed receiver, Fig. 4, in the opposite wall. When a person is passing, the beam is obstructed, the photo cell in the receiver is affected and an impulse is received in a relay set. The latter controls a pneumatic operating gear over the door which is automatically opened and, after an interval, closed. The interval between opening and closing is adjustable between 2 and 8 seconds. If a door is already open or if the closing operation has started when yet another person obstructs the beam, a new opening impulse is received and the closing is delayed for a full interval.

The relay set and the cock valves for the compressed air are concealed in the wall of the entrance lobby. A reduction valve is fitted at each door for adjustment of the air pressure on the operating gear, regulating the speed of operation. The compressor supplying compressed air to the system is fitted in the basement together with tank and filter.

Fig. 3 X 4778
Transmitter for photo cell control of pneumatic door operation

Conference Telephone System

This system consists of two principal's telephone cabinets for up to 30 extensions, Fig. 5, 28 master instruments with extension units for 5—15 extensions, Fig. 6, and 26 subinstruments. Fig. 7 shows a block diagram over the system. Of the master instruments 19 are connected to the public telephone network and all the other are used for internal calls only.

All master instruments and subordinated stations may be used for conference purposes between the executives and their assistants. The master stations are mostly equipped with loud speaking telephones making the executive independent of the handset and enabling him to move about in the room during conversation. The conversation can be transferred from the loud-speaker to the handset by lifting the latter and continue as on an ordinary telephone. A call from another station to a master instrument is signalled by a lamp in the called master instrument.

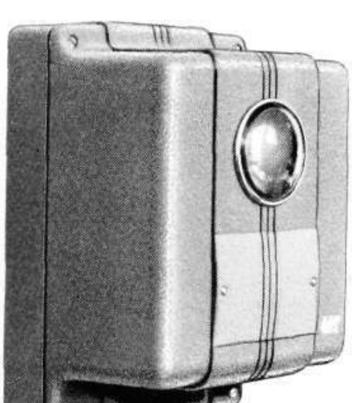


Fig. 4 X 4779
Receiver-amplifier for photo cell controlled door operation

Fig. 5 X 6669

Principal's telephone cabinet, included in the conference telephone system

for up to 30 extensions

When an outside call is in progress an executive with a master instrument may collect information from a station on the conference system without disconnecting the exchange line or without the original caller being able to overhear the conversation on the conference system.

If no answer is received on a call from a principal's telephone cabinet, it is possible to effect a remaining visual signal in the called instrument showing the called person on his return that he is wanted.

The wiring for the system is constructed in such a way that all lines from master instruments as well as sub-instruments are radiating from one point. In this point the lines are connected to a jumper frame, which considerably facilitates the rearrangements of the lines when transfers of stations are required.

Service Signals

Certain departments have their own office attendant. The offices are equipped with desk push buttons and the attendants are provided with lamp panels with

Fig. 6 X 6670

Master instrument for conference telephone system

with extension unit for 5 extensions and equipment for loud speaking telephone. In the centre the white desk panel and the wall lamp panel for attendance indication.

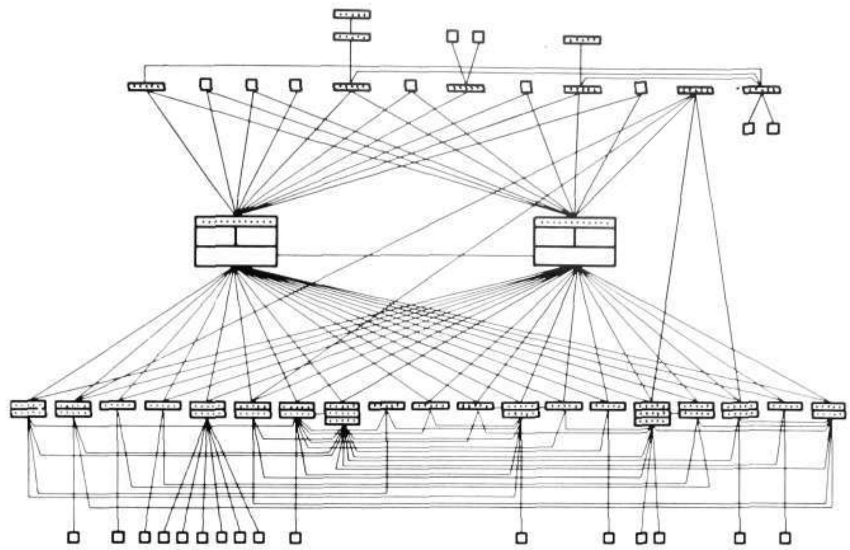


Fig. 7 X 6678

Block diagram for conference telephone system

containing principal's telephone cabinets, master and sub-instruments

restoring relays. The office rooms which are provided with engaged-signals have a common desk panel with switch, push buttons and pilot lamp. In certain departments the lamp panel is recessed in the attendant's desk, Fig. 8, together with the staff locator and the lamp panel for the attendance indication system. The panel can be covered by a roll top.

When a signal is initiated from a desk push button a lamp is operated in the attendant's panel and a buzzer is sounded while the button is pressed. The lamp remains operated until the attendant presses the corresponding restoring button in the panel. Each lamp is provided with a designation frame for a name slip.

Engaged-signals

The executives' office rooms have been equipped with engaged-signals. Outside the door a flush mounted panel is fitted carrying stencils »ENGAGED» and »TELEPHONING». If a switch on the desk panel in the room is operated the stencil »ENGAGED» will immediately be illuminated on the door panel. At the same time the pilot lamp is operated indicating that the door panel is illuminated. »TELEPHONING» is illuminated as soon as the handset on the telephone instrument is lifted or if the loud speaking telephone is used. When a call on the conference telephone sytem is answered the »ENGAGED» signal is automatically operated.

Staff Locator

Office rooms, corridors and the bank hall are equipped with lamp panels holding five differently coloured lamp sections. A person allotted a certain lamp combination should get in touch with the telephone operator when he finds his combination being signalled on the lamp panels. The operator can call up to 60 persons — 30 with flashing and 30 with continuous light — by operating the buttons in the control set corresponding to the wanted persons. Several persons may be called simultaneously. The required lamp combinations are then automatically operated in turn, each combination being signalled for a certain predetermined time.

The lamp panels have the coloured lamp sections arranged vertically one over the other, Fig. 9.

Fig. 8 X 4780

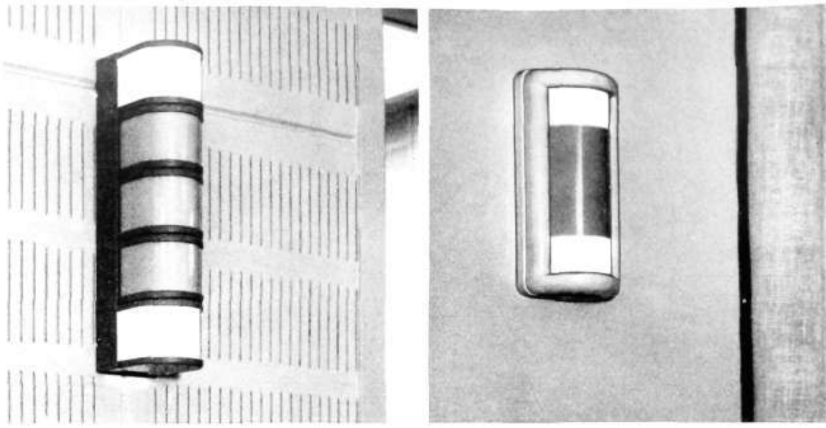
Lamp panel for service signals, recessed in the attendant's desk

Attendance Indication System

Certain prominent persons in the bank are allotted a number on an attendance panel, Fig. 6. To find out if a certain person is on the premises a button in the desk panel is pressed. The lamps for all persons present on the premises

Fig. 9 X 6671

Lamp panels for staff locator system
with the lamp sections arranged vertically; left with steel frame, right with moulded frame



are then operated in the attendance panel. The panels contain 24 lamps marked No. 1 to No. 24. Each number corresponds to a certain person.

When any of the persons covered by the attendance indication system enters or leaves the bank the attendant informs the telephone operator who records this on a control set, Fig. 10, by pressing the In or Out button corresponding to the person in question.

Electric Clock System

Electric slave clocks are fitted on the outside of the premises and in the large office rooms. The slave clocks are driven by electrical impulses transmitted each minute from a master clock system consisting of master clock, impulse unit, pilot clocks and program transmitter, Fig. 11.

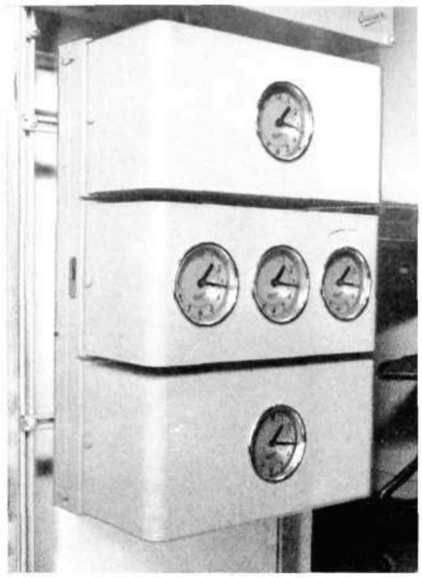
The power supply required for the clock system is an accumulator battery common to all the other telesignal systems.

Automatic Fire Alarm System

As a protection against fire an automatic fire alarm has been installed which is connected to the fire brigade headquarters. The system is based on tempera-

Fig. 10 X 6672

Control sets on top of the switchboard for attendance indication system



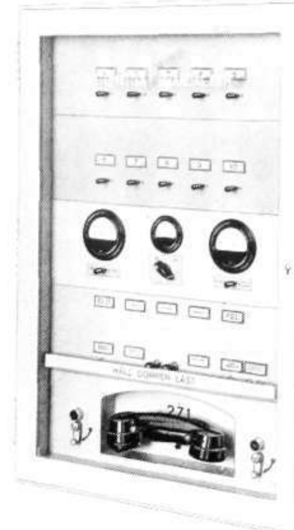


Fig. 11 X 6673

Control board for clock system

with impulse unit, pilot clocks and program transmitter

Fig. 12 X 6673

Control board for fire alarm system

ture operated detectors, thermo-contacts, fitted in the ceiling of the protected premises. The detectors, which have a fusing point of 70° C, consist of double sets of contact springs soldered together with fuse metal. The system is of the closed circuit type, *i. e.*, a low current is constantly flowing through the network and is interrupted when a detector operates breaking the circuit. An alarm signal is sounded in the control board, Fig. 12, and in the fire brigade headquarters.

Hold-up and Burglar Alarm System

The offices and the strong-rooms are protected by a burglar detection system connected to the public central alarm system. When an alarm is initiated the signal is transferred over the central alarm system, Fig. 13, to the radio section of the police headquarters. The system is closed circuit controlled and operates immediately if the detector contacts or wiring are tampered with. If the system is disconnected, entirely or in parts, this is automatically registered in the central alarm office. Local signals, which might warn a burglar, are not used.

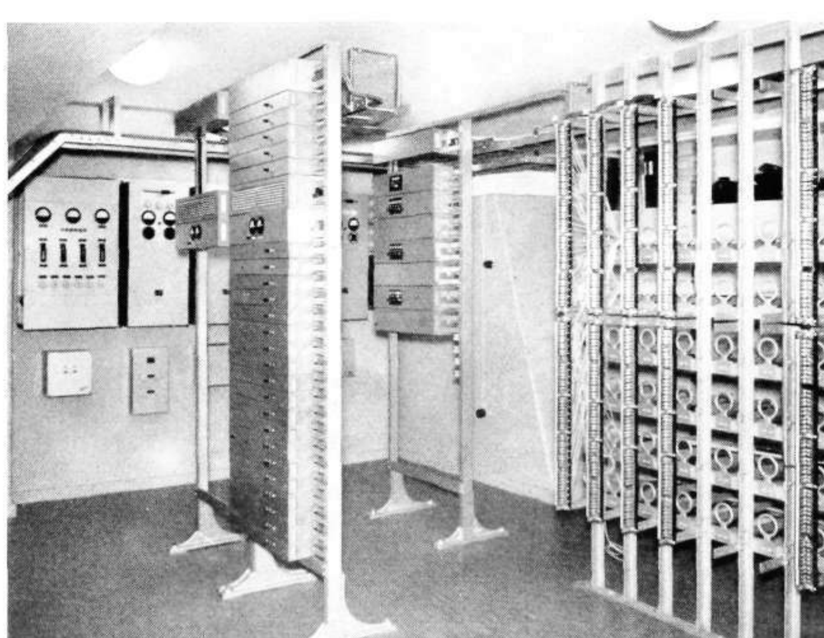


Fig. 13 X 6674

Central alarm office for fire and burglar alarm,

control room equipment

Fig. 14 X 6675
Detector contact for strong-room

To enable the police to distinguish between a burglar alarm and a hold-up alarm, the detector system for the burglar alarm is separated from the hold-up system. In this way different signals are obtained at the police headquarters. The system includes detector contacts for doors, windows and strong-rooms, Fig. 14, as well as alarm push buttons and pedal contacts for the hold-up alarm.

The system is permanently supervised from the central alarm office, which means that a person in responsible position is immediately informed as soon as a burglary has taken place or if the system is not connected at the proper time.

Connection and disconnection of the system to the police headquarters is carried out by the central alarm office on set times. This means that the installation cannot be disconnected from the central alarm office unless the latter has been informed by an authorized person.

Night Watchmen's Control

The night watchmen's control is combined with the automatic public branch telephone exchange. When the night watchman dials a certain number on a telephone instrument, this is registered on a diagram paper in the recording instrument, Centralograph, which is placed in the main attendants' office. The Centralograph diagram will clearly show when and from which places the night watchman has carried out dialling. In positions where no telephones are available control boxes have been mounted from which signals can be transmitted to the Centralograph.

If the night watchman during his round is attacked and no further control signals are transmitted, an alarm signal is automatically issued after a certain predetermined time.

Fig. 15 X 4782
Control set for remote temperature control

Remote Temperature Control

The large office rooms have been equipped with resistance thermometers which enables the personnel in the boiler room to supervise the temperature in these rooms. The control set, Fig. 15, in the boiler room is provided with a contact key for each thermometer and a common temperature indicating instrument. If the temperature in a certain room is wanted the appropriate key is operated and the temperature is read on the instrument.

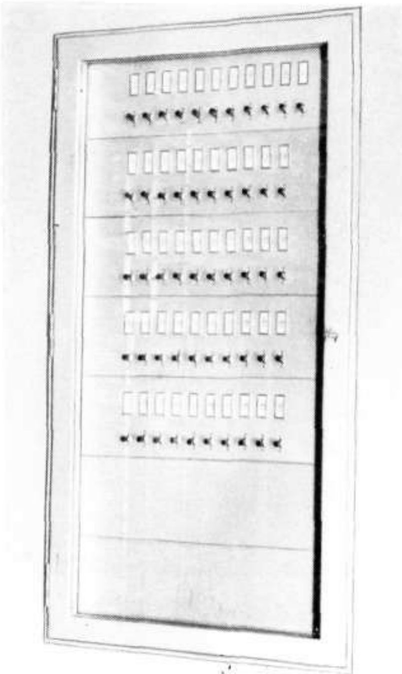


Fig. 16 X 4783
Control board for remote fan control

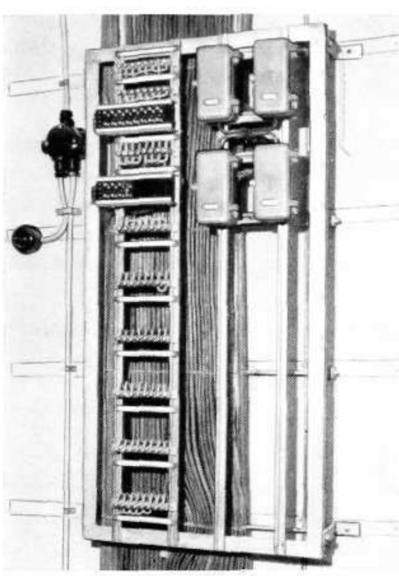


Fig. 17 X 4784
Distribution rack in cable shaft

Fig. 18 X 4785
Channels and floor well for desk connections

Remote Fan Control

Some 40 fans of various sizes are installed in different position of the premises. These are operated from a common control board, Fig. 16, fitted in the boiler room. To check which fans are in operation a button is pressed in the control board operating the control lamps for the fans in action.

Central Aerial

In order to improve wireless reception a central aerial has been installed on the roof. The aerial is connected to an aerial amplifier to which 40 wireless receivers may be connected.

Power Supply

A battery room has been arranged in the basement as power supply for the systems requiring D. C. voltage. The equipment consists of a large accumulator battery and a rectifier unit for boost charging and continuous charge.

Wiring

The wire network constitutes a not inconsiderable part of the installation. The wiring is everywhere transferable and the channel system is amply dismensioned for future extensions and alterations.

The control boards for the various systems are fitted in a control room in the basement. From the control boards the wire network radiates in all directions over cable racks, shafts and channels to the outlet frames for instruments and other equipment. The wiring from the control room runs on horizontal cable racks to cable shafts and slits which pass through all floors of the house. On each floor the cable shafts and slits are provided with doors or lids for easy access. In these positions the distribution boxes are also fitted together with terminal strips and fuses required for the surrounding floor section, Fig. 17. The communications from the shafts and slits to the ducts in the office rooms have been carried out in large diameter conduit drawn in the floors. The feeder conduit runs into the wall ducts in the outer walls over an outlet frame.

In the large bank hall and the legal department, where about 100 desks are without wall connection facilities, steel ducts are built in the floors with outlets in the form of cable wells for each desk, see Fig. 18.

Each row of desks is provided with a common duct finishing in a larger traversing floor duct. The latter communicates with the cable racks in the basement. The steel ducts are constructed with three completely separated compartments intended for the wiring of the electric mains, the telesignal systems and the public telephones respectively. The three groups of cables run together in channels and ducts throughout the system without crossing at any point.

Floor wells and outlet frames are common for the three service types which, however, are run in separate shafts and slits.

The wiring for the telesignal system runs from the control room over the horizontal cable racks in the basement into the cable shaft. On each floor the wiring radiates in channels to the outer walls and continues in ducts in these walls to outlet frames in the office rooms. The desks in the bank hall and the legal department are provided with outlet frames with channels and connection conduit to the floor wells taking the wiring for the electric mains,

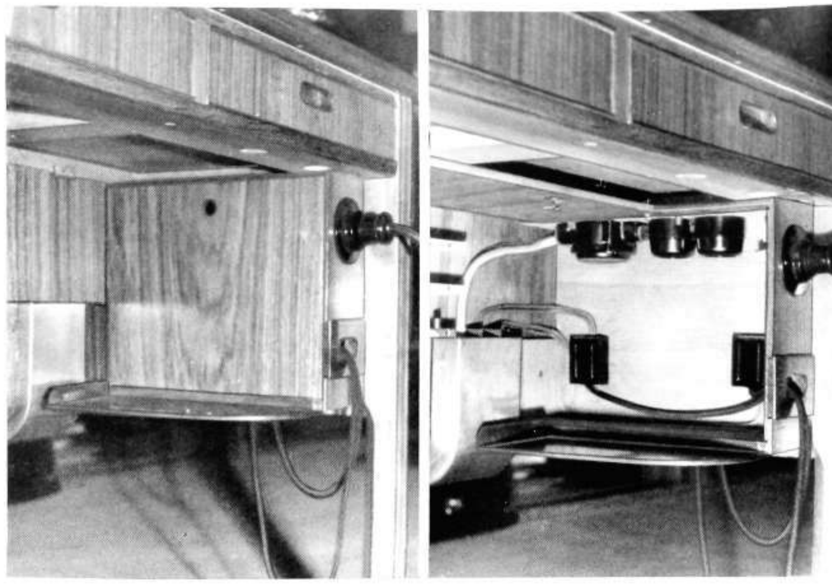


Fig. 19 X 6676

Desk, equipped with outlet frame, channels and conduit to floor well

for main wiring as well as telesignal and public telephone wiring, left with lids mounted

Fig. 20 X 4786

Outlet frame in outer wall of office room

telesignal systems and public telephones, Fig. 19. The conduits and channels are readily accessible and the frames are easily opened when required for rearrangement of the cables.

The desks may, to a large extent, be rearranged in the rooms independent of the wiring as this has been taken into consideration when designing the ducts and the floor wells.

The outlet frames are recessed in the outer walls according to Fig. 20 and interconnected by means of steel ducts. They are provided with a removable lid at the front and the inside is equipped with a steel rack used for mounting terminal strips, junction boxes and wall terminal boxes. The outlet sockets for the electric mains are mounted on a fixed lid on the front of the frame.

The network is consequently extremely accessible for the purpose of alterations, maintenance and fault tracing, although the wiring in the office rooms is completely concealed.

The wire network is registered on junction box cards and record sheets making it possible to establish the identity of the various conductors without undue difficulties.

New Magneto Telephone Instruments

K W NILSSON, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

U.D.C. 621.395.721:621.395.631.4

The range of new telephone instruments lately marketed by L M Ericsson has now been augmented by two instruments with handgenerator for L.B. system. One is a desk type coded DAH 12 and the other is intended for wall mounting and coded DAN 11.

The development and restyling of magneto telephone instruments has not been pursued to the same extent as for dial instruments. This fact is natural in view of the reduced demand for such instruments during the general conversion from manual to automatic operation. There is, however, still a considerable demand for this type of instrument and a radical redesign has, therefore, been carried out in order to meet the present requirements with regard to function and appearance.

Comparing the L M Ericsson new and old magneto instruments with moulded cases, an outstanding feature of the new design is the case which completely covers all components in the set whereas former desk models had the bell mounted in the wall terminal box and wall models the bell gongs mounted outside on the front of the case.

In the development of the new magneto instruments, components identical with or similar to those included in the latest dial instruments have been used as far as possible. In this way the problem of spare parts is considerably simplified for the customer.

Among components identical with those on automatic instruments *DBH 15* and *DBN 13* are the cradle spring set, cradle slide piece, terminal block, bell and gongs, pillar in the case, ticket frame, rubber feet, fixing screws and the handset components.

Fig. 1 X 7614
Magneto instrument DAH 12
right with case removed

The new generator instruments are provided with a new handgenerator *RGH 2001* described further on in this article.

Fig. 2 X 4787
Wall terminal box NEF 1701

The Desk Instrument

The exterior of the instrument, Fig. 1 left, has a shape similar to that of the desk instruments for automatic system, but the height is increased by an extension of the base. The case is moulded in phenolic resin and is provided with four brass inserts for the fixing of the base plate. The generator crank has been placed in a convenient position and there is plenty of room for the hand when operating the generator.

The internal components, Fig. 1 right, are mounted on a flat base plate. The handgenerator is firmly secured by three screws entering from the underside of the base plate. With this method of fixing the position of the generator can be adjusted from the outside in relation to the crank hole in the case. The cradle slide piece with spring set and the induction coil are fitted on a mounting frame screwed on to the bell bracket. This frame also serves as a guide for the cords to the terminal block. The bell gongs are accessible for adjustment but if necessary the mounting frame can be moved out of the way by a simple process allowing inspection of the bell mechanism.

The instrument is provided with a new wall terminal box *NEF 1701*, Fig. 2, containing six terminals for connection of the line, extension bell and battery. The box has a base moulded in phenolic resin and there is ample space for cords and incoming cables under the enamelled mild steel cover.

The handset is the L M Ericsson standard type *RLF 18*.

The Wall Instrument

The exterior of the instrument, Fig. 3 left, has the same distinctive appearance as the corresponding automatic instrument. The front is, however, plain without aperture for the dial. The dimensions of the case are the same with exception of the height which has been slightly increased to accommodate the generator. The case is moulded in phenolic resin and is secured to the top and bottom of the base plate by means of screw and hook. It can be completely detached from the base plate. The chassis, Fig. 3 right, is similar to that of corresponding automatic instruments. The components are mounted on a flat base plate with three fixing holes provided with metal reinforced soft rubber grommets. See further the description of the wall instrument for automatic system in Ericsson Review No. 1, 1949.

As the magneto instrument does not contain a capacitor, it has been possible to utilize the available space in such a way that the terminal block, bell and induction coil have been moved upwards making room for the handgenerator. The generator is fixed in the same way as in the desk instrument and there is plenty of room for the hand when operating the generator.

The handset is of standard type *RLF 18*.

Circuit

The circuit is in principle identical with that used in former magneto instruments, Fig. 4.

The new magneto instruments are provided with a 2 000 ohms bell. The induction coil is dimensioned for the properties of overhead lines.

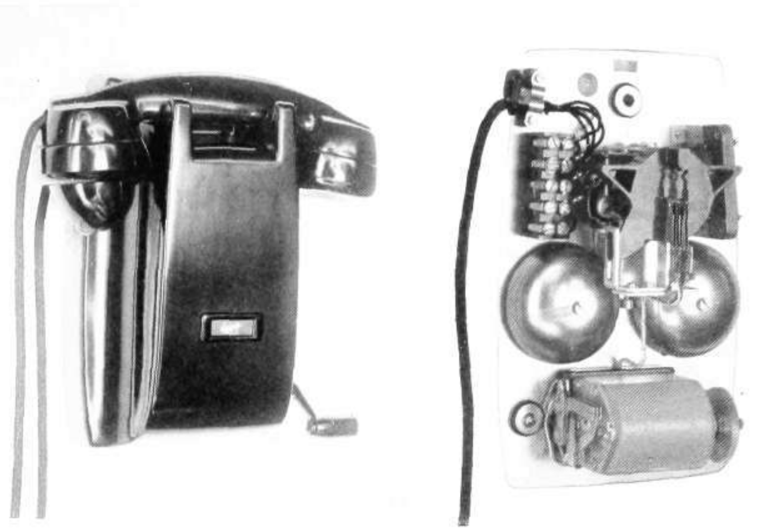


Fig. 3 X 6664

Magneto instrument DAN 11

right with case removed

The New Generator

L M Ericsson have formerly used two types of handgenerators, a large type *RGH 14* with five tungsten alloy magnets and a small type *RGH 50—51* with two or three 35 % cobalt magnets, the latter manufactured since 1935.

Both types have successfully maintained their position as suitable handgenerators in L M Ericsson instruments and switchboards. Particularly during the second world war these generators proved a real boon as the new magnet materials such as aluminium-nickel-cobalt alloys could not be produced owing to the nickel shortage.

From 1952 L M Ericsson is producing a handgenerator with a cast magnet of AlNiCo steel. This generator has been used for some years by the Swedish telegraph and telephone administration.

The new handgenerator, coded *RGH 2001*, will replace former types as standard for telephone instruments and switchboards.

Fig. 5 left shows the exterior of the new generator viewed from the spring set side and Fig. 5 right shows the generator partly dismantled. The armature and the spindles with gear wheels are dismounted together with the side plate when this is detached from the pole pieces.

In passing, it should be mentioned that Fig. 5 does not conform to the actual dismantling procedure for an AlNiCo generator. As known the magnet suffers a loss in magnetic flux if the closed circuit is opened by the removal of the armature. The base plate should, therefore, first be removed and the pole pieces short circuited by a piece of iron. In production the generator is magnetized in assembled condition.

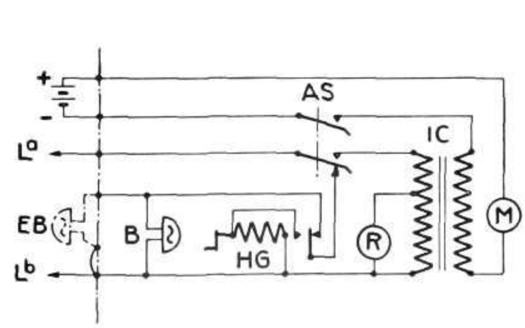


Fig. 4 X 6660

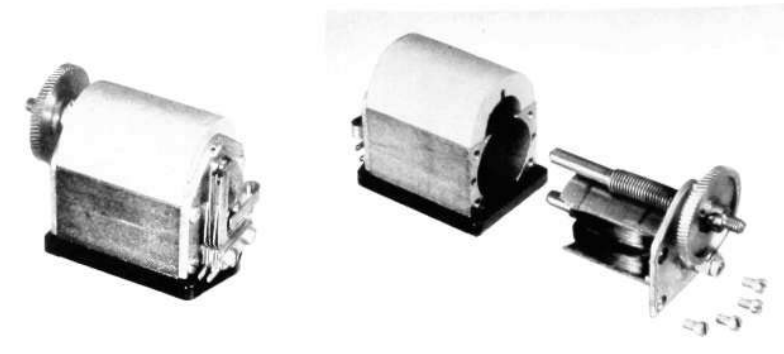
Circuit diagram for magneto instrument DAH 1201

AS	cradle switch
B	bell
EB	extension bell
HG	handgenerator
IC	induction coil
L^a, L^b	subscriber's line
M	transmitter
R	receiver

Fig. 5 X 6666

Handgenerator RGH 2001

right partly dismantled. When dismantling generators with AlNiCo magnets do no proceed as shown in the illustration. See further in the text.



Design

The mechanical lay out will follow from section shown in Fig. 6.

The magnet *A* is a semi-cylindrical casting. The material is aluminium-nickel-cobalt alloy steel. The resting surfaces for the pole pieces are ground as well as the end surfaces. It is retained in position against the pole pieces by the magnetic field and lateral movement is limited by a lip *B* engaging a slot ground in the magnet.

The pole pieces are produced from a soft iron section.

The armature is assembled of 0.5 mm (.020") iron laminations *C* and is provided with end plates *D* of 1.75 mm (.069") iron sheet. The laminations and the end plates are riveted together and press fitted on a 7 mm (.276") silver steel spindle *F*. The periphery of the armature is machined after the fitting of the spindle. As on former designs the inner end of the winding *E* is directly connected to a pin *G* fixed on the armature spindle. The outer end of the winding is connected to an insulated pin *H*, brought out in the centre of the spindle at one of the pivot ends.

The air gap round the armature is 0.4 mm (.016") approx.

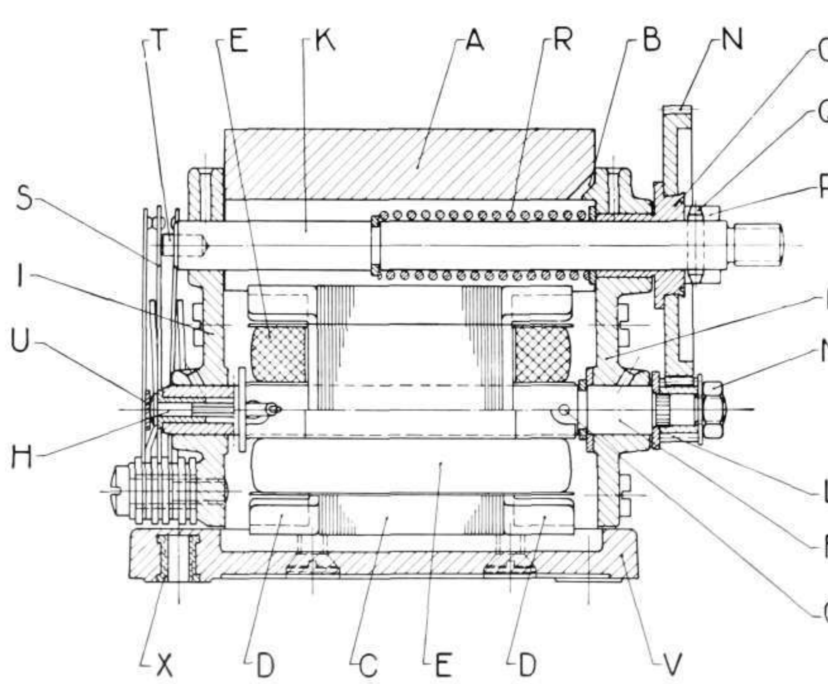


Fig. 6 X 6661

Section through a handgenerator RGH 2001

The side plates *I* are die cast in zink alloy. The bearings are reamed after casting.

The crank spindle *K* is made of 7 mm (.276") silver steel.

The gear wheels are made of brass and have helical teeth. The pinion *L* has a press fit on the armature spindle and is kept in position by a left hand threaded nut *M*. The large gear wheel *N* on the crank spindle is riveted to a bush *O*. This bush is shaped as a bearing sleeve carried in the side plate bearing and takes up the end thrust of spiral spring *R*. In this way end thrust friction is avoided against the side plate when the crank spindle is operated. As compared with previous generator types pin *Q* has been made thicker owing to the crank spindle being increased from 6 mm (.236) to 7 mm (.276"). Pin *Q* is made of stainless steel.

When the crank is operated the crank spindle is displaced laterally by the V-shaped collar *P*.

The point end of the crank spindle is fitted with an insulating stud *T* resting on contact spring *S*.

The gear ratio between the gear wheel and the pinion is 1 : 4.8.

The contact spring in the spring set have ample dimensions and are provided with twin contacts and soldering tags.

The generated voltage is collected by a lateral pressure spring *U* at one of the armature pivot ends and a frame connection.

The base plate *V* is moulded in phenolic resin, insulating the generator from the mounting position. Mounting is carried out from below by means of three projecting metal inserts *X* ensuring a firm fixing although the mounting surface may be uneven.

Electrical Data

The generator supplies a minimum voltage of 57 V on a noninductive load of 1 000 ohms when operated at a rate corresponding to 16 2/3 c/s. This is equivalent to 3.25 watts. The D.C. resistance of the armature winding is 400 ohms approx.

Lubrication

The bearing bushes in the generator side plates are provided with lubrication holes easily accessible and placed in such a way that the oil is retained irrespective of the generator being mounted horizontally or vertically.

As suitable lubricant an extra heavy mineral oil is recommended such as Shell Talpa Oil 30 or equivalent (L M Ericsson code *MTN 12*).

Wearing Properties

The new generator has performed very well on laboratory life tests. Throughout the time of it being used by the Swedish telegraph and telephone administration as standard generator for instruments and switchboards the practical experiences have been very satisfactory indeed.

Weight

The weight of the generator is 0.8 kg (1 lb 12 ozs).

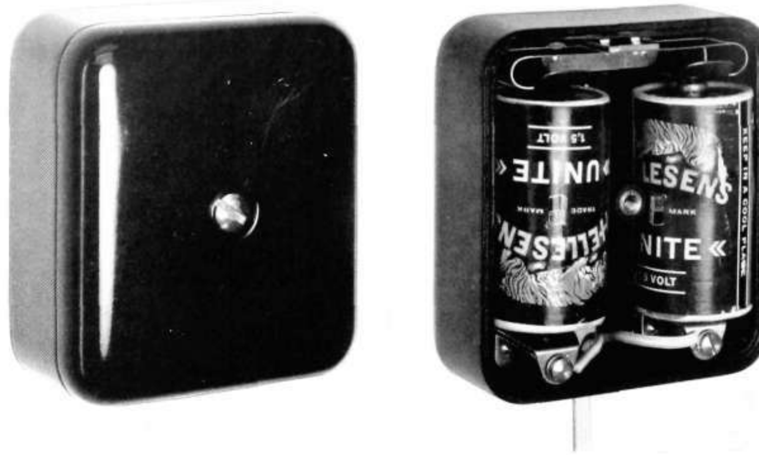


Fig. 7 X 6665
Battery box BKY 1101
right with lid removed

Battery Box

An L.B. system requires a transmitter voltage supply of 3 V. Generally a battery is used consisting of two 1.5 V dry cells with a fairly high capacity. This type of battery is rather bulky and is usually stored in a box near the instrument.

The life of such a battery varies considerably and the replacement of the battery at the proper time always presents a problem for the telephone administration. A high capacity battery is in itself fairly expensive and the actual replacement, requiring a service visit to the subscriber, contributes very heavily towards the maintenance cost.

In order to improve and simplify the service L M Ericsson has launched a new scheme whereby the traditional large battery is substituted by two small 1.5 V cylinder cells, 33×61 mm (1 1/4"×2 3/8") of the same type as used in electric torches. The cells are placed in a box fixed on the wall near the telephone instrument. Practical and laboratory tests have proved that these cells have a life of minimum 12 months. With this new arrangement the telephone administration may supply the subscriber with fresh dry cells each year by post. The actual replacement is carried out by the subscriber himself.

The lay out and appearance of the battery box is shown in Fig. 7. The box has a smart and distinctive shape with the following dimensions: height 97 mm (3 7/8"), width 88 mm (3 1/2") and depth 45 mm (1 3/4"). The box as well as the lid is moulded in black phenolic resin or ivory melamin resin.

The box is provided with robust contact springs for the dry cells and terminal screws for the cable. The cells are easy to replace and clear instructions are given how the replacement has to be carried out.

The code of the battery box is *BKY 1101* in black and *BKY 1102* in ivory.

The Ferrometer, an Apparatus for Testing the Quality of Steel

I SVENSSON, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

U.D.C. 621.317.49:620.179.14

The means for testing the quality of steels have recently been extended, thanks to the resources of the modern electrical measuring technique. In this connection L M Ericssons Mätinstrument AB (Ermi) have designed the Ferrometer, an instrument for controlling heat treatment, crack formation and lack of homogeneity, and also for determining the martensite conversion and residual quantities of austenite and the strength data of steels. The functioning of the ferrometer is based on the relation existing between a steel's technological and magnetic properties.

The employment of the ferrometer for testing the properties of steel, together with the construction and handling of the instrument are described in the article.

The determination of a steel's quality is usually based on the measurement of its hardness in those cases where it is desired to maintain a running control and on metallographic investigations for the more precise determination of its qualities, or on the functional testing of finished parts in order to obtain a conception of the practical serviceability of the parts or material in question.

The first-mentioned method is frequently time-consuming and is difficult to carry out in some cases; moreover, it constitutes an unsatisfactory measure of the correct heat treatment of the steel insofar as hardened and tempered tool steels are concerned. The metallographic method for determining the structural hardness of the steels is expensive; it entails the destruction of the test sample and cannot come into consideration for running control in production.

A certain relation exists between the technological properties of a steel and its magnetic and electrical properties. When this relation is known it is possible, by applying the highly developed measuring technique available, to undertake a detailed study and control of the steel's quality.

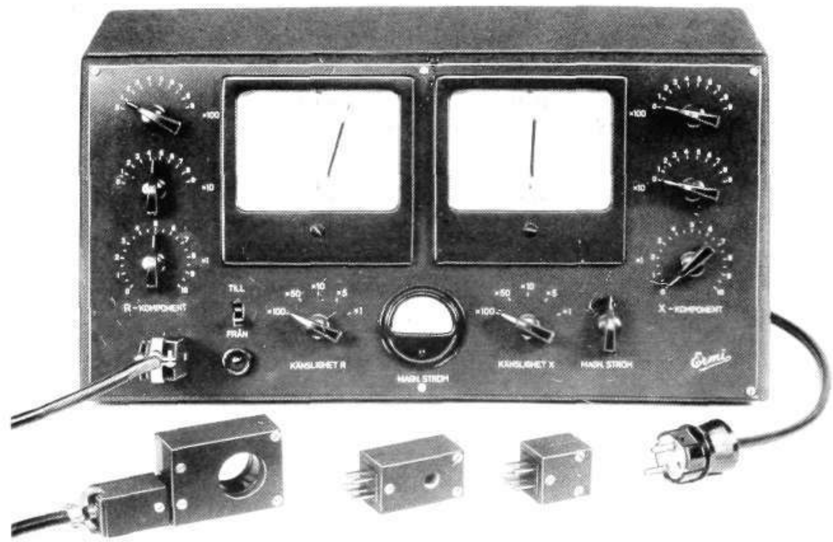


Fig. 1 X 6683

Ferrometer YDR 10

with testing coil at the bottom, left

L M Ericsson's Mätinstrument AB has designed the ferrometer, Fig. 1, for controlling and classifying materials and parts with respect to their heat treatment, crack formation, lack of homogeneity, determination of the martensite conversion and residual quantities of austenite and the strength data of the steel.

For carrying out measurements with the ferrometer a testing coil is employed in which the material is placed or through which it is passed in the case of running control. The testing coil operates on the principle of a transformer working on no-load, in which the unknown sample constitutes the transformer core. A known constant alternating current with a frequency of 50 c/s flows through the primary winding of the testing coil. The voltages generated on the transformer principle in the testing coil are dependent on the properties of the material tested. Consequently, where the respective dimensions of the object tested are similar, every structural dissimilarity will set up different induced voltages in the secondary winding.

In the electromagnetic testing method the two voltage components are obtained, each of which characterizes certain properties of the material tested. The ferrometer distinguishes between these components and indicates them on two direct-reading instruments. One instrument records the apparent permeability of the steel associated with the analysis, the structure and heat treatment of the material. The other instrument indicates the eddy current losses due to surface cracks, porosity or slag inclusions.

Where a rapid running control with a slightly lower degree of accuracy is required, the ferrometer works on the deflection principle. The sensitivity is so adjusted that a suitable deflection is obtained on the instrument. For mass production an auxiliary unit is connected to the instrument, which automatically operates an alarm if the pointer deflection exceeds a given adjustable value when sorting faulty parts. To enable the quality to be determined with greater accuracy the voltages are compensated manually by means of knobs marked »R-component» and »X-component».

The alloying substances in a steel, together with the carbon, produces different forms of carbides which do not have the same fixed temperature of solution in the basic mass of the iron, and they should be in such modified forms that the different carbides can enter into solution and produce uniform austenite, which takes place at a raised temperature.

When cooling down rapidly from the austenite temperature the austenite is converted to martensite which is the characteristic constituent in hardened steel and to a certain extent in residual austenite and undissolved carbides. The permeability which decreases with the continued solution of the carbides is a measure of the heat treatment and reflects variations in the magnetic properties at the hardening temperature more reliably than the hardness test. The relation between hardness and permeability may be sought with the help of an empirical diagram. In the case of carbon steel it may be stated as a general rule that the permeability is inversely proportional to the hardness.

Two parts having the same mechanical hardness exhibit the higher hardening temperature associated with lower permeability and the presence of large quantities of residual austenite which is non-magnetic.

Coarsely crystalline martensite (austenite) exhibits inferior magnetic properties to those of a structureless hardenite (martensite).

When tempering hardened steel the permeability rises and forms a pronounced bend on the diagram at given tempering temperatures for different grades of steel. In carbon steel finely divided ferrous carbides (Fe_3C) are formed at 230—250° and chromium carbides (Cr_3C_2) are formed in chrome steel at 425—450°. In tungsten steel (high-speed steel) the residual austenite is broken down to martensite at 550—560° and finely divided tungsten carbides are separated out. The latter are extremely valuable in cutting tools but are not desirable in materials for magnetic purposes.

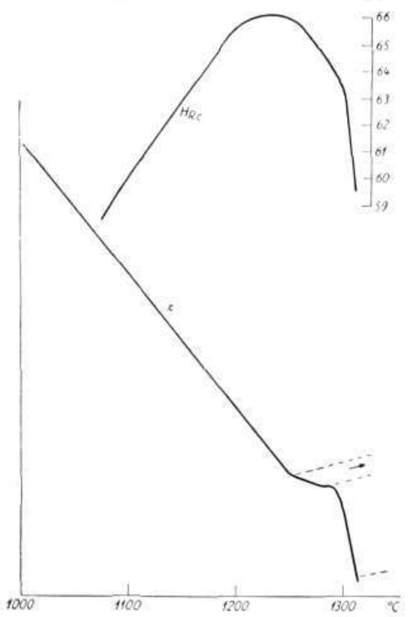


Fig. 2 X 4790

Hardening curve for high-speed steel 18—4—1 with 10 % cobalt

Hardening medium: oil
Hardening time: 2 minutes
Dimensions: 6 × 6 × 35 mm
— — — tempering curves

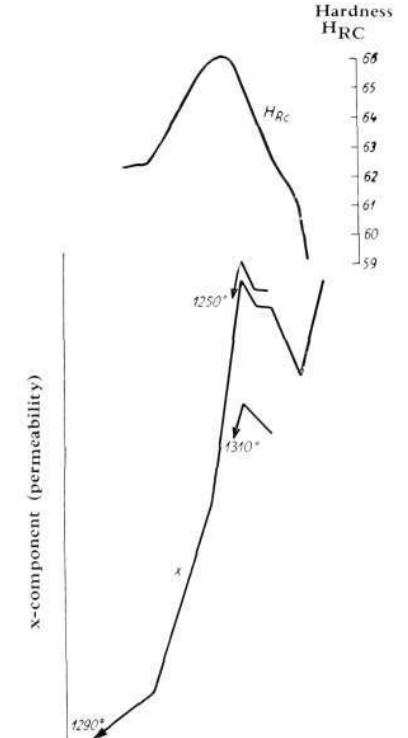


Fig. 3 X 4791

Tempering curve for high-speed steel 18—4—1 with 10 % cobalt

Tempering time: 60 minutes
Dimensions: 6 × 6 × 35 mm

A raised hardening temperature affects the permeability after tempering at a constant temperature in the same way as before tempering. Thus it is possible from the position of the curves to determine the hardening temperature of a steel and sort the parts, prior to hardening, into groups representing the same hardening temperature.

If a test bar clamped in a tensile testing machine is subjected to an electro-magnetic field the permeability of the material will be influenced by changing the load. The crystals have a certain favourable orientation for magnetization. The addition of a mechanical stress changes the orientation of the crystals and therefore the permeability of the whole test bar.

The relation between the effect of the tensile forces and magnetostriction (the material's capacity for elongation or contraction under the influence of a magnetic field) gives rise to different permeability values and indicates the elastic-, proportionality and elongation limits on the stress-permeability curve. The magnetostriction is positive for iron and negative for nickel.

Examples of the Ferrometer's Range of Use

Fig. 2 shows a curve for hardness and permeability obtained with a high-speed steel after the temperatures indicated on the abscissa were reached. At the critical interval, 1250—1290° C, the curve exhibits a bend which gives the most suitable hardening temperature for a given charge. Below this bend the curve falls steeply and thus indicates the initial melting of the residual tungsten carbides which have not been dissolved. It will be seen from the diagram that the hardness curve reaches its maximum before the critical temperature interval and then drops as the temperature and quantity of austenite increase. The maintenance of the temperature over different times has the effect of causing the permeability to fall when the time is increased.

Fig. 3 shows a permeability curve for three parts of high-speed steel hardened at 1250, 1290 and 1310° and subsequently tempered with a rising temperature. As may be seen from the diagram, the permeability increases up to about 550° C and then drops, to rise again above 650° C.

Conversion of Martensite and Residual Austenite

When it is desired to ascertain the contents of the martensite and residual austenite formed with greater accuracy, the older methods employed in these determinations occupy too much time and are unduly complicated.

In the use of the ferrometer the following applies. The permeability is a measure of the steel's magnetic conductive capacity. In a non-magnetic (austenite) steel the permeability is substantially 1.

A testing coil is balanced without a sample and gives a deflection corresponding to that for an austenitic material. For a steel that has reached a temperature within the austenitic range and is placed in the testing coil, the ferrometer will show no deflection. The sample must then be allowed to cool in air. When the martensite conversion begins to take place, the permeability will change as the conversion progresses and the whole martensite conversion can then be conveniently followed down to room temperature or to a still lower temperature.

The determination of the residual quantities of austenite is based on comparative measurements of the permeability in a completely hardened standard consisting of 100 % martensite. A hardened steel can also be depth-cooled down to about —83° C. The difference between the ferrometer deflections before and after depth cooling indicates the quantity of residual austenite that has been converted to martensite.

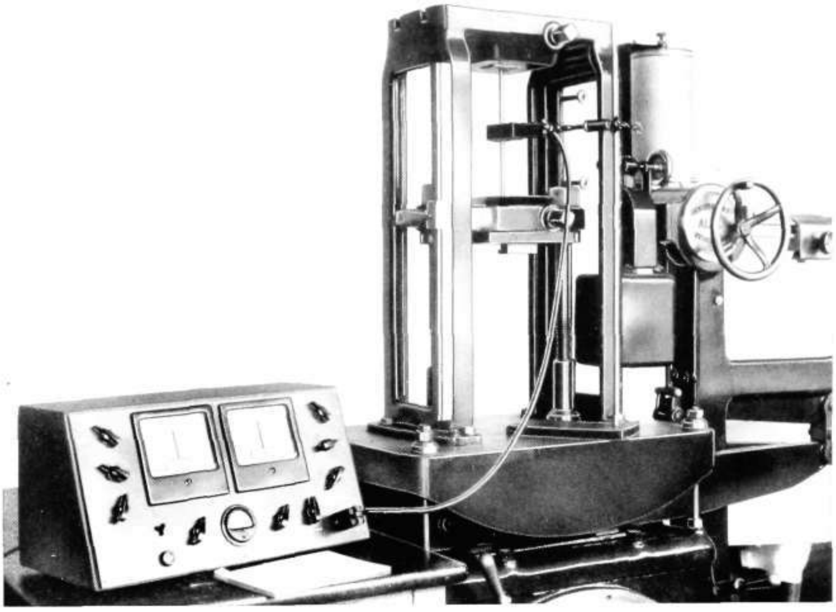


Fig. 4 X 6634

Determination of the elastic-, proportionality and elongation limit with the help of the ferrometer

The ferrometer's testing coil has been placed around a test bar clamped in a tensile testing machine.

Control of Cracks and Lack of Homogeneity

The permeability of a steel is dependent upon the inequalities, segregations, cracks and porosity of the material. A break in the cross-section such as a crack or gas inclusion reduces the permeability. On the other hand, a longitudinal crack changes the eddy current losses. The losses in the steel measured by the ferrometer deviate to a greater extent than the permeability. The method is extremely sensitive and indicates surface cracks with a depth of about 0.1 mm.

Determination of the Elastic-, Proportionality and Elongation Limits

Testing is carried out by placing the testing coil round the test bar which is clamped in a tensile testing machine, see Fig. 4. The bar is first loaded with a preliminary stress and the value for the permeability is read off. After each increase in load and reading, the loading stress is reduced and a reading taken. The value for the permeability changes with the alternate stresses applied.

Fig. 5 shows *curves for the permeability as a function of the load*. The curve in full lines is a measure of the permeability when the test bar is subjected to an increasing load; the curve in broken lines shows the corresponding value on reducing the load. Plastic deformation begins at the surface of the test bar which has the lowest resistance and continues throughout the bar. The effective permeability increases up to a maximum deflection and subsequently decreases at higher loads. At the same time the depth of penetration *of the eddy currents into the material increases*. The maximum deflection occurs at the point on the full-line curve at which spontaneous magnetization sets in with the most favourable magnetic orientation at a given applied tensile stress. The favourable orientations for iron are six in number. According to theory the permeability curve drawn in full lines should indicate falling initial values, but in consequence of the positive magnetostriction the path of the curve will rise to the maximum point.

The curve in broken lines shows the elastic-, proportionality and elongation limits and indicates the values for strength more clearly by the well-formed bends than is possible with the Martens mirror apparatus or other mechanical elongation-measuring apparatus. This latter method is very inconvenient and time-consuming, and it is difficult to obtain accurate and reliable figures insofar as the elastic limit is concerned.

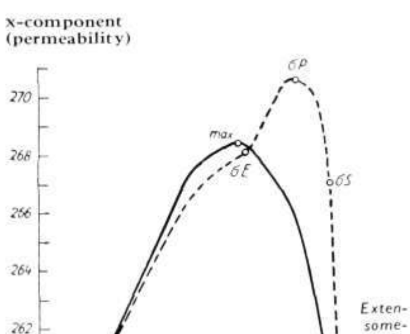


Fig. 5 X 4792

Curves showing the permeability as a function of the load for annealed and ground carbon steel with a carbon content of 0.65 %

Dimensions: 8 mm ⌀

Maximum point:	approx.	27.5	kgs/mm²
Elastic limit σE:	»	28.5	»
Proportionality limit σP:	»	34.5	»
Elongation limit σS:	»	39.5	»
Breaking limit σB:	»	57	»

——— increased load

— — — reduced load

—·—·— stretch according to the tensometer

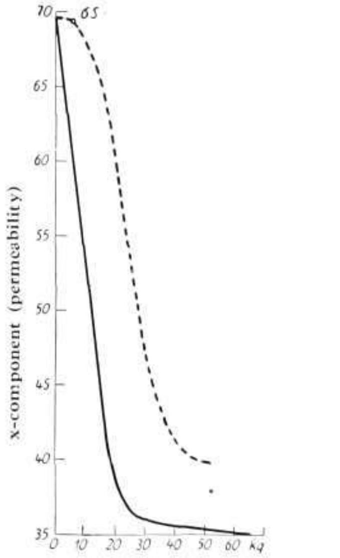


Fig. 6 X 4793

Tensile test curve for nickel strip, annealed to 800° C

Nickel content: approx. 99 %
Thickness of strip: 0.15 mm
Elongation limit σS: approx. 4 kgs/mm²
Breaking limit: 58 kgs/mm²
——— increased load
– – – reduced load

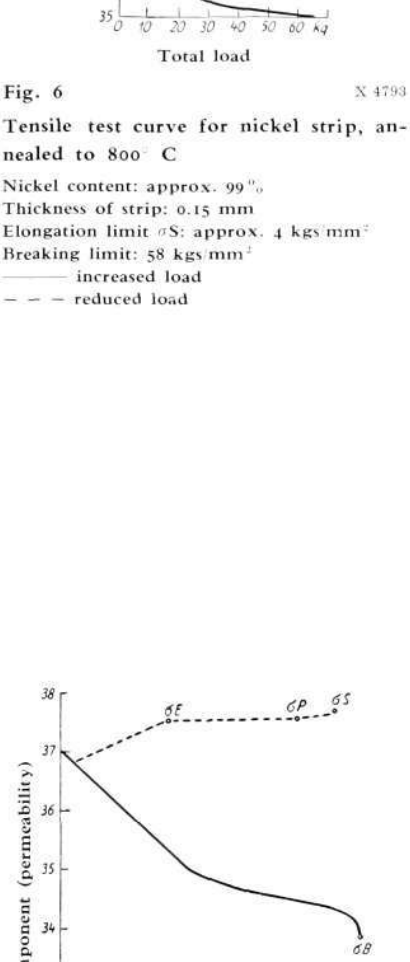


Fig. 7 X 4794

Tensile test curve for hard-rolled nickel strip

Elastic limit σE:	approx.	26	kgs/mm²
Proportionality limit σP:	»	60	»
Elongation limit σS:	»	67.5	»
Breaking limit σB:	»	76.5	»

Nickel content: approx. 99 %
Thickness of strip: 0.15 mm
——— increased load
– – – reduced load

For annealed material the elastic limit usually lies in the neighbourhood of the maximum point.

Figs 6 and 7 show tensile tests on annealed and hard-rolled nickel strip 0.15 mm thick with negative magnetostriction.

The foregoing examples illustrate some very obvious forms of application. The testing control man will find numerous other applications in the course of his work with the ferrometer. Inasmuch as the relations between the magnetic and mechanical properties are somewhat complicated, the motto to be applied in exercising this technique is »experiment and find out».

Description of the Mechanical Construction

The exterior of the ferrometer is dominated by the two large instruments which directly indicate the R- and X-components of the voltage from the testing coil with the material under investigation. Below each instrument a sensitivity-adjusting switch is mounted which is graduated in the factors by which the instrument's scale deflection must be multiplied in the respective sensitivity ranges. On either side of the two instruments three adjusting knobs for the compensating voltages are located, for the R-component on the left and for the X-component on the right. Each set of knobs covers three decades. The values set by the knobs must be multiplied by x1, x10 and x100 respectively. The values both for the decade sets of knobs and on the instruments can be read off directly in mV. Thus these members are fully in accordance with one another. If the X-component is increased manually by 10 mV for example, the X-instrument will give a corresponding deflection to the right and will indicate that 10 mV must be deducted from the value read off on the X-decade.

Beneath both the large instruments a smaller one is installed which shows the current in the magnetization circuit, that is to say, the current which amongst other things magnetizes the test sample in the testing coil. This current can be regulated by a knob on the right marked »Magn. Current». At the bottom on the left the cord from the testing coil is connected up by a flat pin contact. On the right of the latter a mains switch is mounted together with a pilot lamp that lights up when the apparatus is conneced in circuit.

At the back of the apparatus an earthing contact is fitted which should be connected to earth while measurements are in progress. A contact is also provided here for the connection of the alarm device.

On removing the cover plate at the back of the apparatus the mains supply switch and fuse holder are made accessible. The valves can also be changed from here.

Measurement and Reading the Measured Values

The object to be tested is inserted in the testing coil. Both instruments will then give a deflection to the left. If all knobs for the R- and X-components are now set at 0, the scale deflection will indicate the components for the whole of the voltage induced in the testing coil.

To obtain greater sensitivity the voltage can be compensated manually by means of the knobs marked »R-component» and »X-component». The instrument will then indicate the difference between the testing coil's voltage components and the voltages set by the knobs.

If adjustment is made for a test object which has known standard values, and other similar objects are to be compared with the same, the latter are placed in the testing coil, whereupon variations in the voltage components *can be read off directly on the instruments without any manual adjustment.* All measurements can therefore be undertaken very quickly. The absolute measurement values are then obtained by adding the pointer deflection with its respective symbols to the values read off on the voltage decades.

New Automatic Relay Operated Exchange

for 9 Extensions and 4 Exchange Lines

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U.D.C. 621.395.24

In a previous article in Ericsson Review No. 1, 1951, a newly developed private automatic branch exchange AMD 10201 was described. This was the smallest in a range of private branch exchanges working with relays and capacitors only. The next size in the series has now been completed for delivery and covers 9 extensions, 4 exchange lines and 2 local connections.

Principal Design and Application

The new private branch exchange *AMD 10501*, Fig. 1, is primarily intended for offices or other establishments with telephone requirements corresponding to the capacity of the exchange. It can also be used as a subordinated exchange under a large private branch exchange. This is a great advantage and presents an easy method of extending the number of stations when the main exchange is utilized to full capacity.

With reference to main exchange calls AMD 10501 offers as a whole the same facilities as the large-sized modern private automatic branch exchanges. The extension stations are ordinary telephone instruments with dials. No special instrument is used for reception and connection of incoming calls.

Priority facility for local connections can be arranged for any extension by individual strapping. Connection to engaged extension can be carried out even if both of the local connecting circuits are engaged.

Incoming calls are distributed to predetermined extensions by means of an automatic call distributor, Fig. 2. Normally the call distributor is connected in such a way that calls on exchange line *1* in the first place are connected

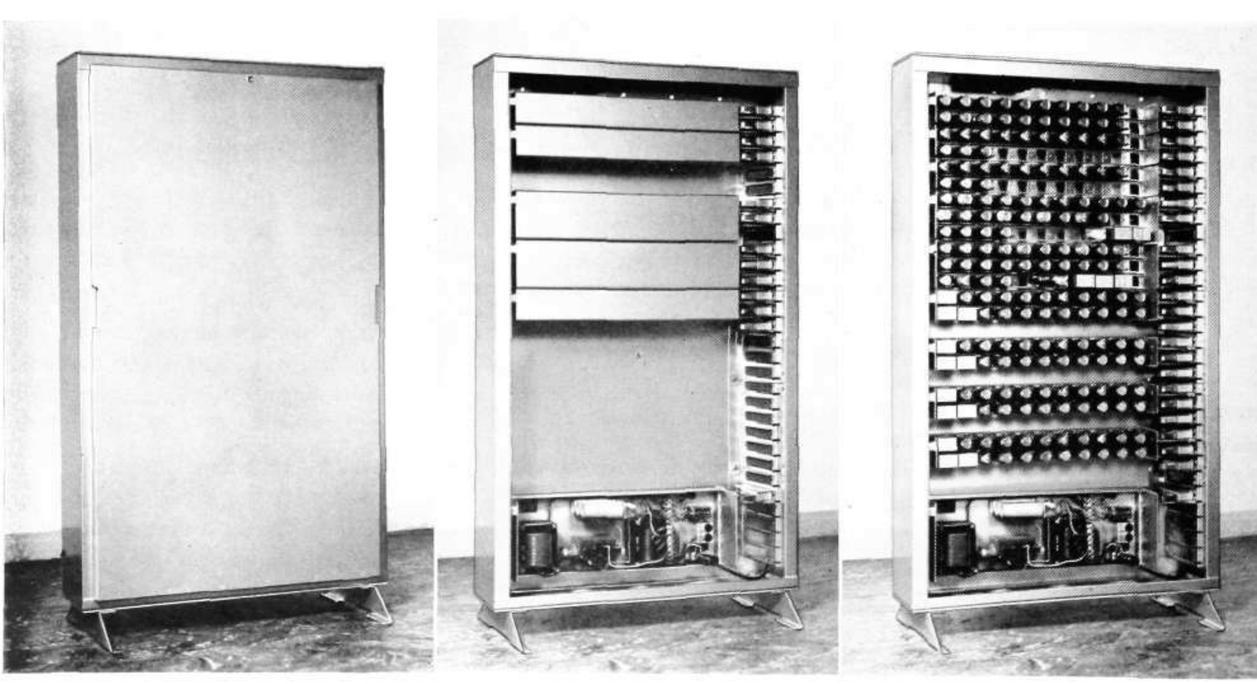


Fig. 1 X 7615

Private automatic branch exchange AMD 10501

left with cover fitted; centre equipped for 9 extensions, 1 local connecting circuit, 1 register, 1 call distributor, 1 exchange line and mains connected power unit; right fully extended

Fig. 2 X 6680
Call distributor
for incoming and outgoing calls

Fig. 3 X 6681
Line relays
for 9 extensions and 1 enquiry line

to extension *1*. Exchange line *2* in the first place calls extension *2* &c. If no answer is obtained from the extension first called, ringing signals are transmitted to the first three extensions in rotation. If one or two of the extensions arranged for incoming calls are engaged, all signals are directed to the free extension or extensions. At the same time an audible signal is received by the engaged extensions indicating that an incoming call is waiting.

The method of direct connection of an exchange line to a certain extension is generally justified considering that no particular person as a rule is detailed for the reception and connection of incoming calls. As the establishment generally is fairly small a calling subscriber will know which person he wants to speak to and he will appreciate being able to dial this person directly. According to this method the majority of calls do not require transfer. In addition the call distributor ensures that all incoming calls with very few exceptions will be answered without a permanently manned reception telephone being necessary.

The terminal connections on the call distributor can be arranged in different ways. All exchange line calls may, for instance, be directed to extension *1* and if this is engaged redirection to extension *2* takes place immediately &c. The variation possibilities in the distribution of the incoming calls are so wide that all conceivable requirements should be adequately covered.

Any extension may be restricted for calls to or from the main exchange. Transfer of incoming calls from the main exchange is carried out by dialling according to the method used for inquiry and transfer.

The operating components in the exchange consist of relays and capacitors only. The exchange equipment and the mains connected power unit are mounted in one and the same chassis. All connecting units, line and cut-off relays, connecting circuits, register, exchange lines and call distributor are plug and jack connected units which are hooked up in the chassis without screw fixings, see Figs 2, 3 and 4. This means that the exchange is easy to handle in transit and erection. If two connecting circuits are in excess of the requirements for the local service, it is not necessary to fit more than one. Similarly the number of exchange line units may be adapted according to the traffic with the main exchange. The power unit is also detachable and is connected to the frame wiring over plug and jack. A position is wired for traffic observation equipment which is fitted temporarily when a check on the traffic intensity is wanted.

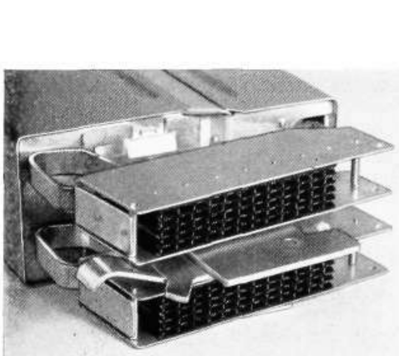


Fig. 4 X 4788
Plug detail

The mains connected power unit normally supplies 24 V operating voltage to the exchange. The relays are dimensioned so as to allow voltage variations

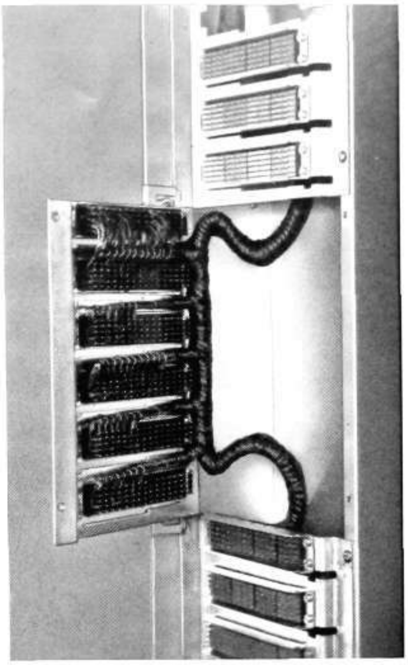


Fig. 5 X 4789

Jack frame

hinged, opened, with soldering pins accessible

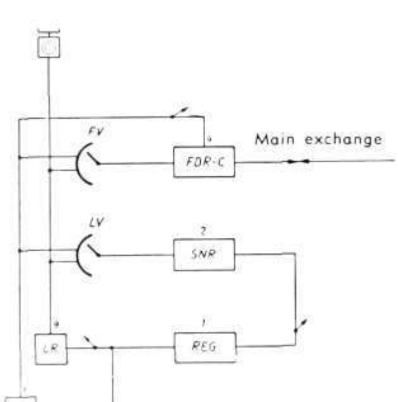


Fig. 6 X 4795

Trunking diagram for AMD 10501

FDR-C	exchange lines
FV	connecting relays for FDR-C
LV	connecting relay for SNR
LR	line relays
LRF	line relays for enquiry
REG	register
SNR	connecting circuit

between 20 and 30 V without detrimental effect on the function. As, in addition, all spring sets are provided with twin contacts an extremely reliable operation is ensured under widely varying conditions at the same time as the maintenance is reduced to a minimum.

In order to safe-guard the telephone connection to the main exchange even in case of mains failure the line branches to the exchange lines are connected over change-over contacts on relays connected across the D.C. side of the power unit. In the case of mains failure these relays are released and the exchange lines are each connected directly to the associated extensions. The extensions to be connected directly to the main exchange are determined in the main distribution frame which is mounted in the portion top of the chassis.

The power unit is intended for connection to A.C. mains. For connection to D.C. mains a rotary converter is required together with starting and control gear.

The exchange should preferably be mounted on the floor against a wall. The total weight of an exchange fully extended is approximately 165 kg (363 lbs). The weight of the heaviest relay unit is 15 kg (33 lbs) and of the power unit 12 kg (26 1/2 lbs). The dimensions of the exchange are: height 1,336 mm (52 5/8″), width 842 mm (33 1/8″), depth 226 mm (8 7/8″).

Principal Lay-out

The trunking diagram, Fig. 6, shows the lay-out of the exchange in principle. Each extension is provided with a line relay and a cut-off relay. The line relay is used for connection to the register in the exchange. The line relay as well as the cut-off relay are operated during line connection. For blocked condition of short circuited line and for engaged the cut-off relay only is operated. The relays connecting the extensions to the connecting circuits and the exchange lines are indicated by selector symbols in the diagram.

The immediate connection of the register to the line relay means that the connection to an exchange line is independent of the local connecting links. Outgoing calls can, therefore, be carried out irrespective of the two connecting circuits being engaged and owing to this such a call can be initiated by dialling alone. No additional push button for earth connection is required for this purpose and the extensions are connected to the exchange over two-wire lines.

Function

Local Connections

Local calls are connected to the register in the same way as in AMD 10201 and the required number is dialled when dialling tone is received. The register connects the selected extension to a free connecting circuit over which the ringing signal is transmitted. After the ringing, which has a duration of about 1 sec., the register is released at the same time as the calling extension is connected to the connecting circuit.

If the called extension is engaged or if both connecting circuits are engaged, the calling extension is immediately disconnected from the register and is blocked in the line equipment, which receives busy tone (quickly repeated tone) during a limited time.

An extension with lifted receiver is first connected to the register but after 5 secs the register is released and the extension is blocked in the line equipment.

When a priority extension is calling an engaged extension the register is not released. Engaged tone is transmitted from the register. The priority extension does not, however, obtain line connection while the engaged tone is received.

If the priority extension wishes to cut in on the call in progress he may do so by dialling two impulses. Line connection is obtained and the engaged signal is replaced by a listening-in tone which is received by each of the three parties.

If both connecting circuits are engaged the priority extension receives engaged tone from the register. By means of two dial impulses connection is obtained to connecting circuit *1*. Line connection and listening-in tone is received.

If the parties of the call in progress replace, the register will select the dialled extension. If this is free, ringing signal is transmitted and the register is released. If the wanted extension is engaged, the connection to the register is maintained and the priority extension is connected to the call in progress. The listening-in tone is retained and is received by the three parties. If the required extension replaces a new selection takes place from the register and the priority extension obtains normal line connection at the same time as the register is released.

Main Exchange Traffic

Outgoing Calls

Outgoing calls are initiated by dialling *0*. The register selects a free exchange line which is connected to the extension at the same time as the register is released. The required subscriber's number is dialled on receipt of dialling tone from the main exchange.

In view of the incoming call distribution with direct calls from an exchange line to the associated extension, exchange line *4* is in the first place used for outgoing traffic. This exchange line should be connected in the main exchange in such a way that it is the last one to be connected for group number calling to the private branch exchange. Exchange lines *1—3* are used in rotation for outgoing calls if the fourth line is engaged. In this way exchange lines *1—3*, intended for direct connection of incoming calls, are not unnecessarily engaged for outgoing calls and when they are required for such traffic they are all utilized to exactly the same extent. If all exchange lines are engaged the calling extension is blocked and receives engaged signal at the same time as the register is released. The disconnection is controlled in the same way as for AMD 10201.

Incoming calls

Incoming ringing signal on an exchange line effects connection to a call distributor which, over a by-pass circuit, transmits ringing signal to a predetermined extension. The exchange line connected to the call distributor determines which extension should receive the first ringing signal.

On the termination of each ringing signal the called extension is connected to the exchange line and remains in this condition until the next signal is transmitted from the call distributor. The first extension is released and the second signal from the call distributor is transmitted to the extension nearest in turn and at the end of the signal this extension is connected to the exchange line. This rotating ringing continues to the three extensions intended for incoming calls until an answer is obtained or until disconnection takes place in the main exchange. The interval between the signals is about 10 secs but can be adjusted differently if required.

The ringing signals from the main exchange are not repeated to the extensions. The first signal effects connection to the call distributor and the subsequent signals maintain this connection and keep the exchange line blocked for outgoing calls. If the ringing signals from the main exchange are discontinued the exchange line and the call distributor are released approximately 15 secs after the last ringing signal.

If the extension associated with the calling exchange line is engaged, the call distributor connects the next extension in turn which is intended for incoming calls. If one only of these extensions is free, ringing signals will be transmitted to this extension at 10 secs intervals.

The engaged extensions receive warning signals every 10 secs. If all extensions are engaged an incoming call produces quickly repeated irregular warning signals.

The ringing signal originated by an incoming call consists of a short signal immediately followed by a long signal. The called extension is, therefore, able to identify a call from the main exchange.

If the warning signals are repeated on a call in progress this signifies that an incoming call has not been answered. If the call in progress is terminated, ringing signal is transmitted from the call distributor to the disengaged extension which may answer the incoming call. The disconnection control is identical with that for outgoing calls.

Enquiry and Transfer

Enquiry and transfer is carried out by the same methods as applied to AMD 10201. An enquiry call is established over a connecting circuit in the same way as a local call. If the enquired extension retains the receiver lifted and operates the dial after the enquiring extension having returned to the exchange line connection a buzzer tone is transmitted to the latter connection. The enquiring extension may then revert to the enquiry connection by means of one dial impulse.

In the case of transfer the enquiry circuit and the connecting circuit engaged for the enquiry call are released.

Enquiry call to an engaged extension is connected over the register and a free connecting circuit to the extension in question but without line connection. The enquiring extension receives engaged tone but will be able to effect line connection by means of two dial impulses. At the same time listening-in tone is connected and is received by the three parties. In other respects the same facilities are available as for a priority extension. Transfer attempts to a restricted extension result in recalling of the extension associated with the exchange line. If this extension is engaged ringing in rotation takes place to the three extensions intended for incoming calls.

If an enquiry call is carried out when the enquiry circuit is engaged, connection is obtained to this circuit at the same time as listening-in tone is connected. If the enquiry circuit is free, dialling tone is received. Return to exchange line connection after connection to engaged enquiry circuit is effected by the replacement of the receiver for a short moment.

Parking of Exchange Line Connection

If warning signals from a new incoming call are obtained on an exchange line call in progress, this connection can be temporarily disconnected; after a predetermined time the connection is restored to the extension associated with the exchange line. This is referred to as parking and is carried out by means of two dial impulses. The extension is released and receives engaged tone. When the receiver is replaced the waiting incoming call is connected and the extension receives ringing signal. When this call has been answered and transferred or terminated, the parked exchange line is reconnected and the interrupted conversation may be continued. The parking facility is only of importance when the call distributor is connected in such a way that all incoming calls are directed to *one* extension.

Comparison with Large Private Automatic Branch Exchanges

In comparison with large private branch exchanges similar views have been decisive in the development of AMD 10501 as in the case of AMD 10201. AMD 10501 has, however, been provided with facilities which for economic reasons are omitted on AMD 10201. The special features are: line blocking, priority connection facility, parking and signalling from enquired extension.

Connection to Other Telephone Systems

In the same manner as for AMD 10201 the exchange lines may be arranged for manual main exchanges or other exchanges of special types by means of adapter units. For an ordinary C.B. exchange a strap alteration only is required in the loose plug fitted in the jack intended for the adapter unit.

When connected to a large private branch exchange an adapter unit for the exchange lines will give the same facilities for enquiry and transfer as described for AMD 10201.

Traffic Observation

The unit for traffic observation contains relays and 8 counters. The following data are registered on the counters:

1. Number of incoming calls
2. Outgoing calls when free exchange line is available
3. Outgoing calls when all exchange lines are engaged
4. Local calls when free connecting circuits are available
5. Local calls when both connecting circuits are engaged
6. Enquiry calls when both connecting circuits are engaged
7. Both connecting circuits engaged
8. Priority cut-in connections

The traffic observation unit is not included in the normal equipment of the exchange but is only fitted when traffic observation is considered necessary.

Power Supply

A mains connected power unit, Fig. 7, is used as power supply and also provides the required tone and ringing signals. Tappings are arranged for connection to 110, 127, 150 and 220 V A.C., 40—60 c/s. In addition the secondary side of the transformer is provided with tappings for 20 % adjustment up or down. When shipped the power unit is connected for 220 V mains voltage. The normal operating voltage is 24 V, but the exchange allows a variation between 20 and 30 V. The line resistance may be up to 500 ohms at the lowest permissible voltage.

The power consumption is very low, with the exchange in rest condition 14 W (36 VA) and at maximum load 160 W (180 VA).

When connected to D.C. mains the exchange is directly connected over a potentiometer, when in rest condition, and receives a voltage of 24 V. As soon as a call is initiated a starting relay is operated for a rotary converter. When this is generating alternating current, the potentiometer circuit is disconnected from the exchange, which then obtains operating voltage from the A.C. power unit. The converter is maintained in operation while calls are in progress.

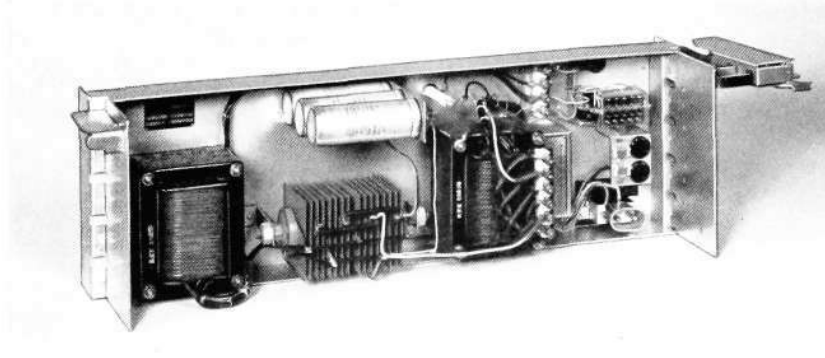


Fig. 7
Mains connected power unit

X 6682

The converter, starting relays and a protection relay for excessive voltage constitute a separate unit. The latter relay serves as protection device when the exchange is in rest condition and directly connected to the potentiometer.

If the voltage to the exchange from the potentiometer exceeds 50 V the protection relay is released and the mains voltage is disconnected from the exchange altogether. Reconnection of the mains after this disconnection can only take place manually.

Summary of Traffic Facilities and Technical Properties of AMD 10501

The traffic facilities and technical properties of AMD 10501 may be summarized as follows:

1. Local extensions numbered 1—9. Ordinary automatic telephone instruments.
2. Two local connecting circuits and four exchange lines.
3. Priority facility for local connection may be arranged for any extension without additional equipment.
4. Transfer and enquiry during main exchange connection initiated by dialling. Answered enquiry call is transferred when the enquiring party replaces. The exchanges contains provisions for enquiry to main exchange. Enquired extension may signal on the dial to the exchange connection.
5. Outgoing call to main exchange initiated by dialling 0.
6. The exchange is designed for connection to automatic main exchange but may be connected to any type of exchange.
7. Incoming calls are automatically distributed to 4 extensions. The extension called is determined by the exchange line. The call distribution can be arranged in a great number of variations.
8. Extensions not used for answering incoming calls may be restricted for traffic to main exchange.
9. When transferring an exchange line connection the transferring party is able to cut-in on an engaged extension.
10. Traffic observation equipment may be connected.
11. All connections are effected by means of relays and all spring sets are provided with twin contacts.
12. All connecting units are connected over plug and jack.
13. Short circuited line or omitted replacement of receiver does not engage connecting devices.
14. Calls to the main exchange never engage local connecting circuits.
15. The power supply is mains connected. D.C. mains require a converter with starting device.
16. In the case of mains failure extensions are connected directly to the main exchange.
17. All connecting units including adapter unit, when such is required, and the power unit are contained in one and the same chassis.
18. Normal operating voltages is 24 V but proper operation is guaranteed between 20 and 30 V.

L M Ericsson Exchanges 1951

During 1951 the following exchanges on the L M Ericsson automatic telephone system with 500-line selectors have been put into service:

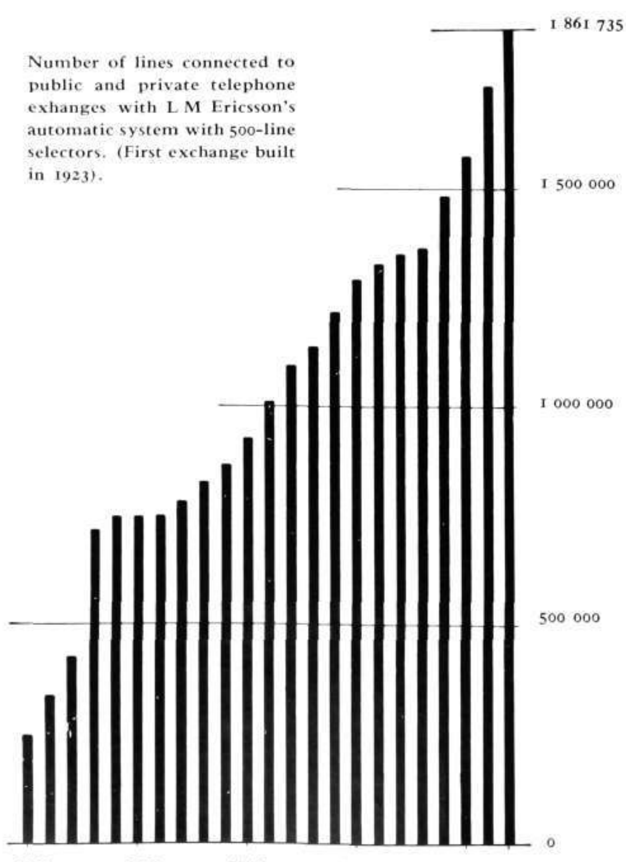
town	exchange		number of lines
Argentine			
Esperanza		(extension)	500
Reconquista		(extension)	500
San Francisco		(extension)	500
San Luis		(extension)	500
Santa Fé	Centro	(extension)	500
Villa Mercedes		(extension)	360
Yerba Buena			200
Bolivia			
Tarija			350
Brazil			
Juiz de Fóra		(extension)	1000
Natal		(extension)	500
Colombia			
Bogotá	Centro	(extension)	1000
Bogotá	Chapinero	(extension)	1000
Bogotá	Teusaquillo	(extension)	1000
Denmark			
Köpenhamn	3 PABX		920
Ecuador			
Quito	Centro		4000
Egypten			
Suez			2000
Finland			
Forssa		(extension)	300
Jyväskylä		(extension)	500
Kuopio		(extension)	1000
Mariehamn		(extension)	1000
Mikkeli			2500
Oulu		(extension)	1000
Rauma		(extension)	500
Seinäjoki			1200
Italy			
Acireale		(extension)	240
Alessandria		(extension)	500
Benevento		(extension)	240
Bergamo		(extension)	330
Castellazzo			200
Catania		(extension)	3000
Napoli	Nolana	(extension)	3000
Novara		(extension)	1000
Padova		(extension)	1000
Palermo	Libertà		4000
Palermo	Ferrovia		3500
Palermo	PBAX	(extension)	50
Potenza		(extension)	240

town	exchange		number of lines
Ragusa		(extension)	240
Rovigo			1500
S. Donà di Piave		(extension)	220
Spinetta Marengo		(extension)	200
Treviglio		(extension)	200
Treviso		(extension)	500
Venezia	Centro	(extension)	2500
Venezia	Mestre	(extension)	500
Venezia	Murano	(extension)	100
Vercelli		(extension)	500
Vicenza		(extension)	500
Mexico			
Campeche			500
Jalapa			500
León		(extension)	1000
México D. F.	Apartado	(extension)	1500
México D. F.	Roma	(extension)	1000
México D. F.	Santa Maria	(extension)	1000
México D. F.	Tacubaya	(extension)	1500
México D. F.	Victoria	(extension)	1500
México D. F.	PABX		400
Morocco			
Tanger		(extension)	1000
Netherlands			
Rotterdam	Centrum		2000
Norway			
Eidanger	PABX	(extension)	200
Harstad			2000
Haugesund		(extension)	1000
Oslo	PABX	(extension)	200
Sarpsborg	PABX	(extension)	40
Selbak		(extension)	80
Panama			
Panama City	Panama II	(extension)	1000
Panama City	Panama III	(extension)	1000
Peru			
Arequipa		(extension)	500
Poland			
Katowice	7 PABX		1800
Warszawa	PABX		500
Salvador			
San Salvador			5000
Sweden			
Eskilstuna		(extension)	2000
Gothenburg	Vasa	(extension)	5000

town	exchange		number of lines
Gothenburg	Sävedalen	(extension)	1000
Gothenburg	3 PABX		1380
Gothenburg	3 PABX	(extension)	80
Huskvarna			3000
Jakobsberg			1000
Krylbo		(extension)	200
Köping			3500
Lidköping		(extension)	500
Linköping		(extension)	3500
Norrköping		(extension)	2000
Skellefteå		(extension)	1000
Stockholm	Högalid		9000
Stockholm	Djursholm	(extension)	1000
Stockholm	Enskede	(extension)	2000
Stockholm	Handen		1000
Stockholm	Lidingö-Brevik	(extension)	500
Stockholm	Mälarhöjden	(extension)	3000
Stockholm	Norrviken		1500
Stockholm	Storängen	(extension)	1000
Stockholm	5 PABX		1680
Stockholm	13 PABX	(extension)	910
Södertälje		(extension)	2000
Värnamo		(extension)	500
Östersund		(extension)	1000
Various places	19 PABX		3170
Various places	23 PABX	(extension)	810
Turkey			
Sivas			500
Venezuela			
Puerto La Cruz			600
San Cristobal		(extension)	500
		Total	127140

During 1951 the following exchanges and switchboards with 100-, 25- and 12-line selectors have been delivered. Extensions to existing plants are not included in the figures.

	number	number of lines
Exchanges with 100-line selectors	21	8700
Switchboards with 100-line selectors, system AHD	260	27520
Switchboards with 25- and 12-line selectors, system OL	1086	33622
Total	1367	69842



Number of lines connected to public and private telephone exhanges with L M Ericsson's automatic system with 500-line selectors. (First exchange built in 1923).

Ericsson NEWS *from All Quarters of the World*

High-tension Capacitors and Carrier Frequency Equipment for Harspränget

On June 15th H. M. the King of Sweden opened the 350 000 kW powerstation of Harspränget, the largest hydro-electric plant in Sweden, and the 1 000 km power line between Harspränget and Hallsberg which carries the highest transmission voltage in the world.

Prior to the completion of the Harspränget line the highest transmission voltage in the world was 287 000 V, in use on the Hoover Dam — Los Angeles power line. The Swedish 380 000 V main feeder line has necessitated an extensive technical development work in which the L M Ericsson concern has taken an active part, mainly at the high-tension laboratories of the Sieverts Cable Works. The transmission system Harspränget—Hallsberg has been equipped with a considerable number of capacitors and the voltage, 380 000 V, is the highest ever used for commercial capacitors.

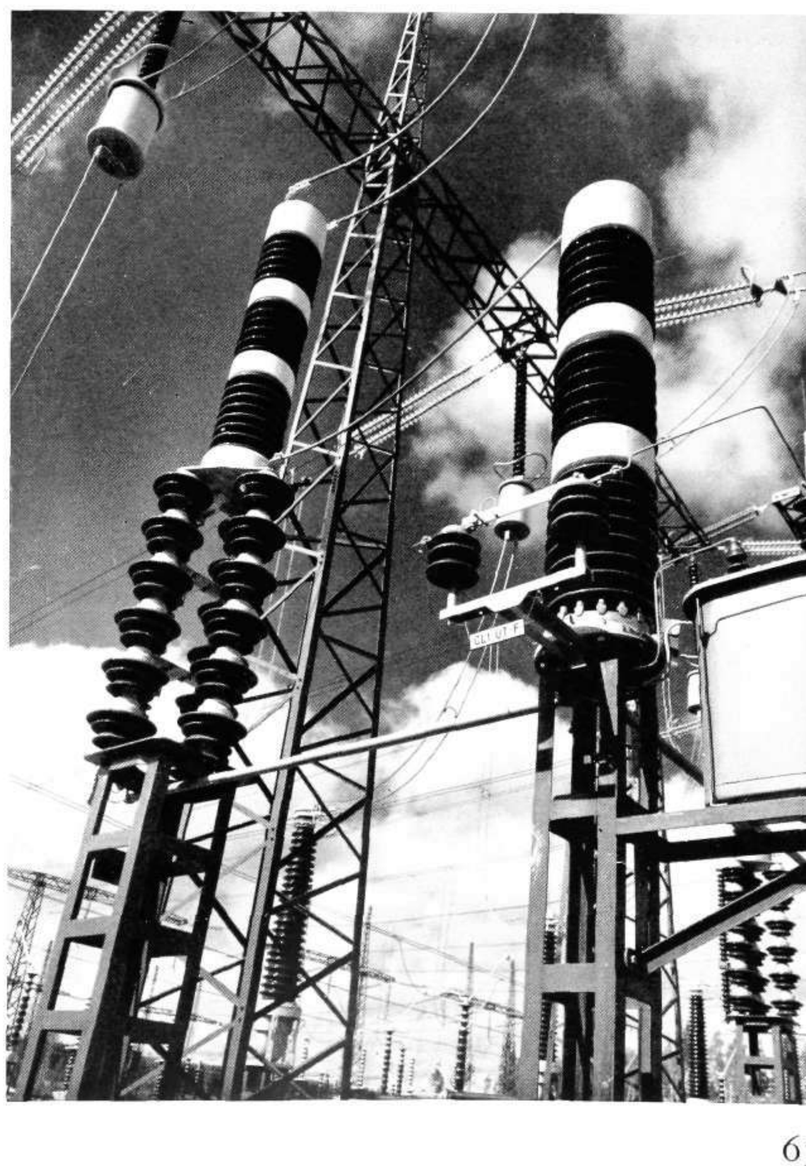
As early as 1925, when capacitor production was in its infancy, the Sieverts Cable Works started the manufacture of high-tension capacitors and were actually the first company in Sweden to do so. Ten years later the first capacitor for 220 000 V was delivered for the Swedish national grid and from then on a great number of capacitors of this type has been put into service. The past experiences have been extremely satisfactory and the technicians did not, therefore, hesitate to continue the development up to 380 000 V.

The capacitors illustrated on this page are the main components in the condenser-transformers, which are used for measuring the voltage across the lines and for feeding relays and synchronizing gear.

The power line is also carrying telephone and signal transmission and for this purpose capacitors are used as links between the high voltage power transmission system and the low voltage high-frequency equipment. L M Ericsson has supplied equipment for carrier frequency communications over the 380 000 V system for the Harspränget plant and the connections to the control grid. This system is equipped for automatic telephone exchanges and remote metering, indication and recording is carried out by superimposed tone impulses on the telephone channels.

The L M Ericsson carrier frequency communication system is also used for the co-ordination of this power transmission line with the national grid and central control of the power production and distribution. If a fault in a certain section of the grid has released the automatic cut-out for this section, this efficient communication system enables rapid rearrangement of the transmission network.

L M Ericsson delivered the first carrier frequency system for power transmission lines 1935. During the following seventeen years a great number of installations have been made in Sweden and abroad. The system has been gradually perfected by continuous research and development and is now an indispensible component in power transmission layout.



1 000 000

Dials Produced at the Söderhamn Factory

The L M Ericsson factory in Söderhamn has now produced more than one million dials. The dial carrying serial number 1 000 000 was appropriately celebrated; during the passage along the conveyor belt it was accompanied by a bouquet of flowers and when it was completed and finally tested a festive coffee party was held by the personnel of the dial shop.

The Söderhamn factory commenced the production of dials in the spring of 1947 and the output has since then been continually increasing. Last year about 300 000 dials were shipped and this year it is estimated that a figure of 350 000 will be reached. This means that one new dial is completed every 20 seconds of the working time.

The telephone dial was originally invented by American Almon B. Strowger, who in August 1896 filed a patent for the first serviceable design.

About the same time as the Strowger invention Lars Magnus Ericsson designed his »selector disk». The first experimental model, shown in the illustration strip below, was drawn by Ericsson and was made in his workshop. The design is, in principle, the same as the present design — an impulsing cam wheel operating a spring set, governor, gearing, drive spring etc.

When the development of the fully automatic telephone systems started in earnest, the impulsing problem reappeared and an engineer, M. Löfgren, suggested just before the first world war a design containing ten push buttons numbered from 0 to 9 where each button transmitted the appropriate number of impulses to the units in the automatic selector racks.

The development work was continued and 1923 R. Edling designed an impulse transmitter with indicators for each of the six digits. The setting of the required number was carried out by means of the buttons at the top of the device and the transmission of the digits was released by the turning of the knob below the indicators.

Below to the extreme right the Lienzén dial, the immediate predecessor to the present L M Ericsson dial.

Above the first Swedish dial, Lars Magnus Ericsson's »selector disk». From left to right M. Lövgren's impulse transmitter with push buttons, R. Edling's design with digit indication and O. Grabe's and J. Hansson's design with dial disk.

Visit of Distinguished U. S. Business Men

Fortyfive U. S. big business men from Detroit toured Sweden in May this year. The program included a few industrial visits and Telefonaktiebolaget L M Ericsson's works at Midsommarkransen, Stockholm, was the first factory to welcome the distinguished guests. About half a day was spent studying the different workshops under expert guidance. In the illustration an assembly girl tells Mr. Wills H. Hall and Mr. Louis Rosetti how a 500-line selector is being put together.

Swedish Broadcasting Programs in Chile

Touring in Sweden, the celebration of the Swedish national flag, the production of L M Ericsson telephones and the maintenance of SKF ball bearings are some of the programs being broadcast to South American listeners. The Chilean station »Radio Cooperativa Vitalica CB—76" (short waves 25 and 49 metres) holds a prominent position owing to its technical capacity and power. It is also referred to as »La voz de Chile para toda America» (The voice of Chile to all America) and is said to be received over a considerable area of the continent. The Chilean L M Ericsson and the SKF company together with the Swedish legation are arranging regular broadcasts from this station. The programs have been transmitted twice a week. Tuesdays and Saturdays 20.30—21.30 hrs Chilean time and L M Ericsson and SKF have taken it in turns to supply the program material.

These programs mainly cover information about Sweden and the publicity matter is generally limited to a closing phrase which may point out that the program was arranged by L M Ericsson.

L M Ericsson Exchange for the Largest Building in Europe

The centre of Rotterdam was badly knocked about during the war, but intensive building has now healed up most of the scars. One of the most remarkable new buildings is the »Groothandelsgebouw» — according to our information the largest building in Europe — which has been equipped with a centralized PABX exchange for 460 extensions. The exchange was put into operation in June and is the second installation of this type which has been delivered to Rotterdam by L M Ericsson. An extension covering a further 460 lines is at present being delivered to the »Wholesaler's House».

D. Lienzén designed early in the nineteen twenties a dial, which with minor improvements was used for nearly 25 years. Five years ago C. O. Sohlberg developed a new design. The chief differences between the new dial and the previous design are that the dial disk is made in a moulding instead of brass sheet and that spur gears are used for the governor drive instead of worm gearing. The new dial wears very much better than the old one and it is estimated that it should have about twice the life of the previous type.

2—

Recent International Exhibitions

At the international Milan exhibition this year the Ericsson concern was represented by the Italian companies FATME and SIELTE. A great number of visitors studied the exhibited articles and the new rural exchange with crossbar switches as well as the equipment for co-axial systems attracted particular interest.

On his visit to the exhibition the minister for the Italian post and telephone administration, Mr. H. E. Spataro, inspected the various L M Ericsson stands ciceroned by the manager of FATME, Mr. Luigi Baggiani.

L M Ericsson also took part in the Canadian International Trade Fair at Toronto displaying samples of the great variety of the Swedish production.

Below Mr. Spataro (right) listening to Mr. Baggiani's demonstration of a loading coil at the Milan exhibition.

New Helsinki Traffic Signals

The first automatic traffic control system in Finland has been supplied by the L M Ericsson Signal Company and has been installed at the crossing of Alexandersgatan and Mikaelsgatan.

The system is entirely vehicle actuated and is provided with a controller for two traffic phases. The first phase admits vehicle and tram traffic on Alexandersgatan and the second phase vehicle traffic on Mikaelsgatan.

The controller can, subsequently, be supplemented with a separate phase for pedestrians. At present these are guided by the ordinary traffic signals. The illustration shows pedestrians waiting for green light.

The system has been installed in co-operation between the Signal Company, OY L M Ericsson AB, Finland, the Helsinki City Electricity Board and the Helsinki Road Board.

At the end of 1951 the Signal Company received an order for a similar system for the crowded crossing Mannerheimsvägen—Simonsgatan in Helsinki. The system will be delivered this summer.

U.D.C. 654.9:725.24

SUNDEMAN, B E:SON & EKSTRÖM, H: *Modern Telesignal Systems at the Head Office of Stockholms Enskilda Bank.* Ericsson Rev. *29* (1952) No. 2 pp. 34—42.

In conjunction with a reorganization of the office routine at the head office of Stockholms Enskilda Bank various kinds of telesignal systems have been installed: photo cell controlled pneumatic door installation, conference telephone system, service signals, engaged-signals, staff locators, attendance indication system, electric clock system, automatic fire alarm system, hold-up and burglar alarm system, night watchmen's control etc. A few new features with reference to equipment as well as to wiring methods have thereby been introduced. In the article the most important of the systems are presented which have all been supplied by Telefonaktiebolaget L M Ericsson.

U.D.C. 621.395.721:621.395.631.4

NILSSON, K W: *New Magneto Telephone Instruments.* Ericsson Rev. *29* (1952) No. 2 pp. 43—48.

The range of new telephone instruments lately marketed by L M Ericsson has now been augmented by two instruments with handgenerator for L. B. system. The instruments of which DAH 12 is a desk type and DAN 11 is intended for wall mounting, are described as regards construction and circuit. In special sections the new handgenerator and the battery box are described.

U.D.C. 621.317.49:620.179.14

SVENSSON, I: *The Ferrometer, an Apparatus for Testing the Quality of Steel.* Ericsson Rev. *29* (1952) No 2 pp. 49—53.

The ferrometer designed by L M Ericsson's Mätinstrument AB (Ermi) has extended the means for testing the quality of steel. In the article some examples of the ferrometer's employment are given together with a description of its construction and functioning, which is based on the relation existing between a steel's technological and magnetic properties.

U.D.C. 621.395.24

NILSSON, E: *New Automatic Relay Operated Exchange for 9 Extensions and 4 Exchange Lines.* Ericsson Rev. *29* (1952) No. 2 pp. 54—60.

In Ericsson Review No. 1/1951 a private automatic branch exchange AMD 10201 was described. This was the smallest in a range of private branch exchanges working with relays and capacitors only. In the article the next size in the series, AMD 10501 with 9 extensions, 4 exchange lines and 2 local connections, is described.

The Ericsson Group

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Esselte, Sthlm 52

ERICSSON Review

3
1952

ERICSSON REVIEW

RESPONSIBLE PUBLISHER: HEMMING JOHANSSON

EDITOR: SIGVARD EKLUND, DHS

EDITOR'S OFFICE: STOCKHOLM 32

SUBSCRIPTIONS: ONE YEAR $1.50; ONE COPY $0.50

CONTENTS

On cover: Operator at an operator's set for the L M Ericsson AGD system with cordless switching.

Manual Trunk Exchanges with Cord Pairs

R HÄGGÖ, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

U.D.C. 621.395.722

Telefonaktiebolaget L M Ericsson has developed a trunk exchange system, type AFA 10, for small and medium-sized trunk exchanges. This system which is described below meets adequately all requirements for a trunk exchange. The end of the article contains an elementary example of how the number of positions and cord pairs for such a system is calculated.

Summary of Trunk Traffic

The purpose of the trunk exchanges is the handling of the telephone traffic between different and separated local networks. With reference to the distances between the local networks the trunk traffic may be roughly divided into the following types:

Rural traffic, mainly covering the connections between a town and the surrounding rural district.

National trunk traffic, covering the telephone traffic between the trunk centres which are generally town-like communities.

International trunk traffic which is mainly the traffic between the capitals of different countries.

The number of lines in a traffic route connecting two local networks is determined by the traffic intensity and the installation cost. If the traffic intensity alone was considered all traffic routes would be dimensioned for the maximum intensity, *i.e.*, the intensity during the busy hours. The installation cost for long trunk lines are, however, considerable, and to ensure reasonable charges, the lines in each traffic route have to be occupied to the highest possible degree. The number of lines in the different traffic routes are, therefore, adjusted according to the average traffic intensity during the day which, however, causes delay during busy hours. Short traffic routes may be more amply dimensioned and as a rule rural traffic can be handled without appreciable delay.

All trunk calls are chargeable and for that reason special operating devices are necessary in the trunk exchanges. These devices are more or less perfected according to the importance of the trunk traffic for which they are used. The rural traffic which is connected over short lines with comparatively low installation costs can as a rule be served by less elaborate arrangements than those required for national trunk calls which are connected over longer and considerably more expensive lines. For trunk calls over very long lines and for all international trunk traffic, which generally are connected over 4-wire lines, all possible means are resorted to in order to reduce the connecting times and in that way obtain highest possible degree of occupation of the lines.

Principally a trunk exchange provides for three different types of calls, *viz.*, outgoing, incoming and transit calls each requiring different handling.

The outgoing traffic requires the greatest amount of attention. Each outgoing connection is preceded by an order from a subscriber in the local network. The order is recorded on a card and initiates the establishment of a connection be-

Fig. 1 X 6686
Manual operation

Fig. 2 X 6687
Semi-automatic operation

tween the ordering subscriber and the wanted subscriber in the distant local network. In addition the duration of such a call has to be measured and recorded on the record card. Finally the cards are collected and sorted and are used as basis for the charging of the subscribers.

The incoming traffic can be handled in a routine manner. The work of the operator consists of answering the calls on the trunk lines and connecting them to the required subscribers in the local network.

In case of transit traffic the operator establishes connections between the trunk lines. For such connections it is often necessary to insert an amplifier.

The relationship between these three types of calls depends, of course, on local conditions but as a rule the outgoing traffic is about the same as the incoming traffic, whereas the transit traffic usually amounts to 10 % of the total.

The traffic routes to and from the local exchange should be amply dimensioned so as to avoid delay due to lack of such junction lines.

The bulk of all trunk traffic is handled manually both ways which means that one operator at the outgoing end of the trunk connection and one at the incoming end are engaged when a trunk call is established, Fig. 1.

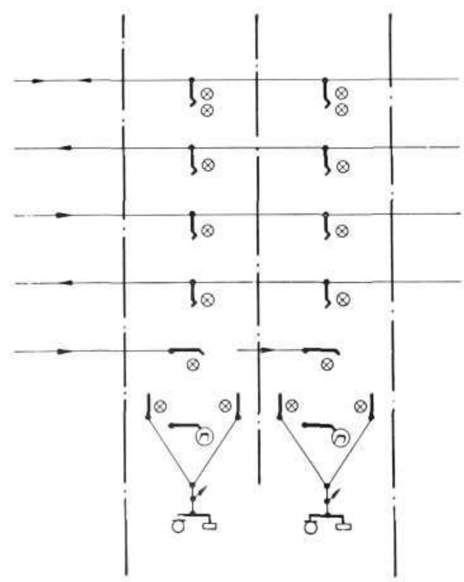


Fig. 3 X 6688
Diagram for trunk exchange, type AFA 10

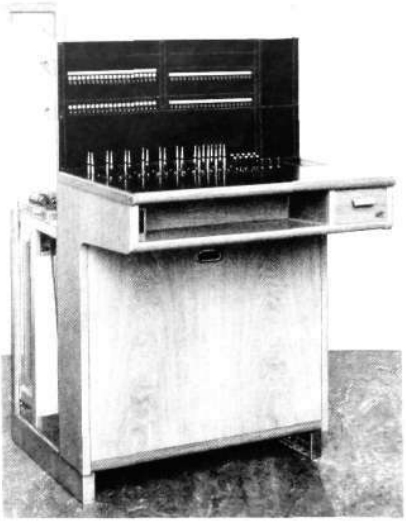


Fig. 4 X 4816
Switchboard section AFA 10
front view

For automatic local networks it may be advisable to introduce semi-automatic operation, the manual handling being discarded in respect of the incoming traffic. The operator at the receiving end is replaced by automatic connecting devices controlled by the operator in the originating trunk exchange, Fig. 2.

In general all trunk traffic is connected over switchboards with or without cords. In cordless exchanges the cords and plugs are replaced by keys and automatic connecting devices. Cordless switchboards are only used in large trunk exchanges. In countries with highly developed telephone traffic fully automatic trunk traffic is used, all connections being carried out by automatic connecting devices operated from the subscriber's dial. The description below will only be concerned with small and medium-sized trunk exchanges with cord pairs. In exchanges of this kind each operator receives trunk call orders and connects outgoing as well as incoming trunk traffic. This type of operation necessitates that all lines are available for each operator, Fig 3.

When a traffic route contains a few lines only, each line has to carry traffic in either direction, but whenever justified by the amount of traffic and number of lines a segregation is made of lines for outgoing and lines for incoming traffic. Such a division considerably simplifies the switchboard equipment on exchanges which allow a corresponding division of the switchboard positions. In the outgoing positions the operators receive call orders and connect outgoing traffic. The operators in the incoming positions only handle incoming traffic and these positions do not require equipment for checking the duration of the calls; nor equipment for answering calls on the record lines.

The more important requirements of a satisfactory trunk exchange may be summarized as follows:

1. The trunk exchange should include equipment for booking and recording.
2. It should be provided with equipment enabling prompt and reliable connections.
3. It should contain devices for reliable checking of the duration of the calls.
4. It should be dimensioned so as to eliminate delay due to lack of operators.
5. It should allow adjustment of the number of attended positions according to the variations in the traffic.

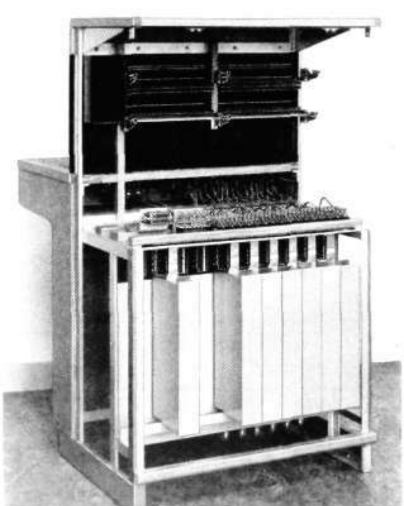


Fig. 5 X 4815
Switchboard section AFA 10
rear view

Trunk Exchanges Type AFA 10

L. M Ericsson have developed a trunk exchange system, type *AFA 10*, for small and medium-sized installations, which well conforms to the requirements specified above. All connections are effected by means of cords and plugs. The system is intended for record as well as trunk service. For this purpose all lines are multiplied in all trunk positions, Fig. 3. The trunk lines are equipped with jacks, calling lamps and busy lamps. The junction lines to the local exchange have jacks and busy lamps.

The record lines from the local exchange are provided with jacks and calling lamps. For the internal traffic between the operators the exchange is provided with a requisite number of service lines with jacks and busy lamps for outgoing traffic. For answering an incoming call over a service line the operator's equipment is provided with a calling lamp and an answering key. The relay sets for the various circuits are mounted in racks and are connected over multipin jacks and plugs.

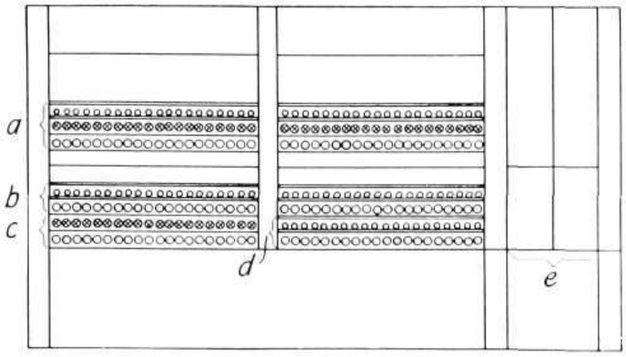


Fig. 6

a trunk lines
b junction lines
c record lines
d service lines
e pigeon-holes

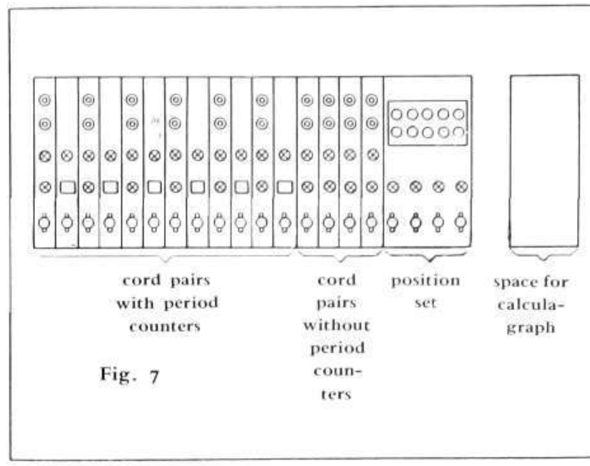


Fig. 7

Fig. 6 X 7626 X 9122
Multiple panel

lamp and label strip

lamp strip

jack strip

Fig. 7 X 7626
Key shelf

The Trunk Switchboard

The trunk switchboard has two panels per position, see Figs 4 and 5. Each board section is so constructed that it can be attached to other sections forming a complete switchboard with the required number of positions. The board section is built up on a steel frame covered by wood. The woodwork consists of light oak veneer over laminated oak with the exception of the rear lid which is made of wallboard on an oak frame. The key shelf is covered by a hard wearing green coloured material suitable as writing support. Below the key shelf a compartment and a drawer is arranged for the operator's personal belongings. The lower part of the board is lined with stainless steel protecting against damages which may be caused by floor cleaning &c.

A board section has the following dimensions: height 1,214 mm (47 13/16"), width 700 mm (27 9/16") and depth 885 mm (34 7/8"). The height of the key shelf is 796 mm (31 3/8") and the free space in front of the cord circuits which may be used for writing is 235 mm (9¼"). The two jack panels hold a maximum of 30 jack or lamp strips. Providing that 20-line jack and lamp strips are used the maximum multiple capacity will cover 120 trunk lines, 80 junction lines, 20 record lines and 20 service lines. At the side of the jack panels a set of pigeon-holes is mounted with four compartments for writing material and record cards. The key shelf holds position set and 16 cord pairs without period counters as well as space for a calculagraph. A period counter takes up the same space as a cord pair. A maximum of 8 cord pairs with period counters can, therefore, be fitted.

The switchboard can also be provided with transit cord pairs for four-wire connection. A transit cord pair requires the same space in the key shelf as an ordinary cord pair with period counter. For such transit connections the relay equipment for the lines have to be supplemented and the switchboard has to be provided with a four-wire multiple.

Fig. 6 shows the multiple panels in a board provided with jacks and lamps for 40 trunk lines, 40 junction lines, 20 record lines and 20 service lines. The busy lamps for trunk, junction and service lines are fitted in combined lamp and label strips.

Fig. 7 shows a key shelf provided with position set, six cord pairs with period counters and four cord pairs without period counters.

The Operator's Equipment

The operator's equipment contains one headset, position set and a relay set. The position set contains the common operating devices such as dial, key for ringing on the trunk side or the local side, key segregating the trunk side and the local side and key conecting the dial to the trunk or the

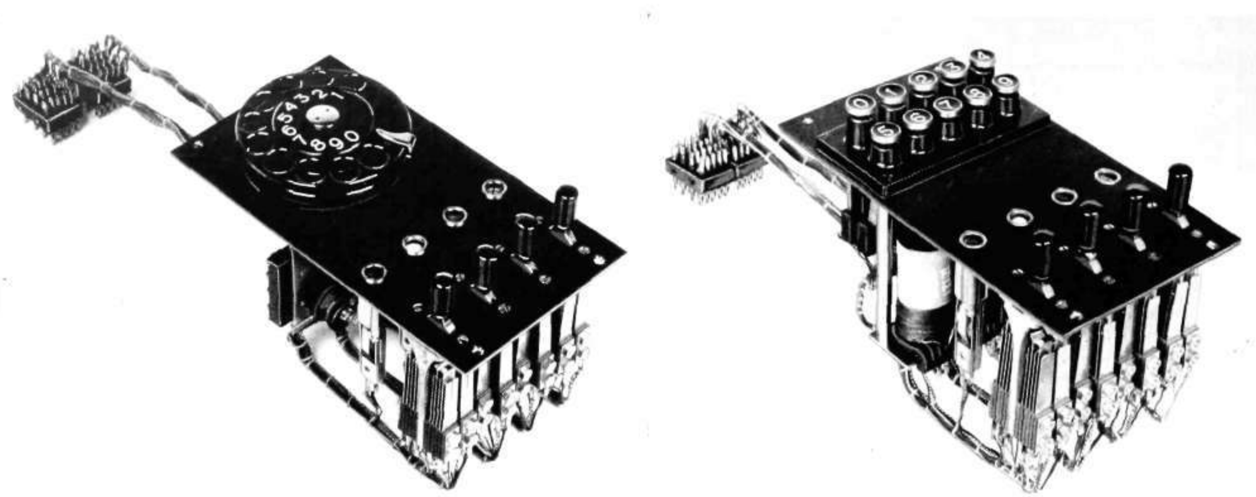


Fig. 8 X 7622
Position set
left with dial, right with key set

local side. The position set also includes three lamps with differently coloured lenses. The white lamp is the clearing signal, the green lamp indicates that the operator's set is connected and the red lamp is a fuse alarm signal. Finally the position set contains a call lamp and an answering key for the incoming service lines. The ringing key also serves as disconnecting key for local calls in favour of trunk calls. The above equipment and the lamps are mounted on a panel and wired to multi-pin plugs, Fig. 8 left. The position set can also be provided with a key set, Fig. 8 right, in place of the dial.

The relays, telephone transformer, listening transformer, shock absorber and the line terminals are assembled to a relay set mounted in the rear of the board and connected over plug and jack, Fig. 5.

The Cord Pair

A cord circuit consists of a switching set, two cords with plugs, two pulley weights and a relay set. The switching set contains a speaking and listening key as well as two supervisory lamps. The components are assembled on a mounting plate and wired to a multi-pin plug, Fig. 9 left.

Each cord and plug has three conductors. The plugs are provided with steel wire spirals to reduce wear on the cords, see Fig. 10.

Each cord pair has two supervisory relays and a test relay connecting the cord pair to the common position equipment. The test relay prevents two cord pairs being connected simultaneously to the operator's equipment. The relays for two cord pairs are assembled to a relay set. When a cord pair is provided

Fig. 9 X 7621
Switching set (left) and period counter set (right)

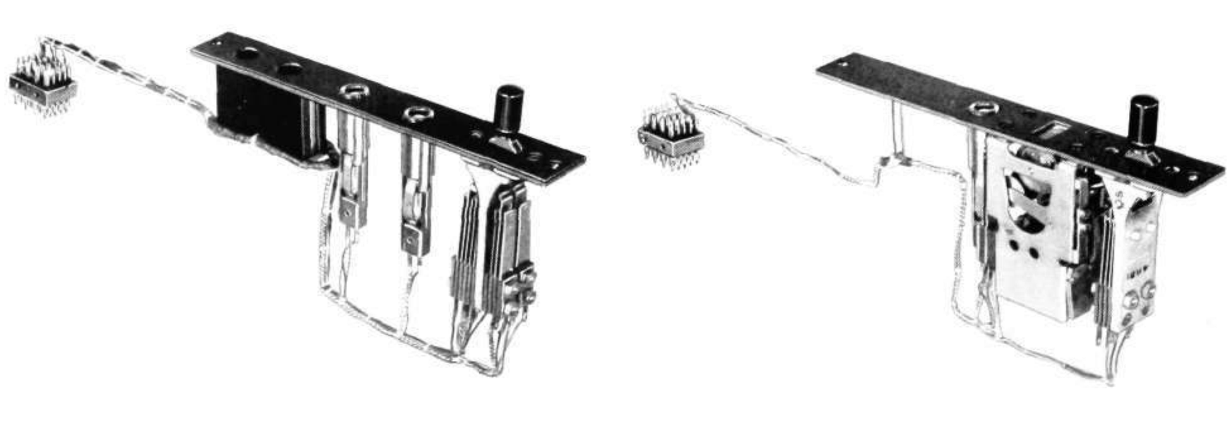


Fig. 10 X 4817
Cord with plug

with a period counter a relay is added for connection of an intermittent warning signal on the line wire in the cord pair. Each relay set then contains relays for one cord pair only. The cord pair relay sets are mounted in the rear of the board and are connected over plug and jack, Fig. 5.

The Period Counter

The period counters are used for computing the duration of the calls. A period counter consists of a counter, a key for starting and restoring the counter and a pilot lamp. These components are assembled on a mounting plate and wired to a multi-pin jack and constitute a period counter set, Fig. 9 right.

The period counters are connected to the cord pairs, each period counter set being mounted at the side of the corresponding cord pair on the key shelf. The counters cover a maximum of 12 minutes and before the end of each 3-minute period a contact is operated in the counter during 10 secs. lighting up the pilot lamp. At the same time as the lamp is operated a faint intermittent tone is connected to the line wires in the cord circuit warning the parties in connection that a 3-minute period is terminated. The counters are operated by electric impulses at 10 secs. interval transmitted from a master clock over a relay set. During a call the counter is controlled by the local subscriber as it is connected over contacts on the supervisory relays for the cord circuit. When clearing signal is received the circuit for the impulses is opened and the operation of the counter is discontinued.

The period counters allow individual control of the calls and are used when the trunk calls are subject to a time limit or when the duration of the calls are measured in periods. The duration of the calls may also be checked by means of a calculagraph. This does not allow individual control of the calls but may be used when there is no time restriction or when period counting does not apply. For trunk switchboards AFA 10 a recorder, model 33, is used which is supplied by Calculagraph Co. USA. The calculagraph is a time recorder driven by an electric synchronous motor. The duration of a call is recorded on the record card by clocking the start and finish of the call. From these time data the duration of the call may be calculated. The calculagraph records the time in minutes and seconds up to 30 minutes. It is provided with a dial indicating the time of the day. As the calculagraph is only used at the start and finish of each call it can be used in common by two operators and one recorder only is, therefore, required for every other position.

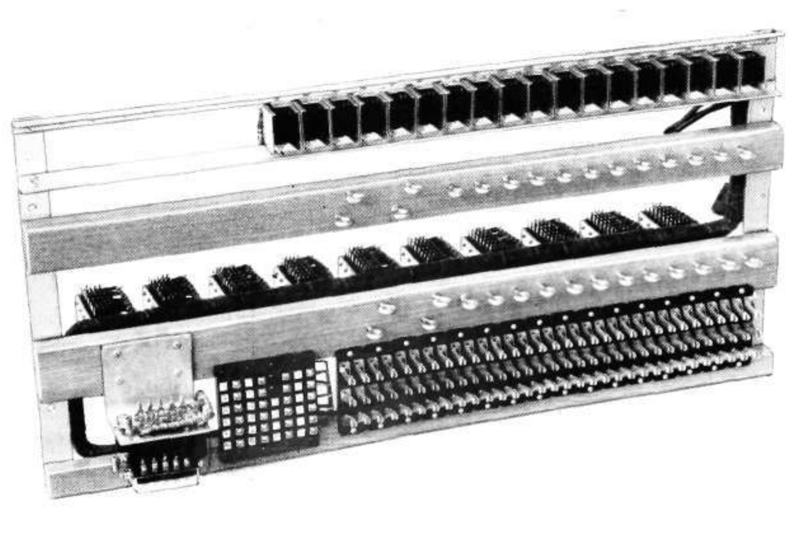


Fig. 11 X 6697
Board equipment

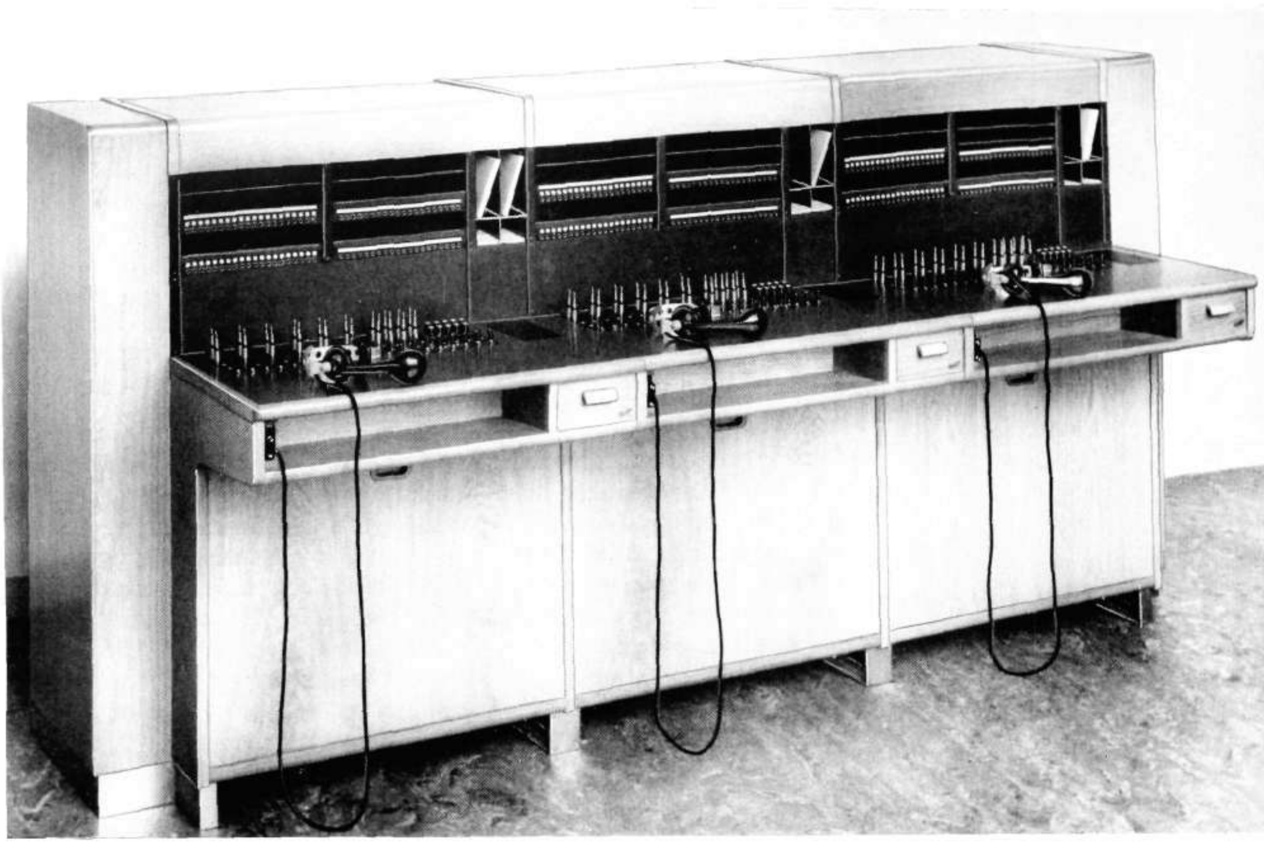


Fig. 12
Switchboard complete
covering 3 positions

X 7625

The Board Equipment

The board equipment, Fig. 11, consists of a completely wired unit containing jacks for connection of the position set and the cord switching sets. The board equipment also includes jacks for the relay sets belonging to the operator's equipment and the cord pairs. The following terminals are fitted in the board equipment: cord terminals, terminals and fuses for connecting the battery and finally a number of terminals for incoming service lines, control circuits &c.

The Switchboard

The switchboard sections may be assembled into switchboards with the required number of positions. Such a switchboard, Fig. 12, contains principally:

1 cable cover, left.
Required number of switchboard sections.
Required multiple equipment.
1 cable cover, right.

Accessories

A trunk exchange requires various kinds of power supply, in the first place a main battery for the transmitter supply, operation of relays, signal circuits &c. The operating voltage is 24 V. The capacity of the battery depends on the size of the exchange. Busy line signalling is effected by 6 V lamps connected in series. For all other visual signals 24 V lamps are used. If the local exchange allows the setting up of subscriber's number by means of key sets in the trunk switchboards, an additional voltage of 24 V is required, which is obtained from a small battery of 10—15 Ah. Trunk exchange AFA 10 is alternatively supplied for 48 V operation. The signalling of the trunk circuits is carried out by means of a generator transmitting suitable ringing current.

As mentioned above the period counters are operated by a master clock over a relay set. The master clock is spring driven with automatic electric winding operated from 110 V or 220 V A.C. or D.C. mains. The impulse contact in the master clock is operated every 10th second and can take a maximum of 5 period counters. To operate counters in excess of this number from a common master clock a relay set is connected in the impulsing circuit. This relay set consists of a relay chain dividing each impulse from the master clock into 6 counter groups. The impulse relay set can take 40 counters. The relay set also includes a relay chain transforming available buzzer tone into the warning signal which is transmitted to the connected subscribers at the end of each three-minute period.

If calculagraphs are used, 20 V A.C., 50 cycles is required for the operation. The speed of the synchronous motor is dependent on the frequency and the A.C. voltage must, therefore, be frequency controlled as the timing otherwise will be wrong. Where frequency controlled A.C. mains are available, the calculagraphs may be mains connected over a transformer. If no frequency controlled A.C. mains are available the exchange is provided with an oscillator generating suitable A.C. voltage. The oscillator is operated from the main battery. The trunk exchange is generally built in conjunction with the local exchange enabling a common power equipment to be used for both exchanges.

Calculation of Number of Positions and Cord Pairs

Number of Positions

When dimensioning a trunk exchange the number of trunk circuits have been determined according to technical and economical considerations, which have been briefly mentioned above. If the average occupation of the circuits is known, a value will be obtained for the total amount of traffic, which as a rule is evenly distributed between incoming and outgoing traffic. The transit traffic is generally insignificant and can be ignored when calculating the number of positions required. In order to determine the number of positions an average value must be established of the number of connections which one operator can handle during a busy hour. It is not possible to give a value which is universally applicable as this varies considerably with local conditions. The number of positions can, however, be calculated when the following factors are known.

The amount of outgoing traffic (E_1 Erlang)

The amount of incoming traffic (E_2 Erlang)

Average duration of calls per connection (t_1 minutes)

Average handling time (recording included) for one outgoing connection (t_2 minutes)

Average handling time for one incoming connection (t_3 minutes)

Average occupation of the operator (α)

$$\text{Number of outgoing connections} = \frac{E_1 \cdot 60}{t_1} \qquad (1)$$

$$\text{Number of incoming connections} = \frac{E_2 \cdot 60}{t_1} \qquad (2)$$

$$\text{Number of outgoing connections per operator during busy hour} = \frac{\alpha \cdot 60}{t_2} \qquad (3)$$

Number of incoming connections per operator during busy hour =

$$= \frac{\alpha \cdot 60}{t_3} \qquad (4)$$

$$\text{Number of positions for outgoing traffic} = \frac{E_1 \cdot t_2}{t_1 \cdot \alpha} \quad (5)$$

$$\text{Number of positions for incoming traffic} = \frac{E_2 \cdot t_3}{t_1 \cdot \alpha} \quad (6)$$

The above is illustrated by the following example:

An exchange has 80 trunk circuits with an average occupation of 50 % at busy hour. Ignoring the transit traffic the total amount of traffic $80 \cdot 0.5 = 40$ Erlang is distributed evenly with 20 Erlang each for the incoming and outgoing traffic

$E_1 = E_2 = 20$ Erlang
$t_1 = 5$ minutes
$t_2 = 2$ »
$t_3 = 0.5$ »
$\alpha = 0.6$

$$\text{Number of positions for outgoing traffic} = \frac{20 \cdot 2}{5 \cdot 0.6} = 13$$

$$\text{Number of positions for incoming traffic} = \frac{20 \cdot 0.5}{5 \cdot 0.6} = 3$$

Total positions 16

Number of Cord Pairs per Position

The number of cord pairs per position can be calculated by means of the values obtained from (3) and (4). These values express, however, the number of connections accomplished by an average operator. The number of cord pairs must be sufficient to cover a high capacity operator which can be assumed to be about 10 % over the average.

The amount of traffic in Erlang per outgoing position =

$$= \frac{1.1 \cdot \alpha \cdot 60(t_1 + t_2)}{t_2 \cdot 60} \quad (7)$$

The amount of traffic in Erlang per incoming position =

$$= \frac{1.1 \cdot \alpha \cdot 60(t_1 + t_3)}{t_3 \cdot 60} \quad (8)$$

From »Table of the Erlang loss formula» the number of cord pairs is obtained corresponding to the amount of traffic according to (7) and (8) with a certain permissible loss (about 1 %).

Continuation of the above example:

The amount of traffic in Erlang per outgoing position =

$$= \frac{1.1 \cdot 0.6 \cdot 60(5 + 2)}{2 \cdot 60} = 2.3$$

The amount of traffic in Erlang per incoming position =

$$= \frac{1.1 \cdot 0.6 \cdot 60(5 + 2)}{0.5 \cdot 60} = 7.3$$

With a permissible 1 % loss 7 cord pairs per outgoing position and 14 cord pairs per incoming position will be required. If each position serves outgoing as well as incoming traffic it is provided with 9—10 cord circuits.

Generally the length and importance of the trunk lines decide the number of lines per operator. In case of international trunks and very long national trunks as few as 1—2 lines may be allotted per operator. For ordinary trunk lines 3—4 lines per operator is usual where 5—10 rural lines can be handled by one operator. It also happens that L.B. subscribers are served from the trunk exchange. The traffic on such lines is generally very low and up to 100 lines per operator is not unusual.

Private Automatic Branch Exchange, AGD System, with Cordless Switching

E LARSON, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

U.D.C. 621.395.26

To obtain efficient service and uniform distribution of the switching operations for private branch exchanges with cordless switching L M Ericsson has developed a new distribution system for incoming calls. All operator's sets are identical irrespective of the number of incoming lines and the number of operators. The system has now been applied to multi-exchange systems with a common number series and with central switching of the incoming traffic, in connection with the conversion to automatic working of installations at the Stockholm Tramway Corporation and AB Bofors, Karlskoga. The system can, however, also be used with advantage for large self-contained telephone exchanges.

In the new distribution system the incoming traffic is connected over an adjustable connection distributor to a free attended operator's set. The adjustable distributor connects the traffic in rotation to the operators ensuring even distribution of the work. Special traffic may be directed to certain operators.

Multi-exchange systems with a common number series and central switching of incoming traffic are suitable for organizations which have their offices spread over a wide area and which require a uniform telephone system.

Fig. 1 illustrates the cordless switching applied on the one hand to an ordinary public branch exchange, consisting of one exchange only, and on the other hand to a multi-exchange system.

Lay-out of the System

The public branch exchanges contained in the system are mainly constructed with the L M Ericsson 500-line selectors controlled by registers. The registers are made to suit the number series and the grouping which is applied to the multi-exchange system. Crossbar switches are used for the connecting devices to the operator's sets and for the registers.

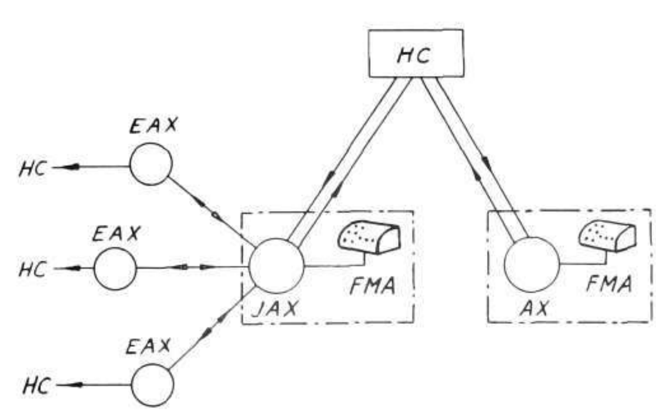


Fig. 1 X 6696

Diagram over cordless switching applied to multi-exchange system and ordinary private branch exchange

- AX private branch exchange
- EAX private branch exchange, terminal exchange
- FMA operator's set
- HC public exchange
- JAX private branch exchange, junction centre

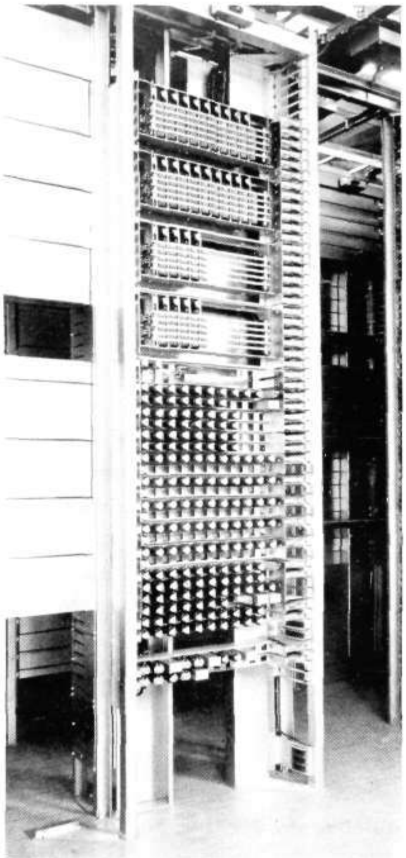


Fig. 2 X 4822
Elements for call distributor to operators

All relay sets, crossbar switches, 500-line selectors and operator's sets are connected to the rack cabling over plug and jack.

The incoming traffic from the public telephone system is connected to the junction centre of the multi-exchange system, which will reduce the number of operators required. A common 3- or 4-digit number series for all exchanges in the system facilitates the switching for the operators and simplifies internal calling. The outgoing traffic to the public telephone system is connected from each individual exchange to the nearest public exchange.

The grouping of the numbers within a multi-exchange system may be arranged according to requirements. If the system is built up on 4-digit numbering for a maximum of 6,000 extensions, 1,000 numbers may be allotted to the junction centre, 400 numbers for each of 5 terminal exchanges and 300 numbers each for 10 terminal exchanges. If the group contains a smaller number of exchanges, a larger number series may be allotted to each exchange or a 3-digit system may be used. The translating circuits of the registers may be arranged for any numbering scheme required. Otherwise standard equipment is used.

Technical Features of the System

During a public exchange call any non-restricted extension can carry out inquiry or transfer to another extension in any of the exchanges in the system.

The operator may park an incoming call for waiting if the wanted extension is engaged.

If a public exchange subscriber requires connection to a number of extensions in succession, known as series calling, a button is pressed in the operator's set. The operator will then receive a signal as soon as one call is terminated, *i. e.*, when the called extension replaces.

Certain incoming lines may be night connected to predetermined extensions. The exchange is automatically switched to night connection as soon as all operator's sets are unattended.

The public exchange is called by a code digit. Groups of 20 extensions may be restricted for outgoing traffic. Incoming traffic from the public exchange may be restricted individually.

By means of different code numbers to the operators, trunk call ordering, information etc. may be directed to one or more operators who are assigned for this kind of traffic.

Distribution and Switching of Incoming Traffic

All *incoming traffic* is distributed to the operators by means of an adjustable call distributor. Different types of traffic such as trunk traffic, ordinary incoming traffic and local traffic to the operators, may be directed to different groups of operators. This distribution takes place by means of buttons in a control unit. The control unit contains pilot lamps enabling a principal operator to supervise the traffic. The distribution buttons are also used to relieve a heavily engaged operator group by transferring operators from another group less engaged. The call distributor connects the calls directed to a certain operator group in circulating succession. If all operators are serving a general group and certain operators are assigned for a special traffic group, the latter are relieved from general calls while they are engaged on calls for the special group.

X 6705

Fig. 3
Operator's set

The lay-out of the operator's set, Fig. 3, is independent of the magnitude of the system and the number of incoming lines. The set contains buttons and lamps required for the control of the switching. The wanted extension number is transmitted from a key set to a register which controls the automatic connection operation accordingly. No cords or plugs are used for the switching.

Each operator's set is connected to 5 connection and control links and includes 5 corresponding control sets, each containing answering button, calling and control lamps.

Incoming calls are distributed and connected over crossbar switches to the connecting links, which remain engaged until connection with the wanted extension is established; when the call is answered the link is released and is then available to connect fresh calls. The equipment required for control and signalling is concentrated in the links which are only in use during the time required by the operator to supervise the connection. All incoming lines have, as a rule, full availability to all links and no special arrangements are, therefore, required when the traffic is concentrated to a reduced number of operator's sets during slack hours.

If the called extension is connected to the junction centre, a marker effects by-path test as soon as the last digit is transmitted. The result of the test is signalled on lamps in the operator's set indicating the condition of the extension, *i. e.*, if the extension is open or restricted, free or engaged, engaged by waiting call or engaged on trunk call.

When the connection is established automatic repeated ringing signals are transmitted. The operator may also transmit manual ringing signals. If the called extension is connected to a terminal exchange, the 500-line selector connects a junction to the wanted exchange and the three last digits are transferred to a register in the terminal exchange. When these three digits have been transferred to the terminal exchange register, a by-path test is carried out in this exchange and the result is transmitted in the form of an impulse code to the junction centre indicating the condition of the called extension. The impulse code operates lamp signals in the operator's set as described above for calls to junction centre extensions.

Capacitor Voltage Transformers

L HÖGFELDT, SIEVERTS KABELVERK, SUNDBYBERG

U.D.C. 621.314.222.6

Sieverts Kabelverk has recently delivered a number of 385 kV capacitor voltage transformers for the new power transmission line between Harsprånget and Central Sweden. These capacitors voltage transformers are the first in the world constructed for this voltage and represent an advance in the design of high-voltage capacitors. The following article describes the construction, properties and use of these capacitor voltage transformers.

As its name implies, a capacitor voltage transformer consists of a capacitor connected up as a potential divider and a transformer which further steps down the intermediate voltage obtained at the capacitor terminals, see connection diagram, Fig. 1.

The capacitor voltage transformer is employed for voltage measurement, in which connection it feeds instruments and relays and in some cases energy meters for debiting consumption also. While the whole capacitor transformer aggregate serves as a potential transformer, the capacitor section can at the same time be used as a connecting device for carrier frequency transmission over the power line, and finally, the capacitor acts to some extent as an overvoltage protective device.

Capacitor voltage transformers are normally manufactured for voltages between 55 and 385 kV, and at the higher voltages they are considerably cheaper than standard potential transformers designed for the full line voltage, particularly when advantage is taken of the possibility of using the capacitor as a connecting device and for overvoltage protection.

Construction

The capacitor is assembled from a number of series-connected elements and, as mentioned above, it is fitted with terminals to which the high-tension winding of the transformer is connected. To ensure the most favourable measuring properties for the aggregate the transformer must be tuned to the capacitor in such a way that the condition

$$X_t = \frac{1}{\omega\,(C_1 + C_2)}$$

is fulfilled. For this purpose the transformer reactance X_t can be varied approximately ± 25 % around its rated value. In consequence of certain unavoidable manufacturing tolerances for the capacitor, the transformer must also be constructed with a variable turn ratio so that it can be adapted to the voltage given by the capacitor at the intermediate voltage terminals.

When connecting up a reactance containing an iron circuit—a transformer in the present case—and a capacitor, ferro-resonance may be set up. This is due to the fact that the magnetization curve of the iron circuit is bent so that the reactance is variable and can oscillate together with the capacitance of the capacitor. These oscillations which usually have a frequency of the order of 5 to 10 c/s, disturb the entire functioning of the capacitor transformer and must be suppressed. For this purpose the transformer is so dimensioned that its working point lies relatively low down on the straight portion of the magnetization curve. By this means the risk of setting up ferro-resonance is reduced. Furthermore, a damping circuit is inserted between the transformer

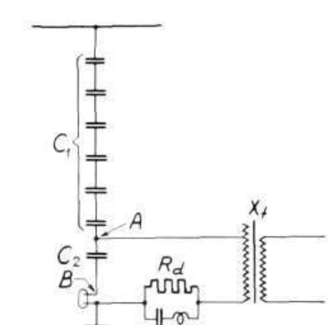


Fig. 1 X 4804

Connection diagram for a capacitor voltage transformer

A intermediate voltage terminals
B bottom terminals
C_1, C_2 capacitor
R_d damping resistance
X_d series circuit
X_t transformer reactance

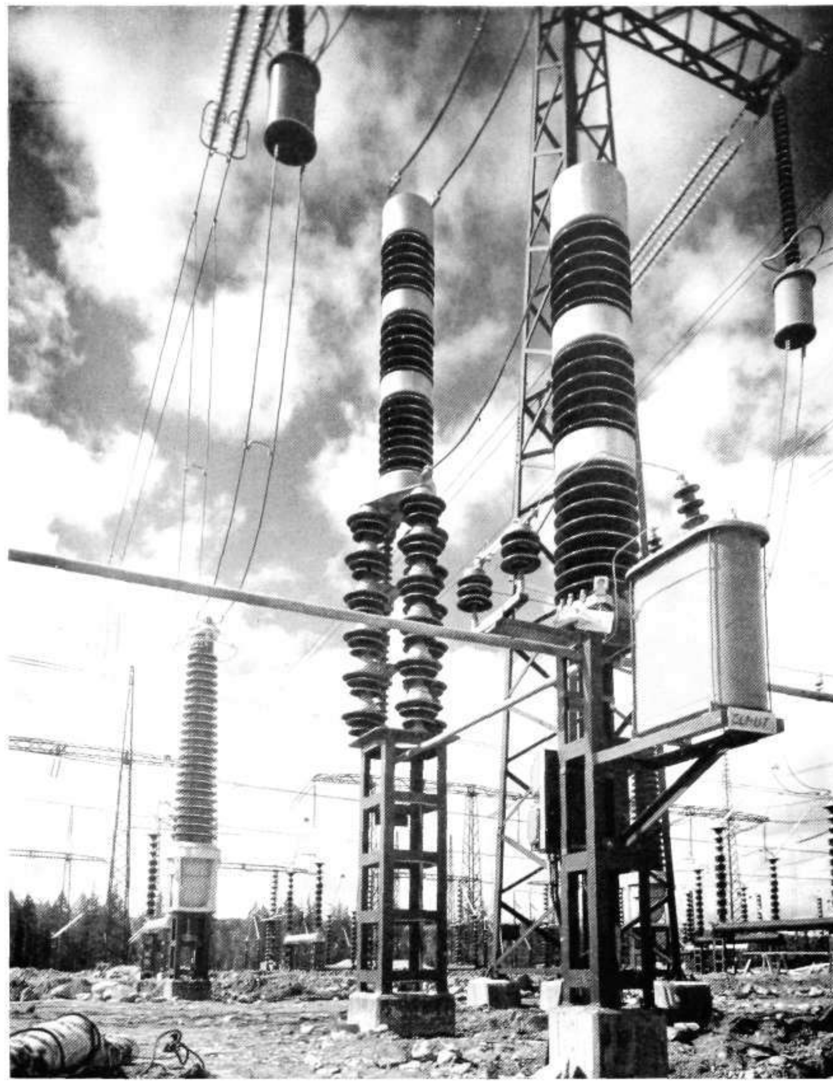


Fig. 2 X 6702

385 kV capacitor voltage transformer

and the capacitor, consisting chiefly of a resistance so dimensioned that it effectively damps the ferro-resonance oscillations. This resistance gives rise to a certain voltage drop in the capacitor-transformer, however, resulting in bad measuring properties, on which account the resistance is shunted by a series circuit tuned to the frequency of the network. The damping circuit will then operate in such a way that it causes a relatively insignificant voltage drop at the network frequency since the current flows mainly through the series circuit, whilst on the other hand, a current having a frequency of 5 to 10 c/s is forced into the damping resistance where it is effectively damped.

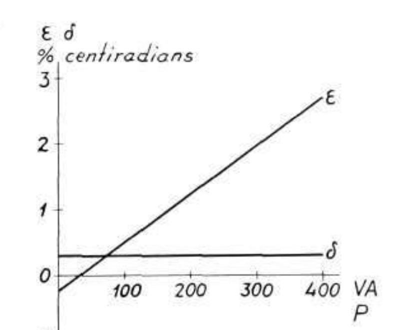
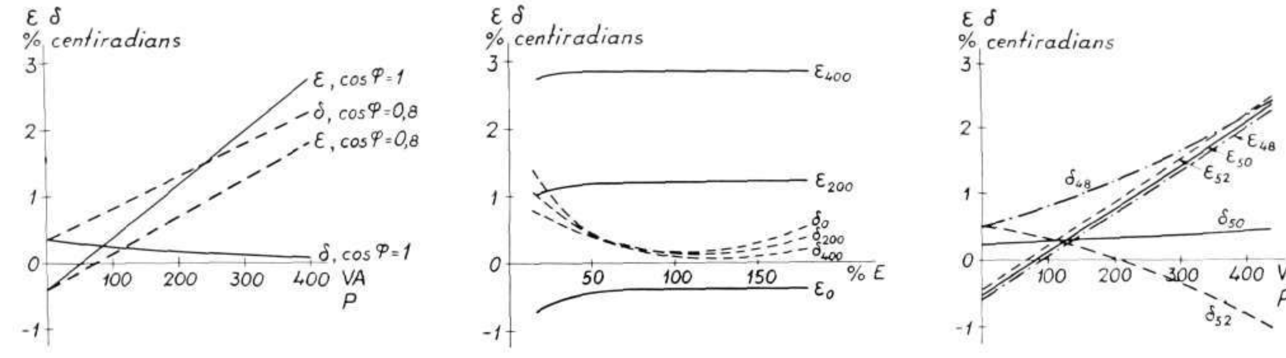


Fig. 3 X 4805

Ratio correction ε and phase error δ for a 385 kV capacitor voltage transformer

Measuring Properties

The measuring properties are characterized by the ratio correction ε and the phase error δ. Fig. 3 shows the manner in which these quantities vary with the load for one of the 385 kV capacitor voltage transformers supplied. In consequence of the resistive voltage drop in the capacitor transformer, ε increases almost linearly with the load whereas δ, the variation of which is principally due to the constancy of the reactance tuning with the load, exhibits a fairly horizontal curve. In view of the fact that the transformer has a variable turn ratio in the form of tappings on the windings, the ε-curve can be displaced in a parallel direction so that the measuring properties at the working point around 50 VA will be as favourable as possible. The curves in Fig. 3 were plotted with a purely resistive load on the transformer. The manner in which ε and δ vary in principle with the phase angle of the load is shown in Fig. 4, left.



X 4806
X 4807
X 4808

Fig. 4

Variation of ratio correction and phase error

left, under load and corresponding power factor; centre, with voltage at no-load, 200 and 400 VA resistive load respectively; right, with frequency within the range 48–52 c/s.

It is important, of course, that the capacitor-transformer should primarily retain its good measuring properties within the range in which the voltage normally varies, and secondarily, at the voltages set up on the occurrence of faults also. Fig. 4, centre, demonstrates that these requirements are satisfactorily met.

As already mentioned, a capacitor-transformer is a tuned aggregate and therefore the measuring properties will obviously be influenced by the frequency to a greater extent than is the case with a magnetic potential transformer. Fig. 4, right, shows how ε and δ may vary with the frequency. Since frequency variations are usually kept within relatively narrow limits under normal conditions, this phenomenon is of minor importance.

On the other hand, the behaviour of the capacitor-transformer under transient phenomena that may arise due to faults in the power network is of great significance. In such cases it is particularly important that the capacitor-transformer should reproduce the voltage variations in the network satisfactorily. That this is actually the case is shown by Fig. 5. When the oscillogram was recorded a comparison was made between the voltages from a resistive potential divider indicated at R in the figure, a normal potential transformer shown at L and a capacitor-transformer indicated at C. The agreement between these three curves is very satisfactory.

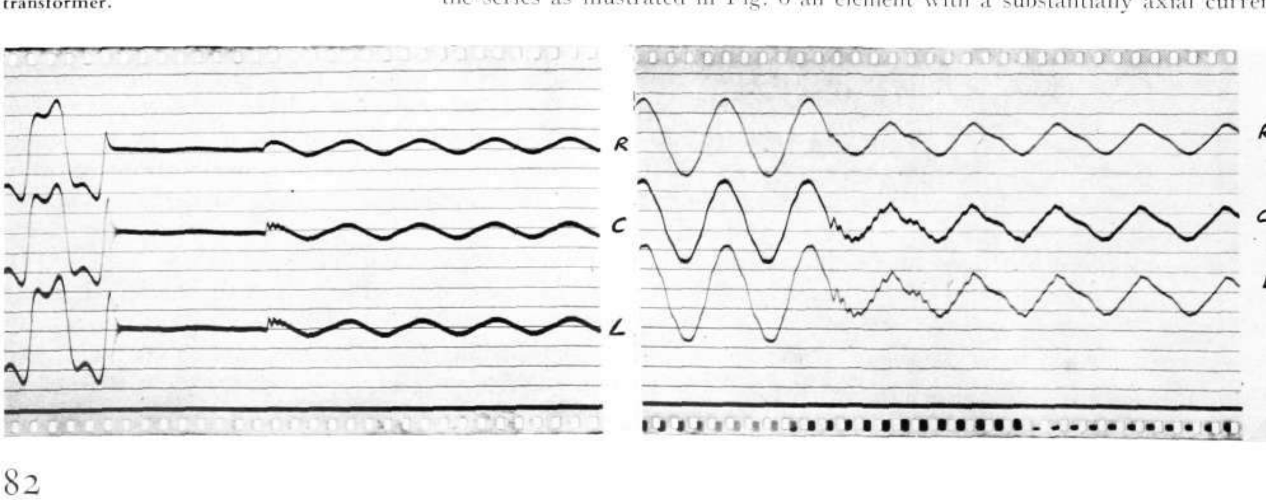
Construction and Manufacture of the Capacitor

The capacitor consists of a number of series-connected capacitor elements enclosed in a porcelain container. The latter is made up of two to four cylindrical insulators joined together. The elements are wound with a special thin paper which forms the insulation, and aluminium foils which form the two electrodes in the element. Each capacitor element contains a number of series-connected sections, the number depending upon the voltage across the element, and each element is wound as shown in Fig. 6. In order to obtain high dielectric strength in a capacitor thin layers of insulation should be employed which will result in a large number of series-connected part-capacitances which are small from a geometrical point of view. By arranging the series as illustrated in Fig. 6 an element with a substantially axial current

Fig. 5 X 7619

Performance at transient voltages

The curves *R* show the network voltage measured with a resistive potential divider, the curves *C* the same voltage measured with a capacitor-transformer and the curves *L* the voltage measured with a normal potential transformer.



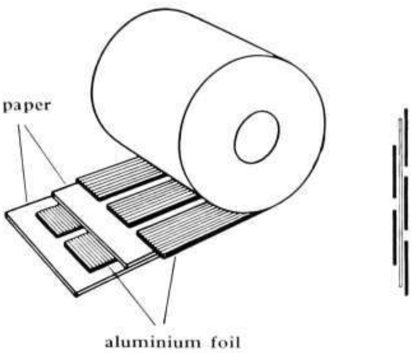


Fig. 6 X 4809
Construction of a capacitor element

flow is obtained, that is to say, the inductance will be as low as possible, this fact being of value when the capacitor is subjected to overvoltages.

After being mounted in the container, the capacitor elements are dried at about 115° C in a high vacuum for several days so that practically the whole of the moisture in the paper is removed. The capacitor is then filled under vacuum with mineral oil and sealed.

An expansion device is mounted at the top of the capacitor consisting of a series of closed, air-filled bellows the purpose of which is to take up variations in the volume of the oil and also to maintain a certain excess pressure in the capacitor. Thus, in this form of construction there is no contact between the gas and oil and the latter which is practically free from gas when it is first filled in, retains its good electrical properties. In addition, the excess pressure is accompanied by high dielectric strength.

These capacitors are usually connected directly to the power network without the installation of intermediate switches, and under ordinary conditions they can only be disconnected when the line is dead. Consequently any fault arising in them implies a disturbance in the network which may result in a breakdown in the power supply. In order to eliminate the causes of faults the capacitors are somewhat amply dimensioned in the first instance and are also subjected to a thorough test before they are passed for delivery.

The test comprises a check to ensure that the paper, aluminium foil and oil are in accordance with the prescribed demands. For example, the paper is tested with regard to the number of conductive particles, losses and electrical breakdown value. The oil is tested for its insulating properties and losses at different temperatures and the aluminium foil is examined to ensure that it is free from grease that may have been used in rolling it, since this grease may have an unfavourable effect on the quality of the impregnating oil during service.

The acceptance tests include, firstly, the checking of the capacitance and measurement of the losses the value of which is a measure of the efficiency of the drying and impregnating processes. In addition, voltage tests are made which consist of a discharge test and an A.C. voltage test. For the discharge test the capacitor is charged with a D.C. voltage up to the value of the testing voltage and is then discharged through a spark-gap connected in parallel with the capacitor. This test replaces an impulse test employed for the majority of other apparatus used in power engineering. The impulse test is difficult to carry out on standard lines as the capacitance of the capacitor is so great in most cases that very large capacitances would be required in an impulse generator to produce the correct form of surge. Moreover, the discharge test is considered to be more stringent than the impulse test at the same voltage. The A.C. voltage test which is carried out after the discharge test is followed by the re-measurement of the capacitance to confirm that no sections in the capacitor have been punctured during the test.

The discharge and A.C. voltage tests are performed in accordance with the regulations prescribed in SEN 30, Standards for Insulation of Electrical Installations and Equipment for System Voltages of more than 600 Volts, particulars of which are given in Table I.

Table I. Capacitor Test Voltages

System voltage kV	Insulation class K_S	Discharge test kV	A.C. voltage test kV
50	275	275	121
70	375	375	165
100	525	525	231
120	625	625	275
150	775	775	341
200	1025	1025	451
380	1775	1775	780

Apart from the tests described above which are general tests, a number of type tests are made the purpose of which is to confirm that the capacitor satisfies the general stipulations with respect to reliability in service, strength of external insulation, etc. made for a capacitor of the type in question. The most important test in this connection is the thermal stability test which is carried out by running the capacitor for 48 hours at 20 % overvoltage in a room at a temperature of 35° C and exposed to radiation which is equivalent to the radiation of the sun during two 8-hour periods. In the course of the test the losses in the capacitor must not increase by more than 10 % of the losses figure after a testing time of 15 hours. During the first part of the test a reduction in the losses usually sets in owing to the fact that the temperature rises in the capacitor, and it is for this reason that the losses figure at the beginning of the test has not been selected as a starting point for assessing stability.

Similarly to practically all other apparatus employed in a power network, a capacitor must be provided with some form of protection. No apparatus is absolutely perfect and faults may occur notwithstanding all precautionary measures. Thus, it is necessary to detect the fault in good time and take steps of such a nature that the damage will be restricted and a breakdown in service avoided. Consequently, all capacitors of this type are fitted with excess pressure protection in the form of a manometer with a contact which enables a signal to be given when the pressure in the capacitor exceeds the permissible value. A fault in these capacitors always causes a certain increase of pressure but the pressure rises relatively slowly owing to the fact that the numerous series-connected sections limit the current. Ample time is thus available for taking the steps necessary to avoid a breakdown.

Arrangement of the Capacitor Voltage Transformers

For voltages up to 220 kV the capacitor-transformers consist of one capacitor unit and a separate transformer. They are usually mounted on pillars so that the current-carrying parts are located at a safe distance from persons on the ground. For 385 kV it was found preferable to construct the capacitor part of the equipment in the form of two series-connected units as shown in Fig. 2. One capacitor unit is then mounted on a steel pillar in the usual way whilst the other is mounted on an insulating column for 200 kV. Both capacitors are fitted with excess pressure protection, and one of them is therefore provided with a pressure pipe which passes down the oil column to a manometer at the top of the steel pillar.

Capacitor Voltage Transformers Delivered

The manufacture of capacitor-transformers was begun in 1931 and since that time the following number of aggregates have been delivered or are on order:

Voltage kV	Capacitance μF	No. of single-phase units
55	0.08 —0.11	87
66	0.06 —0.11	26
77	0.03 —0.05	62
110	0.02 —0.025	305
132	0.017—0.025	172
220	0.010—0.017	282
385	0.06	46

Electricity Meters for Alternating Current

H LUNDSTRÖM, L M ERICSSONS MÄTINSTRUMENT AB, STOCKHOLM

U.D.C. 621.317.785

In recent years apparatus with a continually increasing power consumption has been coming into use both for domestic purposes and industry, apart from the smaller types of electrical apparatus formerly employed. In many instances this has led to a demand for electricity meters capable of carrying heavy loads.

Ermi has now entered the market with an entirely new series of meter types both for single-phase and three-phase systems, which are constructed for heavy loads and are of the most up-to-date design. Particular attention has been paid to accuracy and to simplicity of construction. The dimensions have been kept within the same low limits as Ermi's earlier types.

Single-phase Meters

Ermi now manufactures single-phase meters in two different designs, type *VEN 18 G*, Figs 1 and 2, and type *VEN 19 G*. The single-phase meter type *VEN 18 G* has a brass cover and an iron back plate, while type *VEN 19 G* is mounted in a case of moulding material. By developing two different series Ermi is now in a position to meet varying requirements.

In other respects both types of meters are exactly similar and possess the same excellent characteristics. Type *VEN 19 G*, however, is constructed only for 5 and 10 A ratings.

Both the frame and brake magnet have an aluminium-bronze finish which presents an attractive appearance while at the same time it offers an advantage with regard to the inspection of the meters. Any dirt in the meters is more readily apparent against the white surfaces. (In *VEN 18 G* the inside of the back plate is also finished in aluminium-bronze.)

The brake magnet is manufactured from carefully tested Alnico-steel having a high coercive force, good stability and high resistance to short circuit currents. When calibrating the meter the brake magnet can be continuously regulated with the help of an eccentric.

Compensation for inductive loading is provided by an adjustable resistor moving in an adjustment clamp. As this clamp is rigidly fixed to the frame it offers a convenient support during calibration and facilitates the latter operation.

The friction compensator (for adjustment at low load) is provided with micrometer adjustment.

All calibrating members are continuously adjustable and are accessible from the front, thus rendering calibration of the meter convenient and simple. Each part is stamped with a clearly visible sign providing a guide for calibration.

The counter has six figure wheels, the last of which is calibrated in hundredths. The figures are white on a black ground and therefore easy to read. The position of the counter is fixed by means of two guide pins on the frame.

Owing to the fact that the counter is designed with six digit drums, the meter complies with the »Standards for Electricity Meters», Par. 4, both as regards recording and the number of decimal points.

Fig. 1 X 4797
Single-phase meter, type VEN 18 G

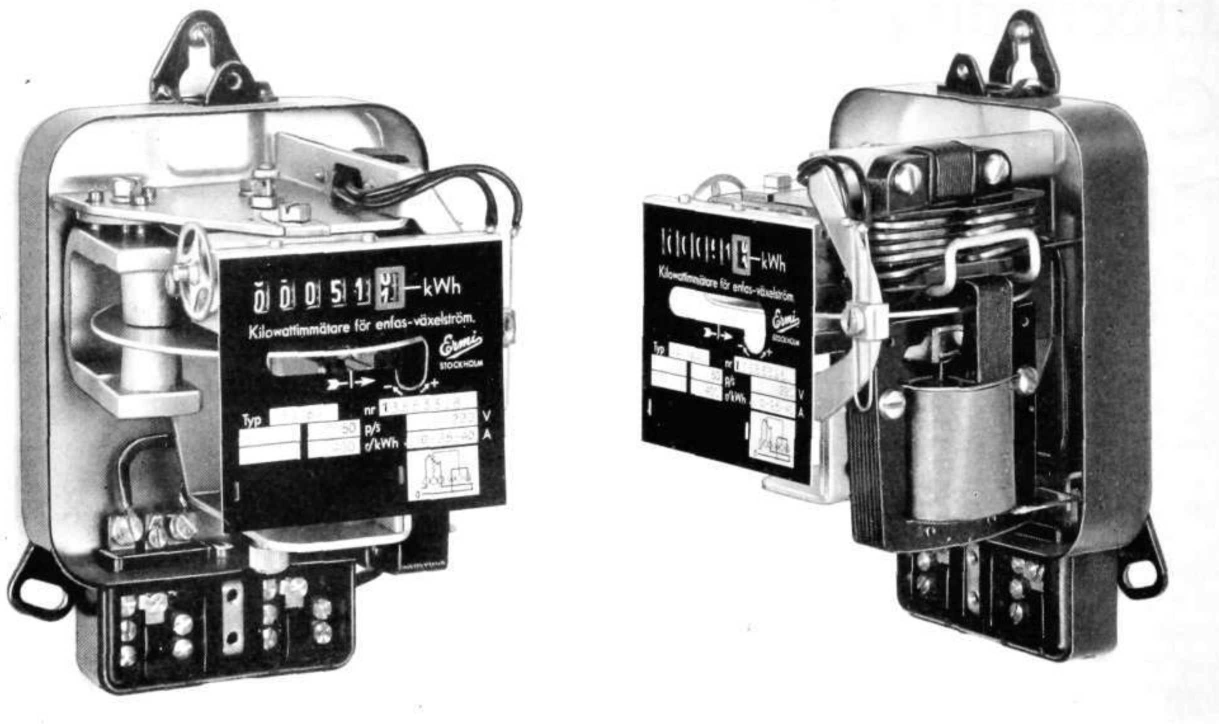


Fig. 2 X 7616

Single-phase meter, type VEN 18 G with cover removed

All necessary data are stamped on the counter plate, which also allows space for an owner's name plate having the dimensions 10 × 40 mm.

The thread of the bottom bearing bush for fixing the bearing in the frame is of very fine pitch, so that it is possible to adjust the position of the rotor disc in the air gap very accurately.

To facilitate connection of the meter, the terminal panel is provided with conical holes. The transition from the moulding material to the connecting terminal itself takes place without presenting any obstructive edges.

All parts of the meters are readily accessible for inspection and are of practical construction.

Technical Data for Single-phase Meters, Types VEN 18 G and VEN 19 G

System: Ferraris

Torque at nominal load and cos φ = 1: approx. 4.2 gcm

Weight of rotor: 23 g

Speed of rotor at nominal load: 15—19 r.p.m.

Voltage drop in current system at nominal load: nominal current

5 A—approx. 0.12 V
10 A—approx. 0.06 V

Power consumption in voltage system: approx. 0.6 W

Starting power: max. 0.5 % of nominal load.

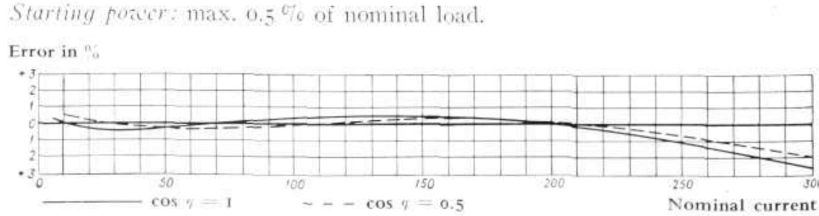
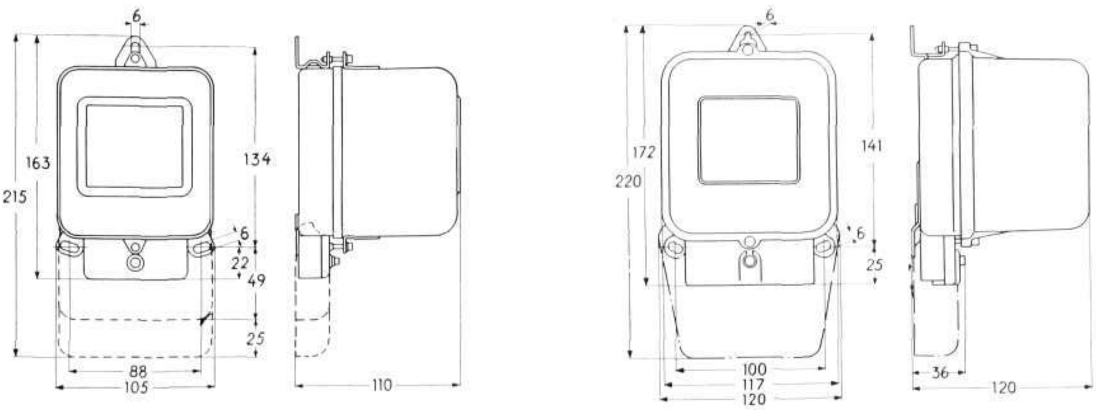


Fig. 3 X 6680

Error curves for single-phase meters, types VEN 18 G and VEN 19 G, 50 c/s



X 6690
X 6691

Fig. 4

Dimension sketches for single-phase meters, types VEN 18 G, 5—10 A (left) and VEN 19 G, 5—10 A (right)

Nominal current	5 A	10 A	20 A	50 A
Measurement limit	13 A (260 %)	25 A (250 %)	50 A (250 %)	100 A (200 %)
Thermal limit	20 A (400 %)	40 A (400 %)	60 A (300 %)	100 A (200 %)
Maximum fuse	15 A	25 A	50 A	80 A
Maximum connector area	10 mm²	10 mm²	25 mm²	25 mm²

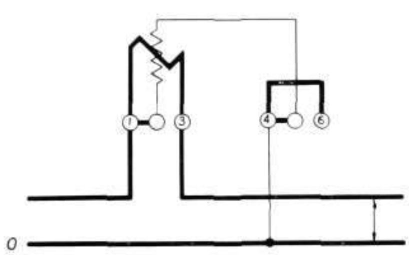


Fig. 5 X 4800

Circuit diagram for single-phase meters, types VEN 18 G and VEN 19 G (single-pole connection)

The designations »measurement limit» and »thermal limit» relate to the Swedish Electrotechnical Standards for Electricity Meters, SEN 32—45, in which it is stated that:

The measurement limit is the maximum current at which the meter fulfils the regulations prescribed by the standards with respect to error indication which may not exceed ± 2.5 %.

The thermal limit is the maximum current with which the meter can be loaded continuously without exceeding the temperature rises prescribed in the standards and without causing a change in the characteristics of the meter after the disconnection of the load.

As a guide to the selection of a suitable meter the maximum size of fuse that can be employed for the meter has been indicated in the table. The fuses given in the table refer to Swedish standard, which in this case is based on the German diazed system.

According to the regulations in force for fuses, the latter should be capable of withstanding a given current (testing current) for a period of at least one hour without breaking down.

On the basis of the above data the meters have been dimensioned in such a way that their measurement and thermal limit correspond to the nominal and testing currents for the fuses.

The meters thus fulfil the requirements made with respect to measurement and heating.

Voltage error: ∓ 0.7 % with ± 10 % voltage fluctuation between 10 % and 100 % of the nominal load, cos $\varphi = 1$

Voltage error: ∓ 1 % with ± 5 % voltage fluctuation between 10 % and 100 % of the nominal load, cos $\varphi = 1$

No load operation: Permissible voltage fluctuation without causing the meter to register on voltage only: 20 %

Test voltage: 2 kV alternating current

Total weight: Type VEN 18 G — 1.4 kgs for 5 and 10 A
1.7 kgs for 20 and 50 A
Type VEN 19 G — 1.3 kgs for 5 and 10 A

Connection: 1- or 2-pole

Fig. 6 X 4798

Three-phase meter, type VKN 12 G

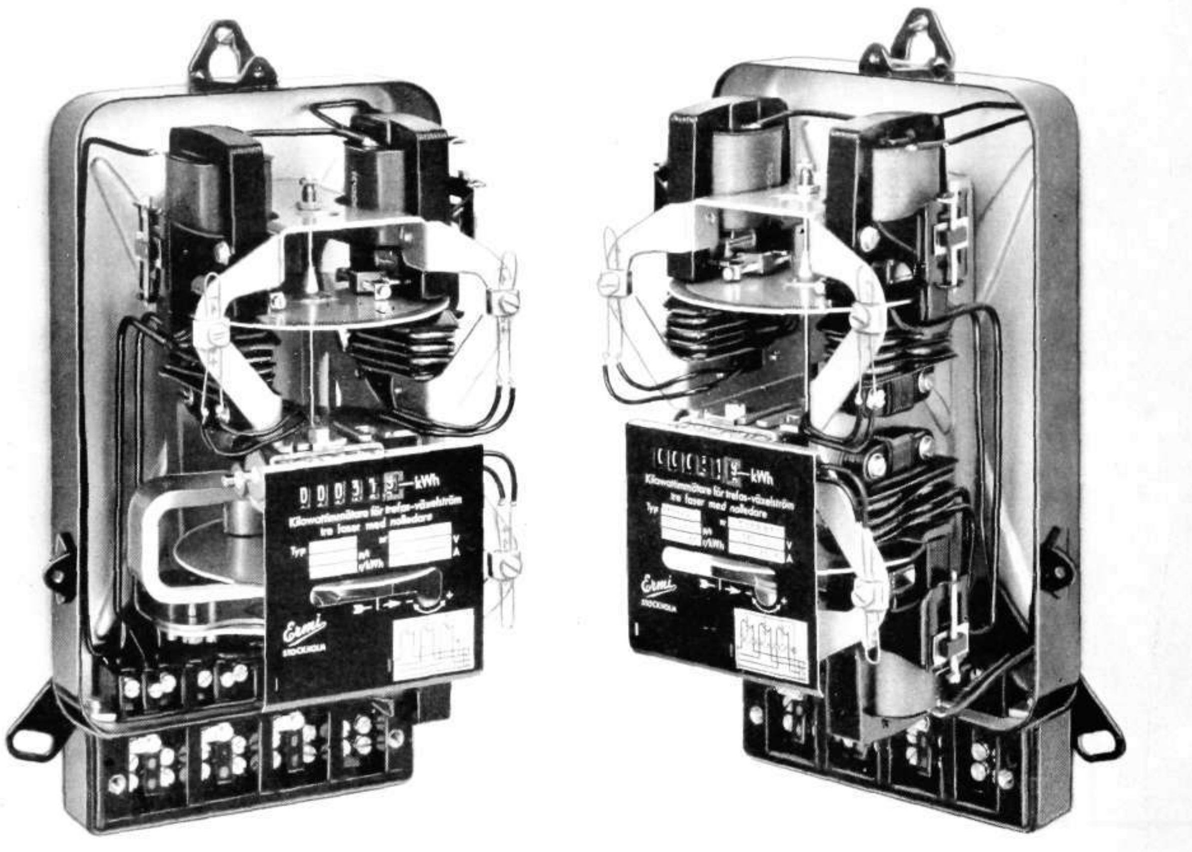


Fig. 7 X 7617

Three-phase meter, type VKN 12 G with cover removed

The counter has six figure wheels, the last of which (*i. e.*, on the extreme right) is calibrated in hundredths.

Standard Design

Nominal voltage: 110, 120, 127, 150 190, 220 and 380 V.

Nominal currents: VEN 18 G, 5, 10, 20 and 50 A
VEN 19 G, 5 and 10 A

Nominal frequency: 50 c/s

Three-phase Meters

The three-phase meters, type *VKN 12 G*, Figs 6 och 7 can be heavily loaded to the same extent as the single-phase meters. See table on page 89.

The same principles have also been followed in their design, that is to say, all parts are conveniently accessible for inspection. This is of special importance when overhauling the meters.

The three-phase meters have several parts in common with the single-phase types, such as the bearings, the calibrating devices and counter which have been described earlier in this article. Among their more prominent features reference may be made to:

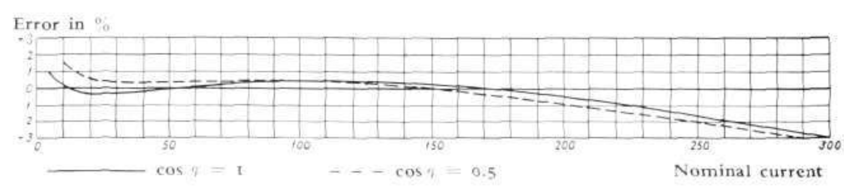


Fig. 8 X 6692

Error-indicating curves for three-phase meter, type VKN 12 G cos φ 50 c/s

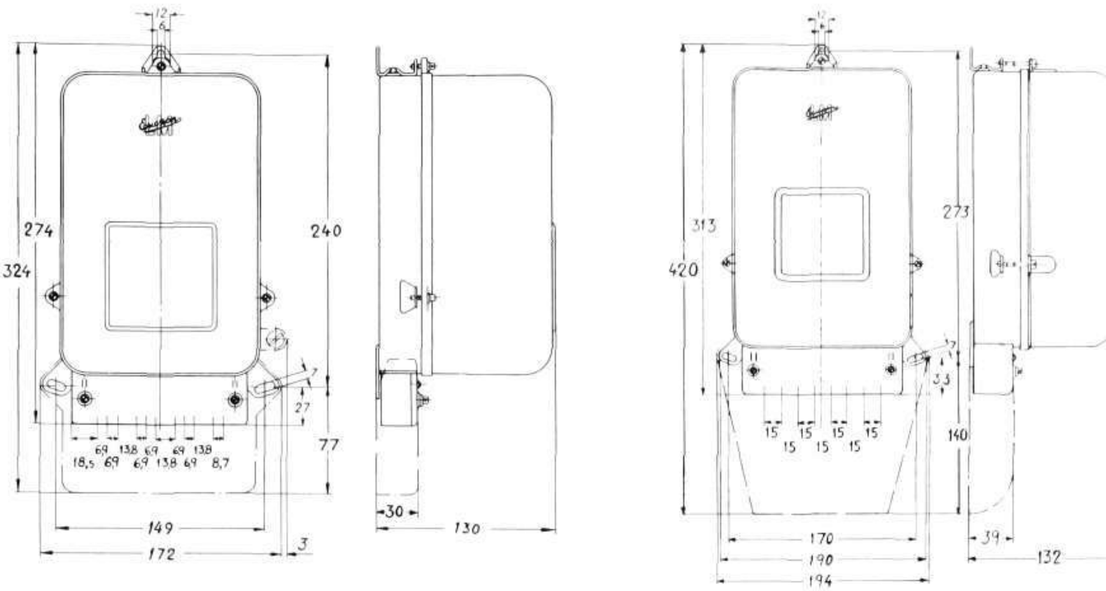


Fig. 9 X 6693 X 6694

Dimension sketches for three-phase meter, type VKN 12 G

left, for 5—20 A and right, for 50 A

The aluminium-bronzed frame and aluminium-bronzed back plate (inside). The Alnico magnets.

All calibrating members are continuously adjustable and are accessible from the front, and consequently, the three-phase meters can also be calibrated with convenience and facility.

The terminal panel is constructed with conical holes and without obstructive edges between the moulding material and the brass terminal. The holes are amply dimensioned.

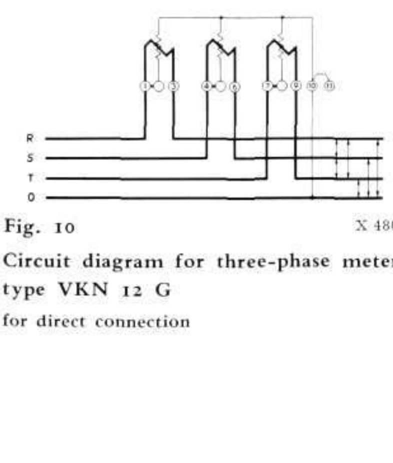


Fig. 10 X 4801

Circuit diagram for three-phase meter, type VKN 12 G

for direct connection

Technical Data for Three-phase Meters Type VKN 12 G

Three driving systems in three wattmeter connection

System: Ferraris

Torque at nominal load and $\cos \varphi = 1$*:* 5 and 10 A — approx. 8 gcm
20 A — approx. 9 gcm
50 A — approx. 11 gcm

Weight of rotor: approx. 60 g

Speed of rotation at nominal load: approx. 16—22 r. p. m.

Voltage drop in current system at nominal load:

nominal current	5 A	—	approx.	0.04 V
»	10 A	—	»	0.02 V
»	20 A	—	»	0.02 V
»	50 A	—	»	0.02 V

Power consumption in voltage system: approx. 0.6 W

Starting power: max. 0.5 % of nominal load

Nominal current	5 A	10 A	20 A	50 A
Measurement limit	13 A (260 %)	25 A (250 %)	50 A (250 %)	100A (200 %)
Thermal limit	20 A (400 %)	40 A (400 %)	75 A (375 %)	125A (250 %)
Maximum fuse	15 A	25 A	60 A	100 A
Maximum connector area	16 mm²	16 mm²	16 mm²	35 mm²

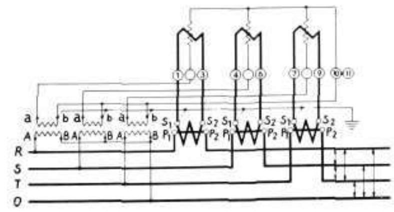


Fig. 11 X 4802

Circuit diagram for three-phase meter, type VKN 12 G

for connection through current and potential transformers

The designations »measurement limit» and »thermal limit» relate to the Swedish Electrotechnical Standards for Electricity Meters SEN 32—45. In other respects reference should be made to the particulars given under the table for single-phase meters. The fuses given in the table refer to Swedish standard, which in this case is based on the German diazed system.

Voltage error: With $\pm$ 10 % voltage fluctuation between 10 % and 100 % nominal load, $\cos \varphi = 1$, the error indication varies about 1 %

Frequency error: With $\pm$ 5 % frequency variation between 10 % and 100 % rated load, $\cos \varphi = 1$, the error indication varies about 0.4 %

No load operation: Maximum voltage variation without meter registering on voltage alone: 20 %

Test voltage: 2 kV alternating current

Weight per meter: At 5, 10 and 20 A: approx. 3.5 kgs
» 50 A » 4.4 »

The counter has six figure wheels, the last of which (*i. e.*, on the extreme right) is calibrated in hundredths.

Standard Design

Nominal voltages: 110/64, 190/110, 220/127, 380/220 and 500/290 V

Nominal current: 5, 10, 20 and 50 A

Nominal frequency: 50 c/s

Ericsson Novelties

C FREDIN, SVENSKA RADIOAKTIEBOLAGET, STOCKHOLM

U.D.C. 621.396.62

Among the novelties of the Svenska Radioaktiebolaget, for the season 1952—1953, the table sets Rondett and Kvartett and a small radiogramophone, the Pianett, are specially prominent. The small radiogramophones Duett and Spinett, have been extended by the addition of A.C.—D.C. models which, similarly to a new A.C. model of the Duett, can play records of all types. The largest A.C. radiogramophones, the Bankett and Kabinett, are now also available both with three-speed record changer and with built-in magnetic tape recorder.

Ericsson Rondett

The Rondett, Fig. 1, is a small receiver in table model style. It has 6 valves with a magic eye, 6 tuned circuits, three wave-band ranges and band spread on short-wave, a pick-up connection, loud-speaker terminals and a simple tone control.

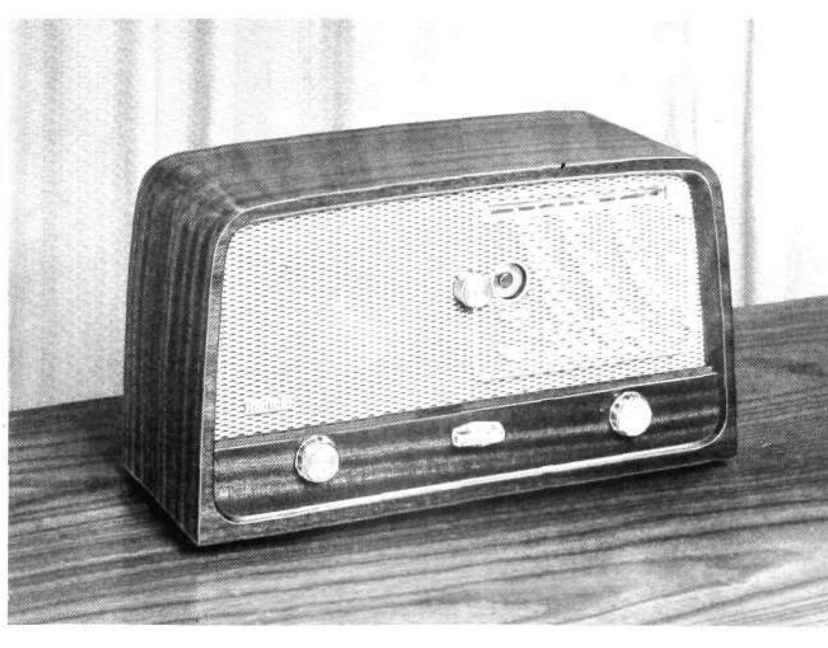
Ericsson Kvartett

The Kvartett, Fig. 2, is a medium-size table model with good sound quality, high sensitivity and satisfactory damping of undesired signals.

The wave-length range runs from 13 m on the short-wave to 580 m on the medium-wave divided into 6 partial bands. The long-wave begins at 690 m and goes up to 2,000 m. The receiver has 6 valves including a magic eye, 7 tuned circuits, pick-up connection and terminals for external loudspeaker.

Specification

Sensitivity:	approx. 10 μV input voltage gives 50 mW output
Selectivity:	approx. 18 kc/s band width at 40 dB
Output:	approx. 3 W
Loudspeaker:	type HK 1018, diameter 7½"
	flux density 10.000 gauss
	impedance 4 ohms
Finish:	highly polished Sapeli- or matt Honduras
	mahogany and walnut.
Type designation:	1524 V



X 6699

Fig. 1

Ericsson Rondett

The controls are, from left to right: combined off-on switch and volume control, knob for wave-band range and band-spread and tuning knob.

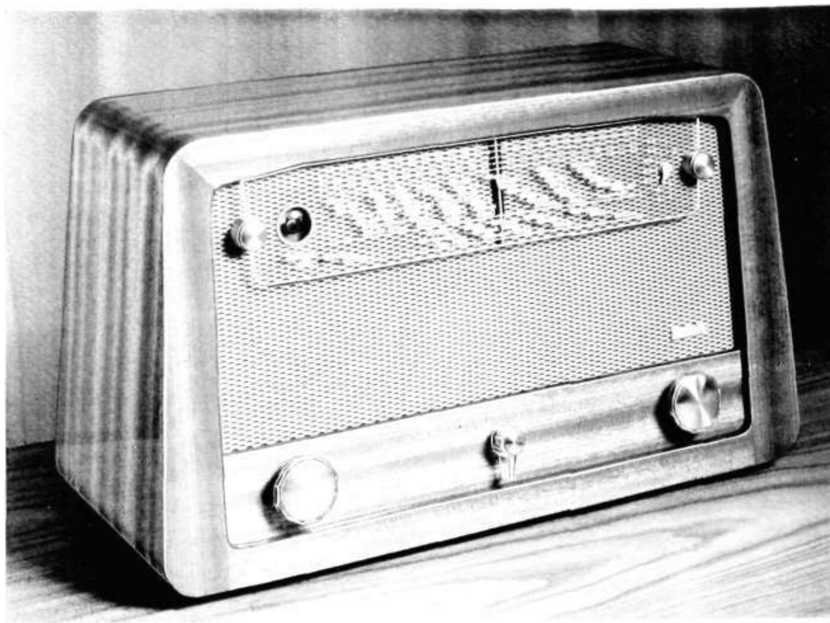


Fig. 2 X 6701

Ericsson Kvartett

The controls are, from left to right: volume control, off-on switch with tone control and combined tuning- and wave-band switch.

Ericsson Pianett

The Pianett, Fig. 3, is a small radiogramophone with fine modern lines and practical design. In all essential details the high-frequency section of the receiver includes the same parts as those employed in the Kvartett. On the other hand, the audio-frequency part of the receiver differs from that of the latter. It comprises a correction valve for the pick-up, phase inverter and a push-pull output stage.

The upper part of the radiogramophone houses the receiver and loudspeaker. The lower part which contains the record changer and record compartment is accessible after pushing aside the roller shutters. The record changer is in

Fig. 3 X 7624

Ericsson Pianett

left: with roller shutters closed. The controls are from left to right: volume control, tone control, off-on, radio-phone-switch control, combined tuning- and wave-band switch.

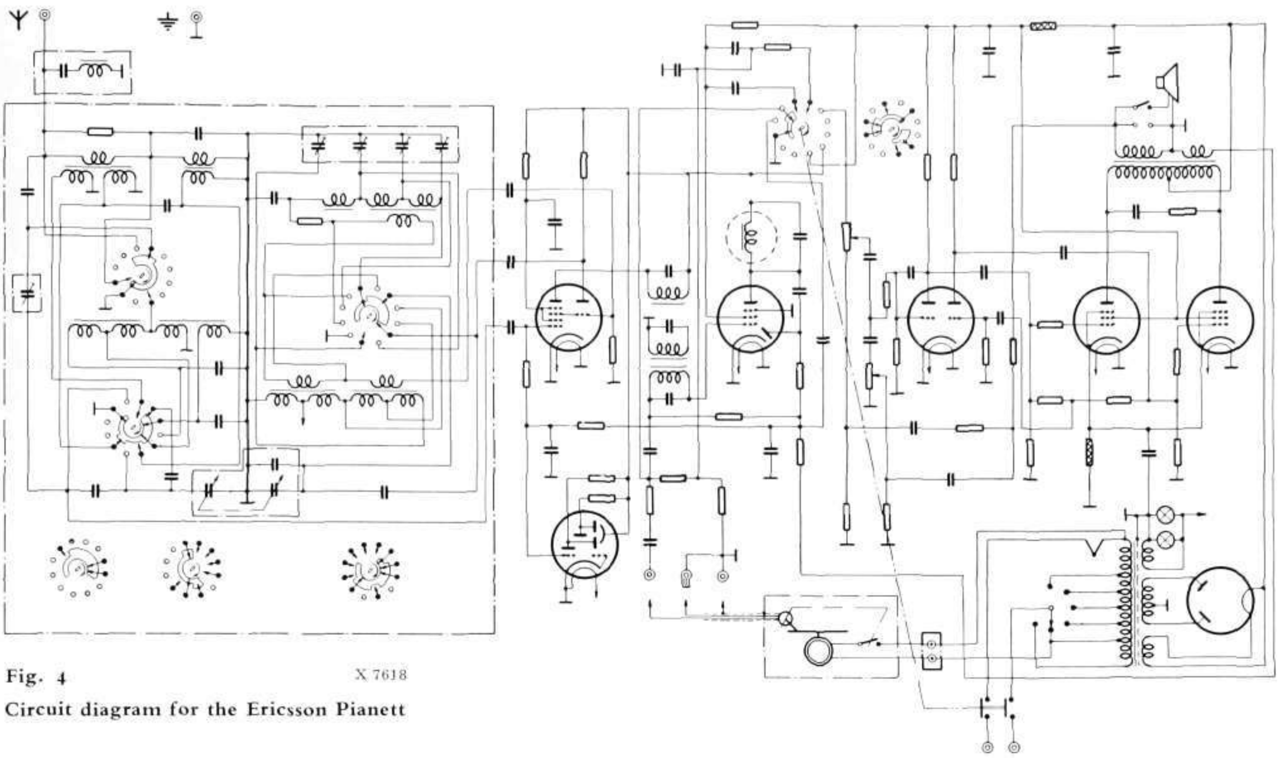


Fig. 4 X 7618

Circuit diagram for the Ericsson Pianett

the form of a draw-out unit. It can be set to take records of all types and changes them silently and rapidly. The pick-up is of the light-weight type with a permanent sapphire.

Specification

Output:	approx. 7 W
Loudspeaker:	type HK 1021, diameter 8½"
	flux density 10.000 gauss
	impedance 4 ohms
Finish:	Matt natural colour or highly polished
	Sapeli mahogany
Type designation:	2527 V

Radiogramophones with Magnetic Tape Recorders

The largest radiogramophones, the *Kabinett* and *Bankett*, are also available this year with a built-in magnetic tape recorder, Fig. 5. The accessories delivered include a microphone and two reels, one reel supplied with tape.

The tape is of such a width that there is space for two recording channels. Each channel has a recording time of 30 minutes. Rewinding or removal to a given point in the recorded program is 20-times as fast as the actual recording. The time spent in rewinding is thus reduced to 1½ mins.

It is possible to record programs from radio, phonograph records or microphone. A specially designed magic eye simplifies the operation.

The tape is ½" in width and the maximum length taken up on one reel is 1,100 ft. The tape consists of a non-magnetic plastic base .0015" thick coated with a thin (about .0006") layer of magnetic material.

The tape recorder has an oscillator for a frequency above the limit of audibility and an amplifier for microphone, radio and pick-up. The oscillator- and audio-frequency are fed to a recording head located centrally between the tape reels.

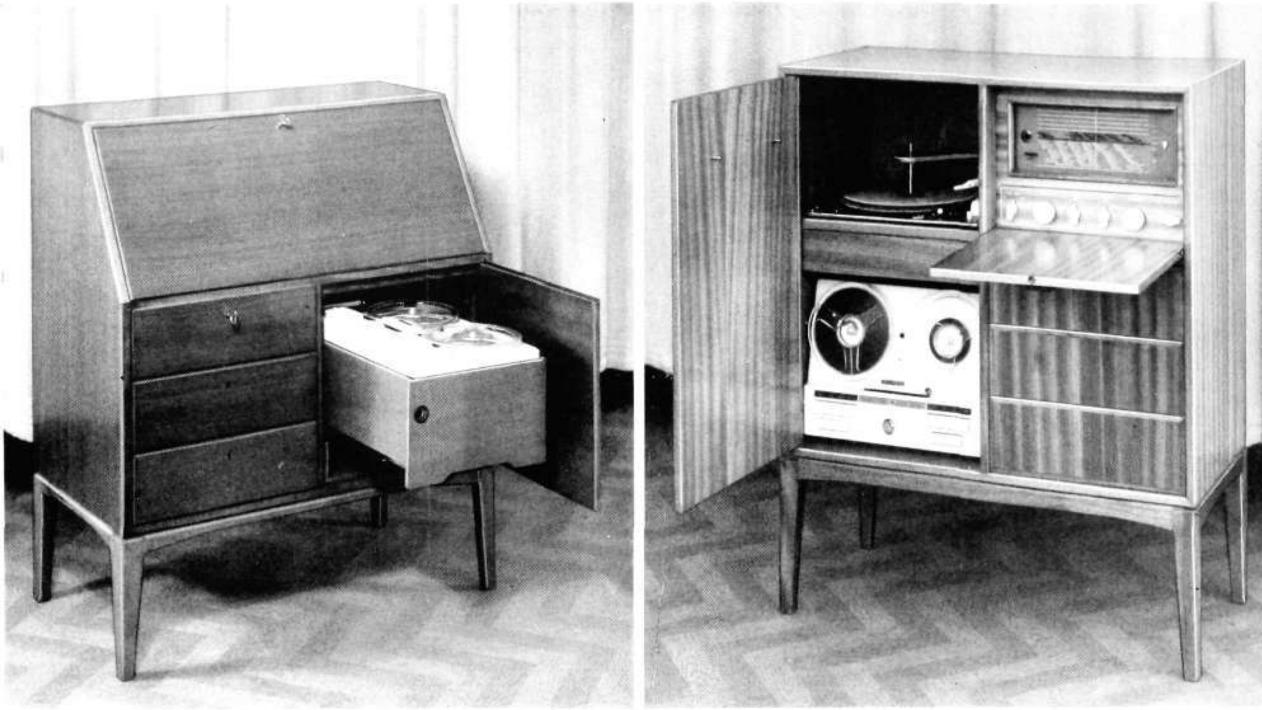


Fig. 5 X 7623

Ericsson Kabinett and Bankett with built-in magnetic tape recorder

Left: Kabinett with tape recorder mounted horizontally; right: Bankett with tape recorder mounted vertically.

When the tape passes over the field of the oscillator during recording, the previous recording is eliminated. Immediately afterwards the tape passes through a narrow gap on the recording part of the head and is magnetized by means of the audio-frequency.

After rewinding, the process is repeated but in the latter case the head acts as a generator. The signal is amplified and fed to the radiogramophone.

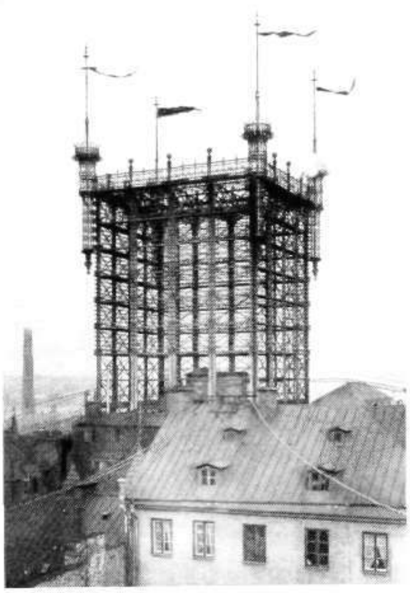
The principle of employing tape in place of wire for magnetic recording represents an improvement in many respects. The wire is too thin (.004") to handle easily, nevertheless it is too thick for satisfactory frequency response. Distortion and variations in the sound level may occur if the wire rotates. A broken wire often leads to a snarl impossible to untangle. Furthermore it is not easy to tie the broken ends together in a knot when the wire is so fine.

Among the advantages which render tape superior to wire, the foremost are its durability and the simple manner in which splicing can be carried out. Cuts may be made and a program compiled according to requirements, splicing then being effected with tape. The tape also possesses excellent electrical properties, however, such as a good frequency response and high signal-to-noise ratio.

Ericsson LM NEWS *from* *All Quarters of the World*

Disappearance of the Stockholm Telephone Tower

One of the outstanding silhouettes of the Stockholm sky-line, the telephone tower on the premises of the Telegraph Administration at Malmskillnadsgatan will shortly disappear. The



Several thousand bare wire lines radiated from the telephone tower. For 20 years the tower was the centre for all lines to the telephone exchange at Malmskillnadsgatan but in the beginning of this century the overhead lines were replaced by underground cables.

dismantling of this dominant structure is already in progress and the first thing to go was the large clock on the top of the tower, which was erected by L M Ericsson 13 years ago.

The dismantling of the tower was decided on last summer after a violent outbreak of fire in the building below. It was established on investigation that the steel structure had been badly damaged by the heat and that it would not be safe to let the tower remain. The experts advised demolition which was immediately started. Had it not been for the fire the tower would no doubt have been left intact for many years to come although it would eventually have had to go in conjunction with a proposed road widening scheme for this district. The telephone tower was completed 1887 and was erected by Motala Verkstad for Stockholms Allmänna Telefonaktiebolag, who had their Stockholm telephone exchange in the same building. Stockholms Allmänna Telefonaktiebolag was 1918 merged with AB L M Ericsson & Co. In 1918 the Telegraph Administration bought up the telephone installations belonging to AB Stockholmstelefon—a subsidiary to Stockholms Allmänna Telefonaktiebolag—and the telephone tower then became the property of the Telegraph Administration.

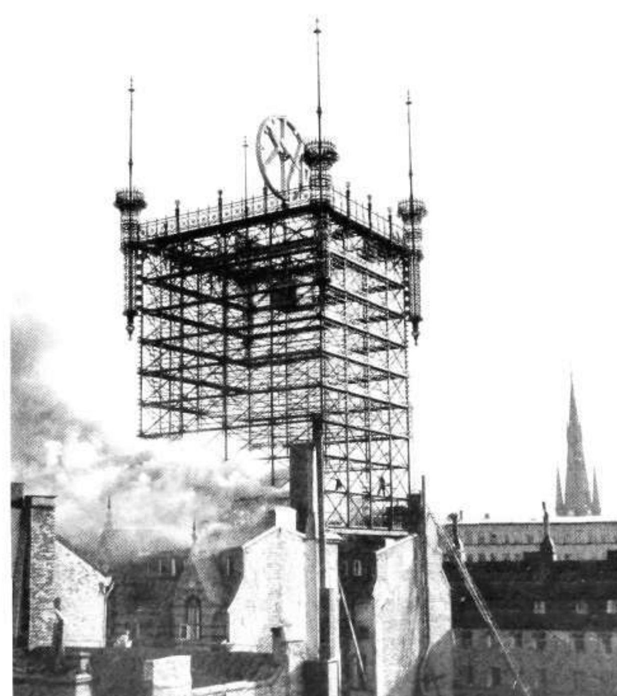
The tower in those days served as a giant crossarm gathering all the overhead lines from subscribers in the Vasa, Östermalm, Kungsholmen and the North districts. In addition the junction lines to the satellite exchanges radiated from this point. The

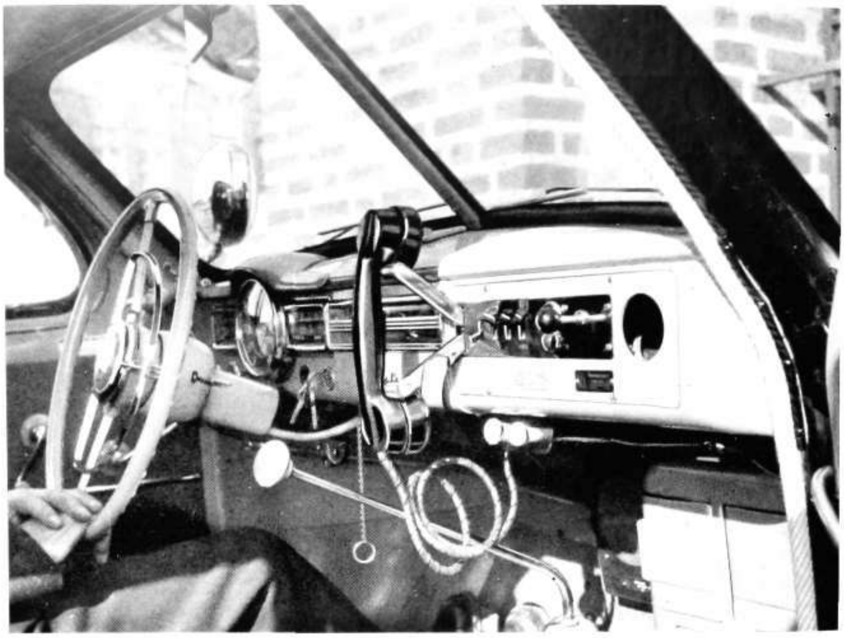
The telephone tower in the original state before the four corner spires were added.

number of lines to the tower increased year by year and eventually, according to a gossip writer, »darkened the sky over Stockholm». This tower became one of the sights of the town and a visible testimony of the astonishing intensity of the telephone traffic in the Swedish capital. The tower was used for its original purpose during 20 years until the overhead lines gradually were replaced by underground cables.

The telephone tower was from the beginning a landmark which always attracted the interest of the public. Originally the tower had a rather truncated appearance but in order to appease public clamour for something

The whole telephone tower was enveloped in a dense cloud of smoke when the building was ravaged by fire.





Radio Cars Directing Stockholm Trams

Stockholm Tramway Corporation have purchased two radio cars for traffic supervision and control and intend to put a further three cars in operation shortly. Svenska Radioaktiebolaget have delivered wireless equipment which has been fitted in small Volvo cars as these have proved to be excellent in the congested Stockholm traffic. One of the cars is stationed in the North of Stockholm whereas the other is patrolling the southern districts of the town.

The two radio cars are in operation from 5 o'clock in the morning to 1 o'clock at night and are patrolling the city in order to be available whenever traffic congestions occur. On these occasions they are assisting the traffic control headquarters by redirecting trams and busses, making loudspeaker announcements to passengers and helping in repair work.

The repair cars are also directed by radio. These rolling workshops are equipped with radio equipment enabling them to be in constant touch with the headquarters.

Telephone Exchanges for Brasil and Morocco

The Moroccan telephone exchange at Tangier, supplied by L M Ericsson some years ago, will be extended with a further 2.000 lines. The exchange is equipped with 500-line selectors.

In Brasil L M Ericsson will erect automatic telephone exchanges with 500-line selectors in the cities of Patos de Minas and Itaberia.

To Las Cumbres in Panama and to Calcutta in India L M Ericsson will deliver rural exchanges with crossbar switches.

The northernmost automatic telephone exchange in Sweden supplied by L M Ericsson is to be found in Kiruna. It was opened October 1950 and was then the most northernly in the world. The Kiruna exchange is equipped with 500-line selectors and covered 2.500 lines. It will now be extended with a further 1.000 lines.

more attractive the structure was provided with four corner spires.

The prominent position of the tower made it a natural signal post and it was frequently used to announce a variety of events. The hoisting of a yellow flag was for instance a signal that the »flying baron» could take off in his flying machine from Gärdet as arranged and a white flag marked with a big S announced that there was herring in plenty to be had at the fishmongers. At the end of the twenties the tower was glaringly illuminated by advertisements for popular weekly magazines and 13 years ago it was let to Nordiska Kompaniet who added a revolving clock to the tower. The clock was supplied and installed by L M Ericsson. Since then the gigantic hands have completed a considerable number of revolutions over the 23 feet wide dial. When the fire played havoc with the tower this did not seem to effect the clock appreciably. Surrounded by a cloud of thick smoke it continued to revolve and to show the right time for a couple of hours until it was stopped on the request of the fire brigade.

From Our Visitors Log Book

The ambassador of Great Britain in Stockholm Sir R B Stevens and wife recently visited the L M Ericsson factory at Midsommarkransen. An hour was spent on a tour round the offices and the works. In the illustration the managing director of the company Helge Ericson is showing a model of the factory in the showroom to the ambassador and his wife.

Emergency Telephones in Helsinki

The city of Helsinki, Finland, has placed an order with O/Y L M Ericsson A/B for about 600 emergency telephones enabling the public to call the fire brigade, police, ambulance or doctor in case of fire, accidents &c. During the summer 150 of these telephones have been installed.

All emergency telephones in the city and the incorporated districts are connected to an emergency centre in the Helsinki telephone administration. From the centre direct junctions are available to instruments at the fire brigade, police station &c and the traffic over the emergency centre is consequently independent of the public telephone system.

Calling signal is transmitted from the emergency telephone when the door handle of the instrument cover is pressed. A seal is broken and the door can be opened. The call is carried out over the handset in the normal manner and the emergency caller states what assistance he requires. At the same time he states the station number or the address. When the appropriate authority has been connected, further information will be presented regarding the emergency.

L M Ericsson will also supply a total of 250 emergency telephones to certain other Finnish towns such as Pori, Rauna, Pietarsaari and Kokkola.

New Automatic Telephone Exchange in Katrineholm

On September 14th the Katrineholm automatic telephone exchange was put into operation. The new exchange is number 20 in size in Sweden and is equipped with the L M Ericsson 500-line selector with crossbar switch registers. At present Katrineholm has about 2,500 subscribers, but the new exchange will cover 7,500 lines when fully extended.

An automatic exchange for 2,000 lines at Klippan was put into operation at the end of the same month.

Efficient Fire Watch with Ion Detectors

The Kville shed in Gothenburg, one of the biggest warehouses in the docks of Gothenburg has been equipped with a fire alarm system with ion detectors which is the largest so far installed in Sweden. The efficiency of the system was demonstrated at a test fire arranged before a gathering of eminent experts.

The ion detector is a world patented Swiss invention and L M Ericsson has secured the sole rights for this invention for Sweden and a number of other countries. The ion detector has been thoroughly tested during four years in about 10 different trial installations in Sweden and has in all respects came up to expectations.

As distinguished from earlier types of fire detectors, which are operated by heat, the ion detector is effected by ion clusters formed in the air when combustion takes place, or expressed in more popular language the ion detector »smells» the fire and gives the alarm.

Cordless Switching for a Complete Telephone Network

In September this year the new automatic telephone exchange at the Stockholm Tramway Corporation was opened. This exchange will replace the eight manual exchanges which were earlier used and out of which four were attended 24 hours a day.

The new Stockholm Tramway telephone system—one main exchange and four satellite exchanges manned by a few operators—is described in detail on page 77 of this issue. It represents a new feature in telecommunications, as it is the first time in Sweden that cordless switching has been used for a complete network, which is attended by operators in one point only. By the use of satellite exchanges the extent of the network has been considerably reduced as this eliminates the need for all extensions being connected to the main exchange.

The capacity of the complete system is 6,000 extensions, but the installation at present only covers 1,300 extensions. It is equipped with the L M Ericsson 500-line selector with crossbar switch registers.

The small arranged fire on the floor of the Kville shed, was not old when it was discovered by the ion detector. In spite of the high ceiling — 52 feet — and the considerable air space — the floor area is 110 × 27 yards — the ion detector in the ceiling operated after 20 secs only, and four minutes later the fire brigade arrived.

75 Million Telephones

The total number of telephones in the world amounted to roughly 74.8 millions on January 1st 1951. This figure represents an increase of 4.5 million telephones on the previous year.

This information is extracted from statistics issued by American Telephone & Telegraph Co., which also state that ten countries have more than 1 million telephones. These countries are Australia, Canada, England, France, Germany, Italy, Japan, Soviet Russia, Sweden, and U.S.A. Per 100 inhabitants U.S.A. have most telephones, *viz.*, 28.1. Number two on the list is Sweden with 23.9 per 100 inhabitants, next Canada with 20.8, Switzerland 19.1, New Zealand 19.1 and Denmark 16.9.

Just over 51 million telephones, 68.5 per cent, are automatic out of the total number in the world. In Europe, with 21 million telephones, 14.7 millions or 69.4 per cent are dial instruments. South America has the highest percentage of dial instruments; out of 1.8 million telephones 1.5 millions are automatic or 74.7 per cent.

Stockholm, up to 1950 number three among the big telephones cities, based on instruments per head, has now slipped back to fifth position. Of all cities Washington is the most telephone minded with 60.6 instruments per 100 inhabitants, San Francisco in second with 55.5, Atlantic City third with 54.7, Evanston, Illinois fourth with 48.2 and Stockholm fifth with 47.9 instruments per 100 inhabitants.

The total number of telephone calls in the world during 1951 is estimated by the same source to 94 milliards. Out of these 89 milliards are local calls and 5 milliards trunk calls. When it comes to the utilization of the telephone Sweden is third. In U.S.A. 56 milliard calls were put through during 1951 which means an average of 370.6 calls per person. In Sweden the corresponding figures were 2.2 milliard calls and 313.3 calls per person.

At the Fredericia fair last summer the Danish L M Ericsson exhibited a wide range of products which attracted considerable interest.

Burmese visitors

A commission from Rangoon in Burma recently paid a visit to the L M Ericsson works at Midsommarkransen. In the show-room new types of exchanges and telephone instruments were demonstrated.

New Sieverts Catalogue

A new English catalogue, No. 546, covering capacitors for phase compensation has recently been issued by the Sieverts Cable Works. As an introduction a short summary is made of the special properties of capacitors, their function and construction. The following sections contain instructions for the positioning of the capacitors and for calculation of required capacitor effect for the compensation of cos φ to required value. A number of short chapters give recommendations for installation, fitting and connection, advice regarding ambient temperature, discharging devices, capacitor protectors and selection of rated voltages. The end of the catalogue contains descriptions and technical data for different types of capacitors.

U.D.C. 621.395.722

HÄGGÖ, R: *Manual Trunk Exchanges with Cord Pairs.* Ericsson Rev. *29* (1952) No. 3 pp. 68—76.

Telefonaktiebolaget L M Ericsson has developed a trunk exchange system, type AFA 10, for small and medium-sized trunk exchanges, which meets adequately all requirements for a trunk exchange. The system is described in the article which also contains an elementary example of how the number of positions and cord pairs for such a system is calculated.

U.D.C. 621.395.26

LARSON, E: *Private Automatic Branch Exchange, AGD System, with Cordless Switching.* Ericsson Rev. *29* (1952) No. 3 pp. 77—79.

Efficient service and uniform distribution of the switching operations for private branch exchanges with cordless switching characterizes the new L M Ericsson distribution system for incoming calls where all operator's sets are identical irrespective of the number of incoming lines and the number of operators. At the conversion to automatic working of installations at Stockholms Tramway Corporation and AB Bofors, Karlskoga, the system has been applied for multi-exchange systems with a common number series and with central switching of the incoming traffic. The lay-out and the technical features of the system are described in the article.

U.D.C. 621.314.222.6

HÖGFELDT, L: *Capacitor Voltage Transformers.* Ericsson Rev. *29* (1952) No. 3 pp. 80—84.

For the new power transmission line between Harsprånget and Central Sweden Sieverts Kabelverk has recently delivered a number of 385 kV capacitor voltage transformers. These capacitor voltage transformers are the first in the world constructed for this voltage and represent an advance in the design of high-voltage capacitors. The article describes the construction, properties and use of these capacitor transformers.

U.D.C. 621.396.62

FREDIN, C: *Ericsson Novelties.* Ericsson Rev. *29* (1952) No. 3 pp. 91—94.

Short description of the new Ericsson receivers: the table sets Rondett and Kvartett, and the radiogramophone Pinett. Moreover, a presentation is given of the previous models Sonett, Duett and Spinett in new designs and the radiogramophones, Kabinett, and Bankett, provided with built-in magnetic tape recorder.

U.D.C. 621.317.785

LUNDSTRÖM, E: *Electricity Meters for Alternating Current.* Ericsson Rev. *29* (1952) pp. 85—90.

The apparatus with a continually increasing power consumption which in recent years has been coming into use apart from the smaller types of electrical apparatus formerly employed has led to a demand for electricity meters capable of carrying heavy loads. In order to meet this demand L M Ericssons Mätinstrument AB (Ermi) has entered the market with an entirely new series of meter types both for single-phase and three-phase systems characterized by accuracy and simplicity of construction and with the same small dimensions as Ermi's earlier types.

The Ericsson Group

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

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Esselte, Sthlm 53

ERICSSON Review

4
1952

ERICSSON REVIEW

RESPONSIBLE PUBLISHER: HEMMING JOHANSSON

EDITOR: SIGVARD EKLUND, DHS

EDITOR'S OFFICE: STOCKHOLM 32

SUBSCRIPTIONS: ONE YEAR $1.50; ONE COPY $0.50

CONTENTS

Five Million Telephone Instruments

HEMMING JOHANSSON, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

U.D.C. 621.395.721(091)

In February *1912* the L M Ericsson works in Stockholm had manufactured one million telephone instruments. Behind this figure were 34 years of pioneer work *in telephone engineering. The step from four millions to five millions, which is* the total number of L M Ericsson instruments produced in Sweden, has taken four years. The passing of this milestone in production presents an occasion to give a short summary of the development of the L M Ericsson telephone instrument.

"It's all very well us having plenty to do in the works, but the telephone demand in the world will surely be covered any time now, and where do we get our orders from then? We would be far better off making consumer goods such as matches." Words to this effect were expressed by Lars Magnus Ericsson sometimes at the turn of the century while he was still in the prime of life, when full employment prevailed in the works and when the demands on telephones often could not be met as promptly as the customers were wishing. Such a remark may sound strange and showing a lack of shrewdness, particularly in view of the conditions to-day, when five million telephone instruments have left the Swedish Ericsson works alone. Certainly Ericsson must himself have been aware of the exaggeration in his words, but the despondent turn which his ponderings sometimes were taking may, however, be understandable.

At the end of the nineties he could look back on a remarkable progress in his work as telephone manufacturer. When he turned out the first magneto telephones in November 1878 from his insignificant factory at Oxtorget, the whole staff consisted of 10 persons out of which 6 or 7 were skilled workmen including the two partners Ericsson and Andersson. In January 1901, just as Ericsson had left the management into other hands, the company employed about 1,000 persons and more than 300,000 instruments had been shipped to all parts of the world. No wonder that Ericsson at times queried the future possibilities of safeguarding full employment in this establishment with its, to his mind, very large staff. He also knew that competition on foreign markets was very keen; the products from his works were still, it is true, superior in quality to those of his competitors, but for how long? Particularly a few worrying incidents of great importance which during the nineties had occurred on the home telephone market, were of a nature to create concern; on that subject more below. Be that as it may, the active steps which Ericsson made to enable an expansion of the company at the very end of his management seem to prove that his assumed distrust of the future could not be very deep-seated.

Initially the production was completely based on handicraft; when Ericsson in 1883 had installed a steam engine in the workshop which he rented at No. 5 Norrmalmsgatan (now Biblioteksgatan) in order to replace the human treadle power, the handicraft was gradually transferred into industry, particularly with regard to the telephone production.

On December 1st 1883 the workshop had turned out 5,000 telephone instruments. According to modern views a trifle, but it was different in those days when the public telephone system in the whole of Sweden did not cover more than about 6,700 instruments of which, however, about 2,100 were included in the Stockholm, Gothenburg and other installations operated by the Bell Company and consequently imported from abroad. At this time Ericsson's staff amounted to between 30 and 40.

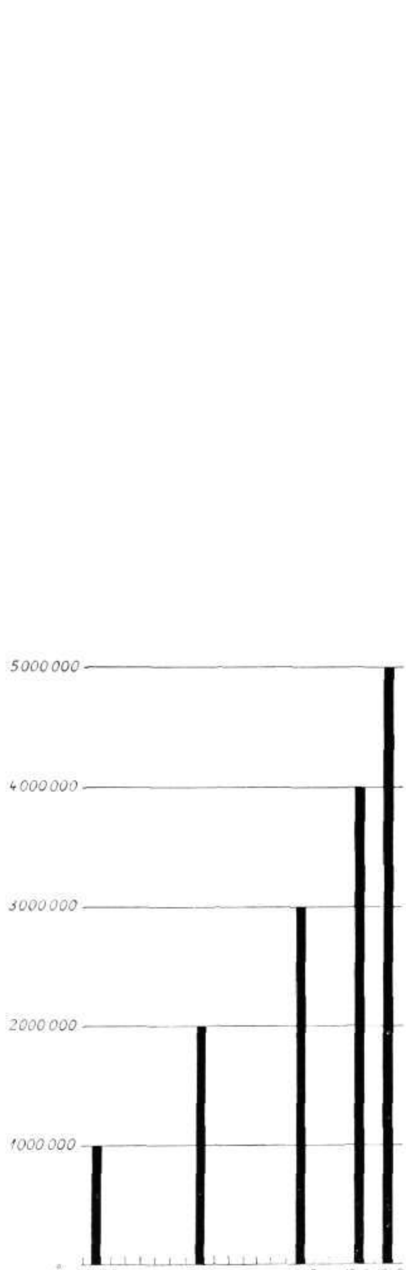


Fig. 1 X 4823

The columns in the diagram indicate which years even million figures were reached in the total production in Sweden of L M Ericsson telephones since the start of the company

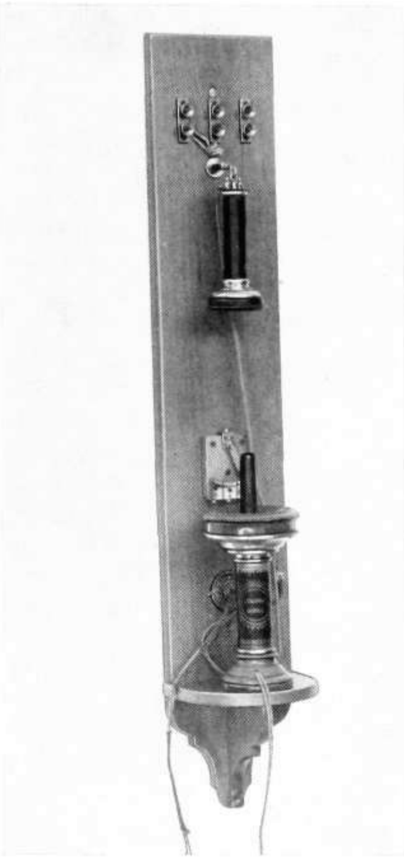


Fig. 2 X 4825

L M Ericsson's first wall instrument, model 1879

Fig. 3 X 4824

The first desk instrument, model 1879

In the spring of the same year H T Cedergren had started Stockholms Allmänna Telefonaktiebolag. The success that this company enjoyed from the very start resulted in a great demand for telephone material and contributed in no small measure to an increase in Ericsson's turnover. In addition the Telegraph Administration, which during the eighties operated telephone systems in the provinces and from 1889 also in the capital, patronized Ericsson's workshop to cover their demand for material. The growing turnover enabled Ericsson to produce instruments and components in ever increasing quantities and to take other steps regarding design and production which would reduce the manufacturing cost. As an example of Ericsson's efforts in this direction a small incident may be mentioned. During several years the iron armature in the rotating part of the signal generator had been cast and annealed; this had to be purchased from outside at a high price and Ericsson spent a considerable amount of work on producing it cheaper and in his own workshop. One day he entered the office very pleased with himself and showing his nearest man, Axel Boström, an armature made of soft iron sheet by a series of press operations; that was the way he intended to make them in future. On Boström's objection that so many hundred expensive armatures were in stock Ericsson retorted: "Scrap them, that's cheaper."

The result of the reduced production costs is reflected in the prices that Allmänna Telefonaktiebolaget paid for the ordinary wall instrument, which from the start was ordered in batches of 500, a considerable quantity in those days. Before the start of Telefonbolaget when only small batches were made, this instrument was priced Sw. Cr. 105: — to 100: —. Already the first order from Telefonbolaget for 500 instruments in the spring of 1883 was quoted by Ericsson at a reduced price of Sw. Cr. 90: —. A few years later he found it proper to step down to Sw. Cr. 85: — and 1886 and 1887 further reductions followed to 78 and 68 resp. These reductions were made on Ericsson's own initiative and were not caused by competition. Attempts at competition does not seem to have been made during the first years of the company. In the spring of 1887, however, when Ericsson's price was Sw. Cr. 68: —, a company in Copenhagen quoted 1,000 instruments at a price of Sw. Cr. 60: —. The Danish company was possibly a go-between for one of the manufacturers which had taken up the Ericsson type instrument on their production program. In spite of the quite considerable difference in price the board of directors for Telefonbolaget decided in a recorded argumentation to decline the offer, displaying their confidence in Ericsson and his products. Gradually Ericsson's prices were reduced further still and in the middle of the nineties a batch of instruments were shipped to Telefonbolaget at a price of Sw. Cr. 50: — for a desk set and Sw. Cr. 40: — for a wall set in both cases with handset. Very low prices, but still profitable. But then Ericsson knew that competition was imminent and very serious competition at that. Allmänna Telefonbolaget, Ericsson's largest customer at that time, was floating a new manufacturing company, A-B Telefonfabriken, which on January 1st 1896 started a factory not only to cover their own requirements of instruments and other material but also to open sales on foreign markets. After a comparatively short time it became apparent that this competitor was able to supply instruments of about the same quality as those turned out by Ericsson's factory. The Swedish Telegraph Administration had as much as five years earlier started telephone production on their own account in a workshop in Södermalm, and Ericsson had consequently lost two of this principal customers on the home market; to this must be added a threatening competition on foreign markets although more or less latent so far. As intimated above these two events so adverse to Ericsson's activities may well have contributed to the spirit of gloom manifesting itself in the expression quoted in the beginning of this article.

Ericsson was, however, not disheartened by these hard blows; at his side he had moreover a man who proved a faithful ally in these hard times, his office manager Axel Boström, later Ericsson's successor as managing director for the limited company to which Ericsson 1896 had transferred his business.

Fig. 4 X 4826

Wall instrument from 1881

with magneto generator and polarized bells

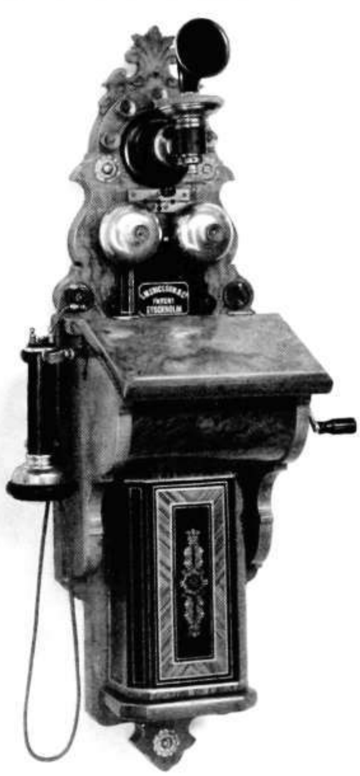


Fig. 5 X 4827

Wall instrument from 1882

with magneto generator and polarized bells

Their efforts were now concentrated on finding a substitute for what had been lost of the home market and their work was amply rewarded. Instruments and other telephone material had been exported already in the eighties in the first place to the Scandinavian countries and Russia; soon England with colonies, Holland and other countries joined as customers to the Ericsson company. The set-backs in Sweden acted as a strong incentive; branch offices were set up in St Petersburg and London, in the first mentioned city in connection with a factory, efficient representatives were obtained in other important centres abroad, and the propaganda for the Ericsson products was intensified based on the secure foundations of superior quality and low prices.

It is not my intention to give a detailed account of the results of this aggressive export drive. A few lines from an article in the jubilee publication, 1887—1912, issued by the Swedish General Export Association may, however, be quoted as they very concisely illustrate the wide distribution of the Ericsson telephones: "If, furthermore, we add that Ericsson telephones are used in Persia and Korea, in Punta Arenas at the Strait of Magellan and on New Caledonia, on the Faroe, Fiji, Canary and Bermudas Islands as well as by the Emir of Afghanistan it should not be too presumptuous to assert that there are few points on the earth so remote that these telephones have not penetrated thither. The vital importance of the export for the Ericsson company will be clear from the fact that during a succession of years the value of the material exported from the Stockholm factory every year has amounted to between 80 and 90 % of the total production volume." Since these lines were written the conditions in all markets have, as known, been substantially changed, particularly as a result of the world wars, and the export targets have been considerably reallocated.

On February 5th 1912 instrument number 1,000,000 was completed, a very illustrious quantity it was thought at the time; it was a specimen of the old well known desk type with catalogue number 375 famous the world over. It is preserved in the company's collections.

The subsequent millions were passed as follows: February 8th 1926 (2 mill.), December 7th 1940 (3 mill.) and May 25th 1948 (4 mill.). In recent years the production rate has increased so rapidly that not more than four years had elapsed before a further million, the 5th, had been completed.

Now, if we were faced with the task of specifying which types of instruments in various modifications are included in this quantity of five millions produced by the Swedish Ericsson Company in the course of nearly 75 years, the answer must be that such a specification would fill a catalogue with a considerable number of pages. The intention in this article is, however, only to cast a glance back on the development of the telephone instrument and in doing so draw the attention to a few more familiar types of special interest.

When L M Ericsson started to manufacture telephones he did not make it on the usual Bell type pattern with a straight rod magnet but on the Siemens robust but rather heavy type with horseshoe magnet. The latter was superior to the Bell type with regard to strength as well as to sound quality, which was very important as the telephone served not only as receiver but also as transmitter; in this respect the Bell type was rather feeble. A telephone system in those days consisted of a single line wire with a telephone and an earth connection at each end. Calling was carried out by means of a trumpet or a whistle which operated the diaphragm of the transmitter over a hammer. Figs. 2 and 3 show what the first Ericsson wall and desk instruments looked like. In Sweden such telephones were never used in public systems; in certain other countries, for instance Germany, they existed as subscribers' sets far into the eighties. When Ericsson 1879 had designed a light hand telephone with horseshoe magnet, which has been used well up in recent years, this type was utilized as receiver whereas the Siemens type was retained as transmitter.

Fig. 6 X 4828
Desk set model 1884

An important step forwards in telephone engineering was taken when transmitters satisfactory in practical use were designed. Ericsson completed the first transmitter, referred to as a spiral transmitter, in the beginning of 1880; it proved superior to the American Blake transmitter which was most commonly used at that time and which was also used in the Bell telephone systems in Sweden. In the beginning of 1881 Ericsson's wall set had the appearance shown in Fig. 4 and he then triumphed over the Bell Company in a competition for the telephone system in Gävle which was the first public system in Sweden apart from the Bell systems installed the year before in Stockholm and Gothenburg. In doing this he put a definite stop to further expansion of American telephones in Sweden outside the existing installations of the Bell Company. The 1881 model was provided with transmitter, receiver, induction coil, polarized bell with two gongs, magneto generator and a cradle which was closing or breaking the transmitter current.

The instrument which was completed 1882, Fig. 5, included a battery box whereas the generator and the bells had been rearranged in more suitable positions. Ericsson had now produced an instrument applicable in widely extended telephone networks. It was coded 301 in the catalogue and was referred to by Ericsson as a pulpit type; it was the prototype for all his subsequent wall models. In the course of time the model was more or less extensively modified with regard to dimensions, equipment and ornaments according to the requirements and wishes of the customers and according to improvements and revisions of the components. The original fundamental idea was, however, as a whole preserved.

Even at an early stage Ericsson endeavoured by carvings, ornaments &c and a high finish to give his models a more attractive appearance than those of American origin. This kind of style is not relished nowadays but in the eighties and nineties such fancies were very much appreciated and the success of the Ericsson models was perhaps not only due to the high quality but also to a certain extent to the appearance and finish. Certain foreign manufacturers also tried to copy the Swedish models although often enough with doubtful success.

All instruments based on the prototype No. 301 and its numerous modifications had a wooden frame work, initially of alder root veneered birch but fairly soon of solid walnut or for tropical countries teak. After a few years the spiral transmitter had to give way for the carbon rod transmitter based on Hughes theories for microphone contacts and for which a patent was filed 1885. After the appearance of the carbon granule transmitter, subject to several patents the first 1888, this was gradually developed and introduced on all models including the handsets.

Fig. 7 X 4829
L M Ericsson's first desk instrument with handset, 1892

The development of an instrument suitable as a desk set which could be considered as an equivalent to the wall instrument No. 301 did not materialize so quickly. In 1884, however, an idea occurred to Ericsson which, when it was put into practice, became a great success and very much contributed to making the Ericsson telephone world famous. A distinguishing feature of the old desk set No. 375, Fig. 6, was the odd design of the generator magnets which were shaped as a supporting frame; otherwise the instrument had no cover whatsoever and it was, therefore, often referred to as the skeleton type. Before the handset had received a shape suitable for use by the subscribers, No. 375 was equipped with a spiral transmitter and hand receiver in conformity with the wall instruments; when the carbon granule transmitter and the receiver with ring magnets instead of horseshoe magnets had been developed at the end of the eighties and these components had been included in the handset this was introduced as an integral part of the desk instrument, Fig. 7.

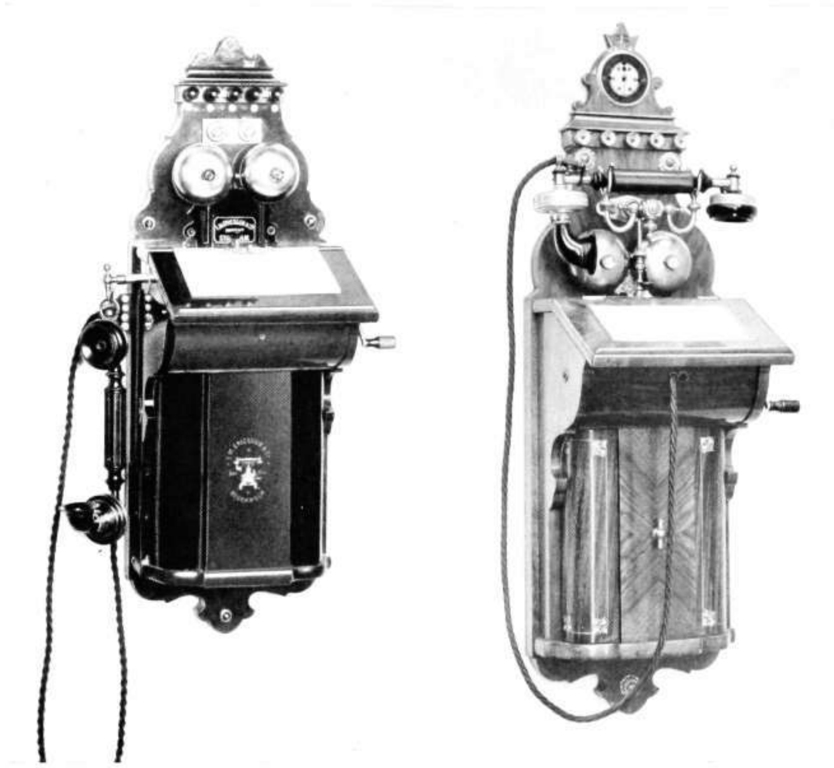


Fig. 8 X 6707

L M Ericsson's first wall instrument with handset, from 1893

Left with handset placed at the side of the instrument, right resting in a cradle switch.

The handset was, however, not only used on this instrument but also gradually on the various types of wall instruments; on certain types it was suspended in the switch hook on the side of the instrument, Fig. 8 left, on others it was placed horizontally on a cradle switch which operated the required switch-over device, Fig. 8 right.

The handset can be considered as dating from the same time as the desk instrument and has served as model for all similar constructions in actual use for the same purpose produced by other manufacturers and a separate chapter ought, therefore, to be devoted to this invention. The history of its origin and development has, however, been described in detail by *Gustaf Collberg* in "Ericsson Review" of 1925 and it will, therefore, suffice to mention that its use initially was very much limited. The first transmitters of the spiral and carbon rod variety operated satisfactorily only in a stationary position and were not, therefore, suitable in a handset, the purpose of which when all is said and done was mobility. In addition the horseshoe magnet receiver was rather heavy and bulky and it was consequently neither suitable nor sufficiently attractive for subscriber's sets. On the other hand there was

Fig. 9 X 7634

The main outlines of the development of the L M Ericsson handset from 1884 to 1947

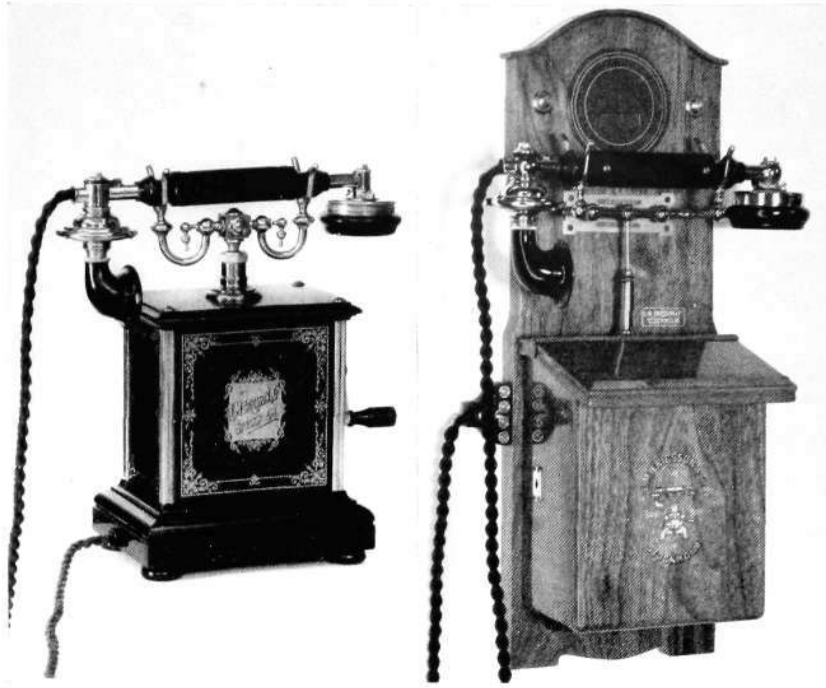


Fig. 10 X 6715

Left, L M Ericsson's desk instrument model 1901

Right, Torbern Gruts' wall instrument, model 1902, for central battery system

nothing to prevent the switchboard operators to use the handset in conversation with the subscribers; they could receive detailed instructions how to handle it correctly. But when, as mentioned above, these disadvantages had been eliminated by the new designs of the transmitter and the receiver, it was a definite success. It was very popular indeed among the subscribers and more than one telephone administration is said to have charged extra for a subscription of a handset instrument, which probably was willingly paid. Gradually the fixed transmitters with hand receivers were superseded by handsets and to-day it should be a very rare occurrence to come across an instrument with a fixed transmitter in something like a modern telephone system.

The handset has of course been revised from time to time in various respects; further details of this will be found in Collberg's article mentioned above. Particularly the transmitter, the most important part, has been the subject of a persistent development work in order to improve the transmission, prevent disconnections in the circuit in certain positions of the transmitter &c. It should also be mentioned that the transmitter already at an early stage was made in the form of a closed loose capsule which could be inserted in the receptacle in one end of the handle. On the whole the handset has retained its original shape from the nineties until 1931 when phenolic resin was introduced as material for the instrument case as well as the handset, see Fig. 9.

Fig. 11 X 4830

L M Ericsson's adjustable transmitter arm, from 1902

In the beginning of the century fashions were changing and this also reflected on the shape of the telephone instruments; the fancies and ornaments of the previous decade gradually lost their attraction, the clean lines and the plain surfaces became more and more appreciated, one important factor no doubt being that they were easier to keep free from dust. L M Ericsson himself had found it advisable to meet this change in fashion by designing an instrument with flat sides of sheet metal and top and base of wood, Fig. 10 left. This instrument was preferred to model 375 by many customers such as the Danish telephone companies.

The introduction of the central battery system in telephone systems during the first decade of the 20th century gave an impulse to the design of new types of instruments, as no magneto generators or galvanic cells were required.

Fig. 12 X 6708

Telephone instruments from 1909

left, wall set; right, desk set

The two first instruments for such a system were wall sets, one drafted by Ericsson, the frame of the other designed by the architect Torbern Gruts, Fig. 10 right, both in wooden cases. Ericsson's model was drawn for the central battery system in Hague whereas Gruts' lay-out was intended for Allmänna Bolaget's installations in Russia and was made on behalf of this company; the instruments were of course manufactured by Ericsson. On the Hague instrument an arrangement was made which as far as is known never has been applied on any other instrument. It is true that an American model was marketed provided with a transmitter arm capable of being turned vertically permitting adjustment to the speaker's convenience, but this model had the disadvantage that the transmitter diaphragm would take upp different angles to the vertical plane. Ericsson made an arrangement for the same purpose only more ingeniously. As will follow from Fig. 11 the transmitter does not deviate from vertical in any position of the arm.

The central battery system gradually gained considerable ground and new instruments for this system was made, wall sets as well as desk sets, Fig. 12. These instruments had deep drawn black enamelled mild steel cases. The ornaments on the plain black sides were limited to a few narrow yellow lines to which sometimes were added transfers with national or city armorial bearings, the name of the customer &c. The same kind of instruments were also applicable in installations with distribution systems of which Ericsson carried out a few before automatic operation was introduced.

In the beginning of 1920 the first of Ericsson's automatic exchanges were put into operation and it was consequently necessary to supply instruments with dials. No special instruments for dial operation were, however, designed at that time although dials were available. This problem was solved by fixing the required dial on the case of a central battery instrument, Fig. 13. From technical point of view this solution was quite satisfactory, but it was nevertheless not a very happy one as it gave an impression of a makeshift. Considerable efforts were unsuccessfully spent during the following years to master the problem of creating an instrument which would appear as attractive with as without dial.

Fig. 13 X 4836

Desk instrument with dial, model 1922

In the beginning of 1931 a suggestion was, however, put forward, which differed radically from the old design with regard to shape as well as ma-

Fig. 14
1931 telephone instruments
left, wall set; right, desk set

X 6716

terial. After a careful and very critical examination in different respects the suggestion was adopted and Ericsson had now obtained a type of instrument which not only met the requirements of the company but also was favourably received all over the world and by now about 2,000,000 sets have been shipped. It was the bakelite desk set, now well-known everywhere, Fig. 14 right. All exterior components of the instrument are moulded in phenolic resin, the case and the handset handle as well as the caps over the receptacles for the transmitter and receiver insets. The instrument constitutes a very complete harmonic unit, more than has been the case with any previous telephone instruments. The active components had to a certain extent to be redesigned in order to be accommodated under the case; any deterioration of the transmission properties has naturally not been allowed. The bakelite desk set was soon followed by a wall instrument in the same material, Fig. 14 left.

About 20 years have now elapsed since the creation of these instruments; during this time no essential alterations have been made with reference to the exterior, only minor modifications.

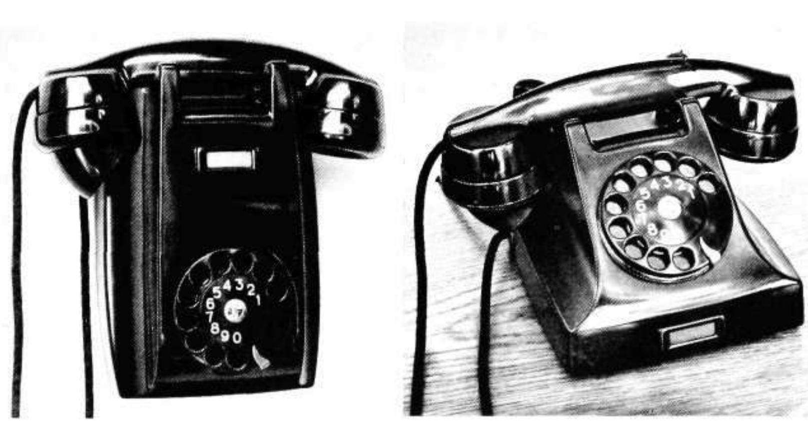


Fig. 15
1947 telephone instruments
left, wall set; right, desk set

X 6717

Gas Control on Telephone Cables

G ÅBERG, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

U.D.C. 621.315.211.4

The method of controlling the tightness of the cable sheathing in a telephone network by the application of a continuous over-pressure to the cable has been employed by numerous telephone administrations for many years past. As far back as the 1930s L M Ericsson began to apply this system to the installations in Mexico for which purpose the company developed certain methods of its own, and also special materials and tools. A brief report on the method and its application in Mexico together with a description of the novel features recently introduced in this branch are given in the following pages.

I. Historical Notes

Gas control has been adopted by a number of telephone administrations quite independently of one another. It was the A.T.&T., the leading telephone concern in the U. S. A. that took the initiative in this respect however. Since the early 1930s the A.T.&T. has adopted the practice of placing all interurban cables under gas control when installing them.

The employment of the method in urban networks with their numerous short and relatively small cables is accompanied by complications and increased costs. For this reason it has not been so widely adopted in urban as in interurban networks, since it was primarily necessary to protect the expensive interurban lines carrying a heavy traffic, the relatively cheap urban cables with their lighter traffic being of secondary importance.

The special conditions encountered, however, provided L M Ericsson with an incentive to introduce gas control in the urban networks in Mexico, and the network in Mexico City is probably one of the first in the world in which the method has been employed on a relatively wide scale.

The further development of the method which has now become better known, coupled with the more exacting demands regarding operating reliability not only for interurban, but also for urban telephone cables, have been accompanied by a steadily increasing interest in gas control. In addition, the exceptionally high prices for cables ruling at the present time, together with constantly rising wage rates have further stimulated interest in the maintenance of the cable network as regards the reduction of replacement material to a minimum and keeping the labour costs at the lowest possible level.

II. Brief description of the method

General

Although the method and the problems associated with it have already been dealt with at length elsewhere (see bibliography) a brief account of the nature of gas control is given here. The description is limited to *continuous gas control*, however, that is to say, a form of control in which the over-pressure is maintained in the cable continuously. On the other hand, that form of gas control, very important in itself, which comprises the *temporary* application of an over-pressure for the purpose of determining whether a soldered joint is leak-proof or for drying out a damp cable, etc., is not described.

The continuous gas control of cables consists in the application of an over-pressure to a cable section which is hermetically sealed at the ends. The over-pressure continues until a leak occurs in the lead sheath. The pressure in the cable will then fall more or less rapidly, depending upon the quantity of gas in the section, the pneumatic resistance of the cable and the size of the leak.

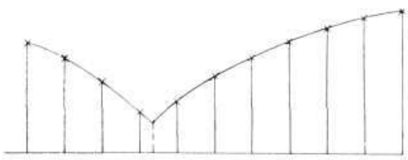


Fig. 1 X 4831
Pressure curve for fault localization

The section should be arranged in such a way that even when a large leak occurs, sufficient time will elapse before the over-pressure falls to zero to enable an alarm to be given and the fault localized and provisionally repaired at least. If the cable is too short and small to permit the forming of a gas section of adequate dimensions, it may be permanently connected to one or more gas containers or compressors which feed gas into the cable automatically when the pressure drops. Thus, the over-pressure in the cable prevents moisture from penetrating into the latter and destroying the insulation, in the same way as over-pressure in the blood prevents bacteria from entering the human body.

The Alarm System

To continue the analogy: gas control offers no counterpart to the coagulation of the blood which stops the flow of the latter, however. Thus, in the event of a fault an impulse must be sent out so that the necessary precautions can be taken to prevent the pressure falling to a dangerously low value. This impulse is produced by allowing a pressure sentinel of some form or other to close an alarm circuit when the pressure drops to a given value. These sentinels are installed along the gas sections. Pressure sentinels are constructed in different forms, some of which are designed for placing outside and others inside the cable.

When the gas is fed in automatically from a gas container or compressor the alarm is sent out in connection with this supply.

Fault Localization

It is not sufficient merely to know that an alarm has been sent out by a certain gas section, however. The fault must be localized in time to allow the cable to be repaired before the pressure drops to zero.

Some idea as to the position of the fault can be obtained by localizing the pressure sentinel which first gave the alarm. The closer the pressure sentinels are placed to one another, the more accurate will be the resulting indication.

To go a step further, use is made of the pressure conditions along the cable. With the help of a portable manometer the pressure is measured at certain points at which valves have been soldered in for this purpose from the outset. A pressure curve is plotted the lowest point in which will indicate the approximate position of the fault, Fig. 1.

When the gas is fed in automatically the quantity of gas supplied will provide a rough assessment of the distance from the fault.

In this manner the fault in a heavy paper-insulated cable can be ascertained to within about 100—300 m. Various methods are adopted for determining the position of the fault more accurately such as special pressure gauges, the connection of gas flow indicators, the use of tracer gas, etc. Final localization is carried out by coating the suspected part of the cable with soapy water. The gas flowing out will then produce soap bubbles over the fault and thus indicate its exact position.

Summary

It may be said, therefore, that gas control consists in the following:

1. An over-pressure is applied to a hermetically sealed cable section. This over-pressure prevents the damp outer air from penetrating into the cable if a fault occurs in the lead sheath.
2. On the occurrence of a fault the pressure in the cable falls, whereupon an alarm is sent out to the service staff.
3. The fault is localized by observing the gas pressure and the flow conditions in the faulty section.

Thus, the purpose of gas control is not to prevent faults in the lead-sheath—for which other measures must be adopted—but to prevent moisture penetrating into the cable and causing breakdowns in service.

III. Gas Control in Mexico

General

The cables in Mexico City have frequently given rise to trouble due to faults in the lead sheathing which permit moisture to enter the cable and thus interrupt the service. The causes of these faults are of numerous kinds—such as strong electrolytic action, earthquakes, soil conditions, etc. Furthermore, matters are aggravated by the climate in view of the fact that faults arising during the dry season are not as a rule noticeable until after the first or second rainfall at the beginning of the rainy season when they all become apparent at the same time instead. In order to reduce the percentage of faults and, first and foremost, to prevent the accumulation of faults which make their appearance at the beginning of the rainy season, it was proposed during the 1930s to fill the cables with gas.

For this purpose a start was made with the junction cables as was quite natural, since these cables present very much the same problems as the interurban cables. Moreover, it was the junction cables that primarily required protection against interruptions in service as they carry the heaviest traffic, and a serious fault on one of these cables may entail a breakdown of the whole telephone service.

After studies carried out at the A.T.&T. in 1938 the planning of a gas control system for the junction cable network was started. The first section was placed in service in 1940 and the whole of the junction cable network was under control by 1947. Since 1940 all new junction cables have been equipped with gas control. When interconnection service was arranged in 1948 all the interconnection cables were put under gas control. Since the number of automatic exchanges in Mexico City amounts to 19 at the present time, the junction- and interconnection cables represent a considerable part of the network.

Even before the gas-filling of these cables had been completed, gas-filling of the primary network had been put in hand. By the end of 1951 all junction-, interconnection- and primary cables in the Teléfonos de México (TDM) system had been gas-filled. The progress made is shown by the following figures

	kms of gas-filled cable in the ETE's (TDM's) network in Mexico City
1941	28.5
1943	128.5
1945	197.3
1947	298.0
1949	480.0
1951	518.0

Gas control has also been successfully adopted in certain provincial towns, although on a smaller scale. Its employment has in most cases been dictated by special problems, such as long junction cables the maintenance of which entailed difficulties.

The installation and operation of the gas equipment in Mexico have been carried out in an extremely efficient manner from the outset by the engineer, Ignacio Cervantes B. of the TDM.

Materials, Tools and Instruments

Materials

Gas

The gas used must not affect the paper, copper or lead. Moreover, it should be cheap and must be available in a dry condition. In Mexico oil-dried nitrogen gas is usually employed and is delivered by the factory in an adequately dry condition. (1) In small networks or places where nitrogen gas is not obtainable dry air is used.

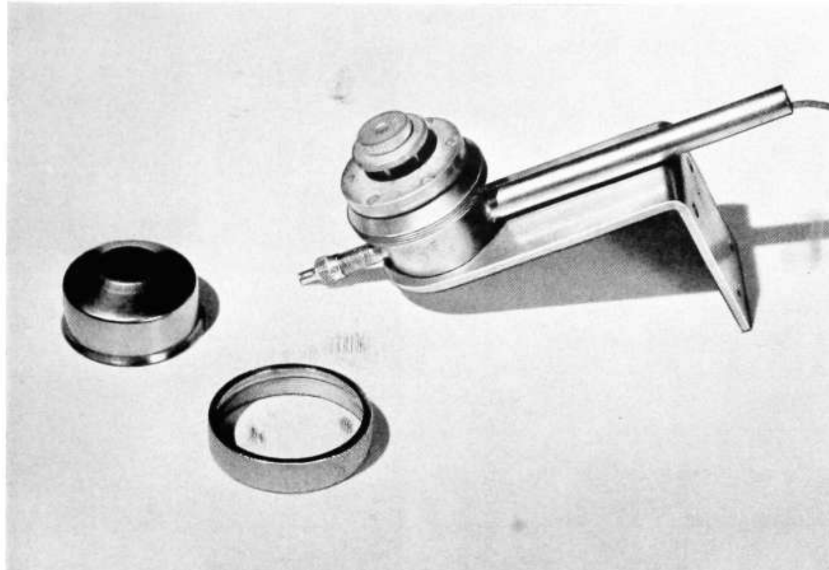


Fig. 2 X 6710

Pressure sentinel VAF 1801

The working pressure in the cables is 0.7 atm. The alarm pressure is 0.5 atm. When gas-filling is adopted the pressure is increased in order to save time, but preferably not above 1.0 atm. and never above 1.4 atm., to prevent damage to the cable. The tendency is in favour of lower working pressures.

Valves

These are usually motor-car valves modified with a view to the method of fitting them. A hole is drilled in the sheath with a special drill, the valve then being screwed into it and soldered tight.

Pressure Sentinels

The pressure sentinel *VAF 1801*, Fig. 2, for mounting outside the cable, is mainly employed in Mexico. Here, the effective pressure is the difference between the pressure inside the cable and the atmospheric pressure, that is to say, it is not necessary to adjust the pressure sentinel for varying heights above sea level, which is an advantage in Mexico where great differences in height exist. On the other hand, changes in atmospheric pressure due to varying weather conditions operate in such a way that when the barometer is high, the alarm is given somewhat prematurely and vice versa. Since fluctuations of this kind are of small amplitude at high altitudes, no troubles due to this cause have been experienced in Mexico City which lies at an altitude of 2,200 m above sea level.

Material for the production of gastight plugs

Certain special materials are required for this purpose, such as anhydrous beeswax, asphalt, filling plugs, etc. The manner in which these materials are used is described below.

Connection tubes, cocks

In order to connect up two cables as far as the gas flow is concerned, a lead pipe with a 1/2" external- and 1/4" internal diameter is soldered tightly to the lead sheathing of the cables. To enable a given cable to be separated temporarily from the remainder, an intermediate cock is inserted in these connecting pipes. A cock of this kind is also inserted in the lead piping, which shunts certain plugs in a gas section. With this arrangement, in the event of cable faults the cocks can be closed and the section divided up, which both economizes gas and facilitates the localization of faults.

Tools, Instruments

Gas containers and constant pressure regulators

Standard equipment for nitrogen gas is used.

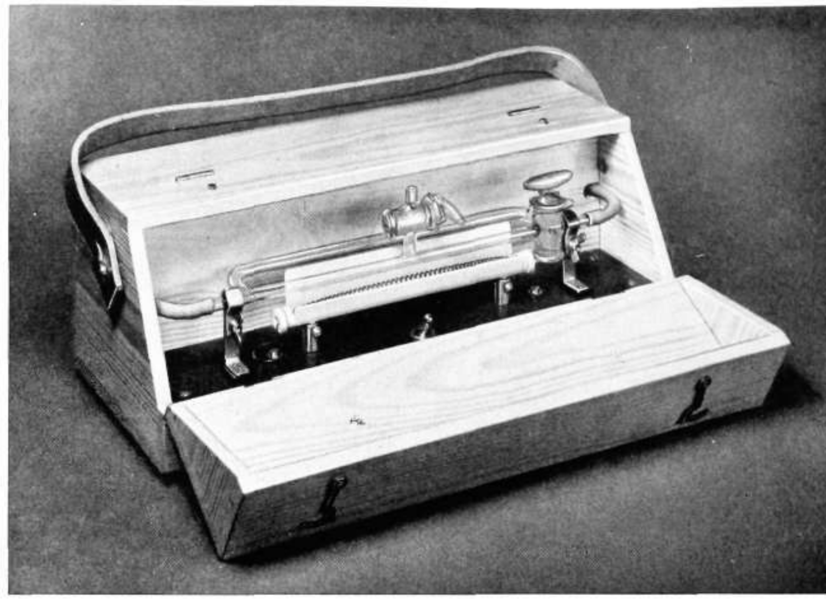


Fig. 3 X 6711
Gas flow indicator LTP 2111

Manometer

For routine measurements a manometer *LTP 2051* with a measuring range of 0—1.4 kp/cm² and an accuracy of 0.02 kp/cm² is used. A mercury manometer is employed for more accurate measurements.

Gas flow indicator

To determine the direction of flow of the gas at a given point when localizing faults a gas flow indicator *LTP 2111*, Fig. 3, of the following construction is used. A glass tube is connected to the cable at two points by two rubber tubes, these points being at a distance of at least 1.5 to 2 m from one another. Some grains of iodine are placed in the glass tube and heated up whereupon violet fumes are generated. Owing to the fact that the flow resistance in the rubber tubes and the glass tube is low in comparison with that of the cable, the gas will flow through the indicator, drawing the violet fumes with it in one direction or the other.

Cable pump and drying cylinder

In places where nitrogen gas is not obtainable or where the installation is small, air is employed and is pumped into the cable by means of a cable pump *LTP 2021*. Two drying cylinders *LTP 2031* filled with calcium chloride are connected in series between the pump and the cable.

Division of the Cable Network into Gas Sections

The form which this division should take is dependent upon the character of the network. Where junction cables 2—4 km in length are in question and one cable has an insufficient volume to form a gas section by itself, 4 to 5 such cables must be combined for which purpose they may suitably be connected by lead pipes, arranged one after the other or in a loop. Finally, in the case of primary and secondary cables which spread out in a fan pattern from a point, the different cables must be connected in parallel at this point. In all cases the end points of the cables must be provided with a plug as they do not terminate in gastight boxes. The plugs are constructed broadly as follows.

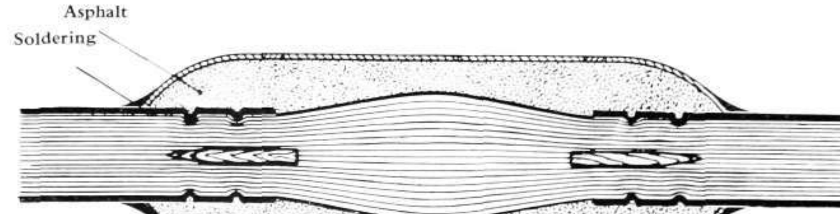


Fig. 4 X 6712
Gastight plug

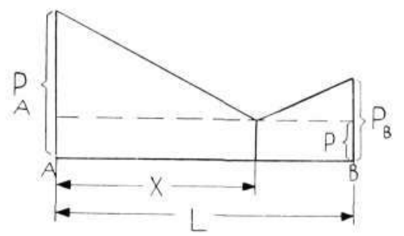


Fig. 5 X 4832

Pressure diagram for fault localization with a gas container

a) The cable is opened up and the sheath removed.
b) The cable is pressed together so that the core assumes a balloon shape.
c) A filling plug is pressed into the core on each side.
d) Around the latter the lead sheath is pressed together forming two annular grooves.
e) A lead pipe is soldered in and provided at the top with two holes and at the bottom with a drain cock.
f) The tube is rinsed with beeswax.
g) The tube is filled with asphalt.
h) The tube is soldered up again.

When the different sections have been formed in this manner pressure sentinels are installed at approximately every 3rd kilometre and valves at about 500 m apart. The pressure sentinels are placed in suitable manholes or cable chambers. In the primary network they are located in cabinets or cabinet manholes.

The pressure sentinels are connected through one and the same wire in the cable to an alarm relay installed in the nearest attended exchange, whereupon the section is filled with gas.

Fault Localization

When a fault occurs in the sheath the pressure falls and the pressure sentinel nearest to the fault sends out an alarm signal. It is ascertained by bridge measurement which of the sentinels has sent out the signal, and in this way a first, very rough approximation of the position of the fault is obtained.

As insulation faults never have time to set in, the exact position of the fault cannot be determined by bridge measurement in the ordinary way. In place of it, a pressure curve and gas flow indicator are used. By this means the fault can be localized with an accuracy which is only limited by the accessibility of the cable. Thus, when the cable is laid in conduit, the fault can be localized to a certain manhole span.

For armoured cables, two lead pipes are taken from each joint to a box above ground at the time the cables are being laid, so that faults can be localized to within a cable length.

To trace the fault more closely the following method may be adopted, see Fig. 5. A gas container is connected up to one end A of that part of a section in which a fault has been localized. After stable conditions have been established the pressure is read off at both ends of the section, P_A and P. The gas container is then moved to the opposite end B and the constant pressure regulator is so adjusted that the pressure at A after equilibrium has set in will be just as great, P, as the pressure at B during the previous measurement. The pressure at B is now taken as P_B; assuming that the flow is laminar, the distance from A to the fault will then be

$$x = L \frac{P_A - P}{P_A + P_B - 2P}$$

Final localization is effected with soapy water.

Operating Experience

In Mexico gas control has proved an extremely effective means for preventing interruption in service and reducing the amount of material and labour necessary for the maintenance of the cable network. From the time the junction cables were first placed under pressure practically no breakdowns have occurred in these cables. This is particularly important in view of the fact that all the interurban circuits also lie in these junction cables.

The improvement as regards reliability in operation is still more apparent in the primary network. In 1951 when the majority of the primary cables were gas-filled the number of faulty pairs was only about 1/10th of that recorded 10 years earlier at which time gas-filled primary cables were not in use. Furthermore, the lower figure relates to a more extensive network.

The saving in materials is obvious since the gas prevents moisture from entering the cable. Even if the lead sheath is punctured by electrolytic corrosion or a workman accidentally drives a pick into the cable, the fault is restricted to the damaging of the sheath, or at the worst, some of the conductors are broken off. Consequently, replacement of the cable is only necessary in exceptional cases and the material required is usually limited to that necessary for splicing.

The saving in labour is, however, even more important. From the description of the manner in which a fault is localized in a gas-filled cable it will, it is true, be realized that fault localization may be a lengthy process, but on the other hand, plenty of time is available for the work. When measuring the position of a fault due to moisture it is frequently only a question of hours or possibly minutes before the moisture can be prevented from entering the cable, interrupting the service and destroying the cable. This entails a "fire brigade call" in the most unpleasant meaning of the term, with guard duty and calls at all hours of the day. With gas control, on the other hand, the work can be arranged in the most efficient manner. Overtime work is scarcely ever necessary. At the worst, the pressure can be increased by pumping in a little more gas.

Moreover, as already pointed out, in a country such as Mexico with its pronounced dry and wet seasons the great advantage is gained that repair work is more uniformly distributed over the year. In a network which is not gas-filled faults that occur during the dry season accumulate and all make their appearance at the same time at the beginning of the wet period. This entails an additional strain on the maintenance staff, heavy repair costs due to overtime and long interruptions in the service. In a gas-filled network, on the other hand, faults are signalled as soon as they occur, and there is no reason to fear a peak load at the beginning of the rainy season.

In no few instances gas control has enabled the life of a cable to be appreciably prolonged. The lead sheath is exposed to phenomena of various kinds which cause it to leak after 20 to 30 years, or in some cases sooner. These may take the form of slow-acting electrolysis or chemical corrosion, intercrystalline corrosion due to vibration from the traffic or other causes. As a rule, a cable of this kind is not worth repairing, it has served its time. If the cable is placed under pressure, however, it can continue to be used. The defects in the lead sheath are so small that very little gas flows out and the filling costs are insignificant. A parallel may be drawn with a motor-car tyre that is not completely airtight and requires pumping up from time to time—perhaps rather more frequently than under normal conditions. In both cases it is usual to proceed until the tyre or cable has deteriorated to such an extent that it is no longer worth while filling it with air or gas.

In the event of floods gas control has proved to be the only means of maintaining faulty cables in service. An alarm is sent out from the fault but no steps can be taken before the water has fallen again. Gas is then fed in and allowed to bubble out through the hole. There is a loss of gas as long as the flood lasts, but this cost is of minor importance compared with breakdowns in operation and the costs resulting if the water were allowed to penetrate into the cable.

Costs

If the cables are gas-filled at the time of laying them, the installation costs amount to $^1/_4$ %—$^1/_2$ % of the total cost of the cable. The operating costs are dependent upon the frequency of occurrence of faults. A conception of the saving that can be effected by gas control may be obtained, however, on comparing the costs resulting from a cable fault located at a manhole. In a network which is not gas-controlled the fault may lead to the cable going out of service altogether and to the penetration of moisture to such an extent that the cable must be exchanged in both directions. In a gas-filled network a fault merely implies that a small quantity of gas will be lost and it will

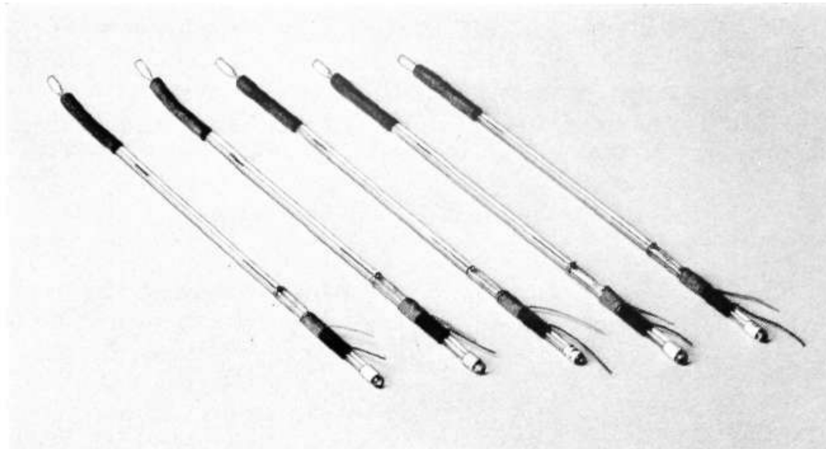


Fig. 6 X 6713
Pressure sentinels NVB 20

become necessary to solder up a hole in the sheath. In the one case the costs may easily amount to several thousand crowns, whereas in the other it may be possible to cover them by a few ten-crown notes.

Moreover, in the first case the fault may possibly cause an interruption in the service to several hundred subscribers for a whole day or longer. In the second, *no one* apart from the staff in charge of the gas section will perceive that anything unusual has occurred.

IV. Development of the Method

The encouraging results achieved in Mexico have provided L M Ericsson's network department with the incentive to proceed with the work of developing the gas control method. From the technical literature on the subject already published, it would appear that interest in gas control is increasing in other quarters too. The foremost aim is to provide effective protection for the important interurban cables, particularly the coaxial cables, but there is also a marked tendency to extend the system's range of use to include urban cables.

The problems for which solutions are primarily sought are:

the internal gas sentinel (installed inside the cable),

improved fault localization,

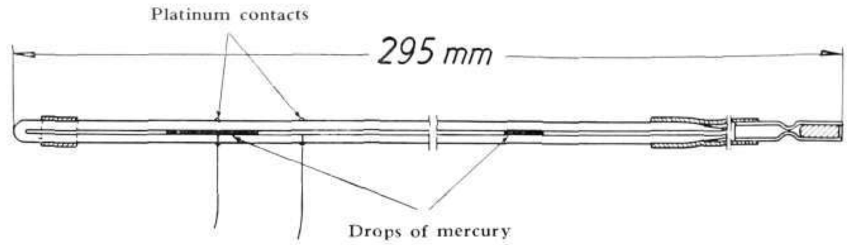
gastight cable boxes in the distribution cabinets, and spreading points, and

the continuous feeding in of the gas.

The Internal Pressure Sentinel

When, as is the case in Mexico, the cables are mainly laid in conduit or take the form of overhead cables the pressure sentinels may be located outside the cable without causing inconvenience, in manholes or on poles, for example. In the case of armoured lead-covered cables, however, the external pressure sentinel entails numerous difficulties. It must be placed in an accessible position above ground, such as on a concrete pillar to which a gas connection from the cable must also be laid. Since a pillar of this kind cannot be placed in any position indiscriminately, these gas connections may be long and expensive to lay. Consequently, it is preferable to employ a pressure sentinel which can be installed inside the cable.

For the same reasons advanced in connection with the external pressure sentinel, it is also desirable to eliminate the valves for fault localization which are placed at approximately 500 metres apart along the cable. This necessitates the installation of more pressure sentinels, preferably one at each cable joint, if fault localization is not to be too unreliable. It is important, therefore, that internal pressure sentinels should be available at a low price in order to keep laying costs within reasonable limits. The engineers Lindström and Jedvall of the Swedish Board of Telegraphs have solved the problem in the following manner. The pressure sentinel shown in Figs. 6 and 7 consists in principle of a glass tube closed at one end, into the walls of which two platinum contacts



X 6714

Fig. 7
Pressure sentinel NVB 20

are sealed. A column of mercury is inserted in the tube which is of such a length that it can short-circuit the two contacts in a certain position. With a normal over-pressure in the cable the mercury column is displaced at the closed end of the tube. When a fault in the lead sheath causes the pressure to fall, the mercury column moves towards the open end of the tube and short-circuits the two platinum contacts after the pressure has fallen to a given value.

The pressure sentinel has been employed in the Danish coaxial cable network (12) amongst other places. It has also been tested by the Swedish Board of Telegraphs with satisfactory results (15). It has been patented and is sold by L M Ericsson under the type designation *NVB 20*.

Improved Fault Localization

The method generally adopted for the approximate localization of a fault by means of a pressure curve has been found to possess certain drawbacks. The desirability of eliminating external pressure sentinels and valves in connection with armoured lead-covered cables has been referred to above. This excludes the possibility of plotting pressure curves. Nor is the more accurate localization of faults with the help of gas flow indicators very satisfactory for armoured cables, since it entails the digging up of the cable and removal of the armouring for each test. Furthermore, in the case of coaxial cables, for example, the resistance to the gas flow is so low that the resulting curve will be very flat which renders both rough localization from the pressure curve and more accurate localization with the gas flow indicator more difficult. The same conditions exist for an urban cable when the hole is very small. Where there are a number of small holes it is impossible to obtain a minimum value at all.

This problem has been solved with the help of the tracer gas method and by measuring the quantity of gas fed into the cable (gas flow method) from two points located on either side of the fault.

Tracer Gas Method

The method consists in the introduction into the cable of a tracer gas which leaks out through the hole and can be located. Various forms of tracer gas have been proposed and tried out such as mercaptan which can be detected by a dog specially trained for the purpose (5). The tracer gas most widely employed in Europe is a radio-active gas (such as radon, half life 3.83 days) which is located by a Geiger-Müller (G-M) counter. The method of procedure is roughly as follows (11, 12, 16).

On connecting a container filled with nitrogen gas (or dry air) to one end of the defective cable, gas flows from the container through the cable and out through the hole. When stable conditions have been established radon is introduced into the cable in the form of a plug. This plug flows forward through the cable at the same speed as the nitrogen gas. The speed is dependent upon the feeding pressure, the resistance to flow in the cable and the size of the fault. It can be calculated when the quantity of gas fed in per unit of time and the flow resistance of the cable are known. With the aid of a G-M counter it is possible to follow the course of the plug. Owing to the fact that the lead sheath acts as a screen, however, the radiations are appreciably weakened and it becomes necessary to dig down to the cable and place the G-M tube quite close to the armouring. The radon gas flows out through the hole at the faulty point and a clearly marked deflection on the G-M counter can be obtained even at the surface of the ground.

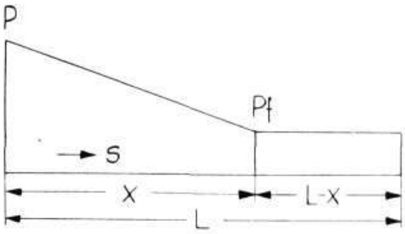


Fig. 8 X 4833

Pressure diagram for fault localization by the gas flow method

Another tracer gas method has been described recently in *Bell Laboratories Record* (18). In this case the tracer gas is Freon 12 (CCl_2F_2) and the seeker is a halogen detector. The method is specially intended for overhead cables. The cable is filled with Freon 12 and the detector, which is mounted on a lineman's chair, is drawn along the cable. When it passes over a leak through which Freon gas is flowing out, it gives a visible and audible signal. After the fault has been located the Freon gas must be drawn off and nitrogen gas (or air) pumped in.

Gas Flow Method

If a gas container is connected to one end of a defective cable, Fig. 8, so that the gas is fed into the cable and the same quantity of gas subsequently flows out through the leak, assuming that the flow is laminar, the relation between the pressure, the gas flow and flow resistance is given by the following equation (2):

$$P - P_f = s \cdot r \cdot x$$

where P = feeding pressure
P_f = pressure at the faulty point
s = gas flow
r = flow resistance/unit of length
x = distance from gas container to the fault.

x and P_f are unknown quantities.

In order to be able to solve x it is necessary to be in a position to measure s with sufficient accuracy and also to be able to set out two equations including x and P_f. The latter will be the case when the gas is fed in from both ends simultaneously, Fig. 9.

Thus, we have

$$\left. \begin{array}{l} P_1 - P_f = s_1\ r\ x \\ P_2 - P_f = s_2\ r(L - x) \end{array} \right\}$$

where P_1 and P_2 are the pressure for feeding gas into the cable.

If $$P_1 = P_2 = P$$

then $$s_1\ r\ x = s_2\ r(L - x)$$

or $$x = \frac{s_2 L}{s_1 + s_2}$$

For measuring the gas flow s, the engineers Swenson, Petrén and Lidén of the Swedish Board of Telegraphs have designed an apparatus operating on the following principle. The flow counter, type *LTP 206*, is connected to the gas container and gives an impulse to the counting mechanism each time the pressure in the container falls by 3 kp/cm² for example. Thus if the capacity of the gas container and the number of impulses per unit of time are known, a very accurate value can be obtained for the gas flow.

A constant pressure regulator of a new design, type *LTP 213*, is furthermore inserted between the gas container and the cable, and keeps the feed pressure, P, within limits as narrow as $\pm$ 0.005 kp/cm².

A patent application has been filed on the apparatus which is sold by L M Ericsson. It has been tested by the Swedish Board of Telegraphs in combination with the tracer gas method and has yielded excellent results.

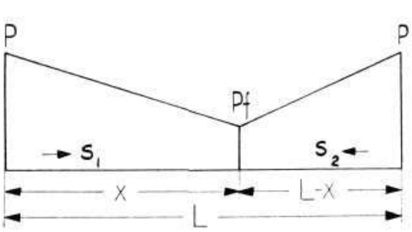


Fig. 9 X 4834

Pressure diagram for fault localization by the gas flow method

Gastight Boxes

When forming a gas section the cable ends must be sealed. Generally speaking, the cables terminate in boxes, and the most suitable arrangement would be to have these boxes gastight. Gas control could then be extended right up to the terminal blocks. Boxes of the conventional types are not gastight, however, insofar as a capacity for withstanding a constant over-pressure up to 1 kp/cm² is concerned. Consequently, it has been necessary to place a gastight plug in front of each box which has been accompanied by considerable drawbacks and has rendered gas control impossible in some cases.

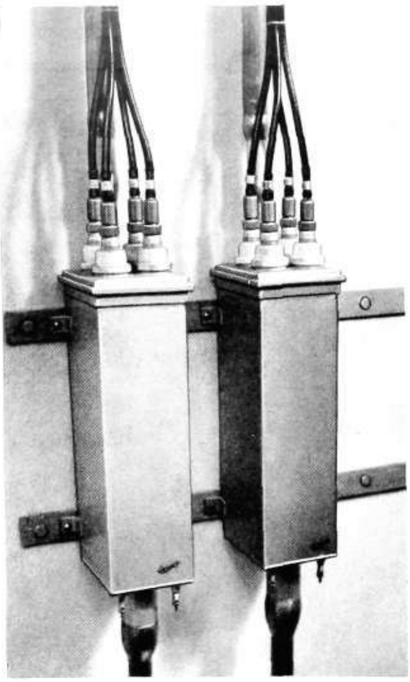


Fig. 10 X 4835
Coaxial cable box NDE 95

It is particularly advantageous when gas-filling of a secondary network with its numerous small cables is in question, to employ gastight boxes at distribution cabinets and spreading points. It has been found that unless gastight spreading boxes are used for terminating the small cables it is scarcely worth while to adopt gas-filling in a secondary network.

In order to overcome these difficulties much development work has been carried out by L M Ericsson's network department with a view to producing new designs for gastight boxes of different types. By way of example the gastight boxes for coaxial cables, types *NDE 951—NDE 953*, Fig. 10, employed, inter alia, for terminating all coaxial cables in Sweden may be mentioned.

Continuous Feeding in of the Gas

The method adopted in Mexico consists in the application of an over-pressure to a closed system comprising one or more cables. The enclosed and compressed gas thus provides a guarantee in itself that an over-pressure which prevents moisture from penetrating into the cable will be maintained for a certain time. The duration of the over-pressure will depend upon the size of the leak, the flow resistance in the cable, the working pressure and the volume of the gas section. If the volume is very small, the time available may be too short to enable the fault to be localized and repaired.

In order to solve this problem a gas container connected to the cable through a constant pressure regulator has been employed for a long time past. An arrangement has been devised which sends out an alarm when the pressure in the tube has fallen to a certain low value, whereupon the gas container is changed.

The apparatus mentioned earlier in connection with the gas flow method can, of course, be used with advantage here. When an urban network is to be placed under control, for example, the flow counter is placed in the M.D.F. and connected up to a part or all of the cables. The counter is kept under daily observation by the M.D.F. staff. The absence of the impulses implies that the cables are free from leaks. Their occurrence at long intervals is an indication of an insignificant leak, and a decision must then be reached as to whether the fault should be repaired or whether the loss of gas is so slight that it is preferable to accept the costs for this loss rather than those entailed in localizing and repairing the fault.

A sudden increase in the number of impulses per unit of time indicates the occurrence of a new fault. If the loss of gas is considerable the fault must be localized and repaired. Various methods may be adopted for the approximate localization of faults depending upon the character and size of the cable network; these include the use of pressure sentinels, pressure diagrams, the sectioning of the cable network or a combination of two or more of these methods. More definite localization is effected with a gas flow indicator, tracer gas and soapy water.

In localities where nitrogen gas or dry compressed air cannot be obtained at reasonable prices the gas container may be replaced by a compressor. The air must then be passed through two or more drying cylinders to ensure that no moisture is pumped into the cable. The drying medium cannot absorb more than a given quantity of moisture, however, and must be regenerated in the course of time. Thus, in the USA two sets of drying cylinders are used, one of which is in service while the other is being regenerated. The sets are exchanged automatically (17).

V. Summary

Gas control offers a relatively new means for simplifying and reducing the cost of maintenance in a telephone network whilst at the same time the operating reliability is considerably increased. It is very natural, therefore, that most telephone administrations exhibit great interest in the method. This interest has been primarily directed to interurban and suburban cables but there is a growing tendency to adopt the method for urban cables also. The reasons for this are numerous: the increasing interurban traffic, the employment of urban cables for purposes other than telephony (teleprinters, wired wireless, emergency alarms), more exacting demands on the part of the subscribers for operating reliability in the case of urban traffic also, and a desire to reduce maintenance costs. The further work of development aims at improvements in the fault localization methods, gastight cable seals permitting a reduction in the number of gastight plugs to a minimum, and finally, better and cheaper gas control apparatus which will also offer an economic justification for the employment of the method for urban cables carrying a light traffic.

In spite of the fact that many problems still remain to be solved, the desired end is already in view: a 100-per cent gas controlled network in which interruptions in the service due to moisture in the cables are insignificant.

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Improved Telephone Headset

V SÖDERSTRÖM, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

U.D.C. 621.395.613.384

The telephone headset, type RLF 20, described in Ericsson Review No. 3/1940, has been redesigned and is now available in an improved version.

Fig. 1 X 4818
Telephone headset RLF 20

Fig. 2 X 4819
Telephone headset RLF 20 in use

A distinguishing feature of the new version of the L M Ericsson telephone headset is the recently developed transmitter arm. Originally a transmitter was used with a diameter considerably smaller than that of a normal transmitter inset. The transmitting properties, however, proved not be of the same high quality as those of the transmitter inset in a handset, and the transmitter arm has therefore been modified to take a normal transmitter inset, type RLA 19. The »spoon» has been made shorter and straighter and is now situated at the side of the mouth instead of in front, wich is preferable for hygienic reasons. The lid of the spoon is made of aluminium, which gives the transmitter arm considerably higher impact strength. The head strap has also been altered, since the cord in the old version had a tendency to stick in the V-shaped aperture in the strap and get damaged. This aperture has been replaced by a large round hole, and the small holes along the length of the strap have been changed to a continuous slot.

The supporting pad has been altered to a U-shaped ear rest which can be slid up and down to fit round the ear. In this way the headset rests very much more firmly on the head than previously. The strap is made to fit a normal shape of head. In order to ensure that the set is securely and comfortably mounted, however, the strap should be adjusted by the individual so as to distribute the pressure equally between the receiver, ear rest and strap. When properly adjusted to the shape of the head, it will be noticeable how light and comfortable to wear this headset is.

Any suspicion that may be felt as concerns the lightness of construction is quickly dispersed when its advantages become apparent, and the operator soon learns to treat the light headset more carefully than a heavier one. A girl who is given a headset that fits the shape of her head and coiffure would not for a moment consider changing back to the old, uncomfortable type of breastplated transmitter and head harness.

Battery Box for Portable Telephone Instruments

S PORSNER, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

U.D.C. 621.395.721.5

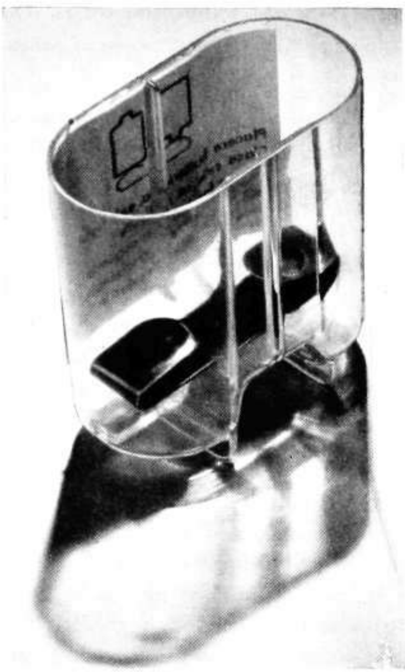


Fig. 1 X 4814
Battery box BKY 1111

When the L M Ericsson portable telephone instrument DPA 10—13 was designed some years ago it was made for a special type of dry cell batteries which did not fit in other types of instruments. This battery consisted of two 1.5 V cells connected in series and moulded together in a block with a base of 35 × 67 mm and a height of 85 mm.

The life of a dry cell battery is, as known, considerably reduced after long storage. To avoid this disadvantage, which is of course particularly apparent when batteries have to undergo lengthy transport, another solution of the battery problem has now been developed.

As cylindrical batteries are to-day produced in almost every country and the dimensiones now have been standardized, a battery box has been designed for two such cells. This fits in the space provided for the special battery in the portable telephone instrument.

As shown in Fig. 1, the battery box is made of transparent plastic material. The bottom of the box contains a double bent phosphor bronze spring connecting the two cells. To effect series connection of the two cells one of them must be placed upside down as indicated by the instructions on the box. When the cells have been placed in the box, this is inserted in position and the contact springs in the instrument make connection with the battery. The battery lid is closed and the instrument is ready for use.

The L M Ericsson portable instruments will in future be supplied with battery box, but without batteries.

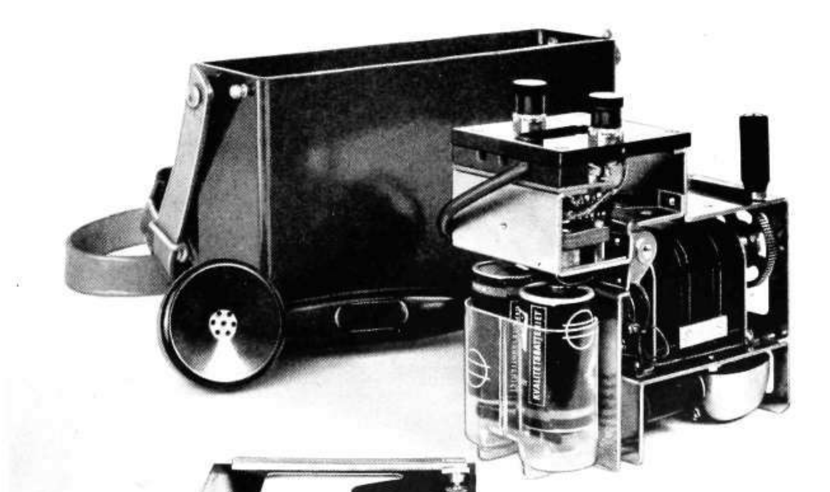


Fig. 2 X 6704
Portable telephone instrument
DPA 10–13

Lacquer Tensometer

E JONNERBY, AB ALPHA, SUNDBYBERG

U.D.C. 621.317.39:667.61

Surface finishing with paints and lacquers is gaining a wide importance with regard to appearance as well as quality. In order to meet the requirements of test instruments in this field AB Alpha has completed the development of the lacquer tensometer in cooperation with the Swedish Mechanical Trade Institute and the Central Research Laboratory of the Swedish Paint and Varnish Industries. The lacquer tensometer is an instrument for testing tensibility and adhesion of paints.

One of the latest additions to the range of material testing instruments produced by AB Alpha is the lacquer tensometer, which is used for testing the tensibility and adhesion of lacquers and paints. It may, however, also be used for testing any surface finish which gives an electrically non-conducting coating on metals.

The surface finish is to-day not only a question of appearance but an operation of utmost importance for the quality of the product. This has created a need for instruments to test the properties of the finish in the same manner as the quality of the steel in the product is tested. It is not only the manufacturers of paints and lacquers who have an interest in the quality of their products but quite naturally also the consumers who in the end apply the coatings and who have to check that the result meets their requirements.

The development in this field is in Sweden handled by the Central Research Laboratory of the Swedish Paint and Varnish Industries in which the largest paint manufacturers have an interest. This laboratory has developed and is using the test method employed in the lacquer tensometer and has given recommendations to the members associated with the laboratory regarding the application of the method. Alpha has in collaboration with this research laboratory completed the design of the tensometer, Fig. 1, which is now being marketed.

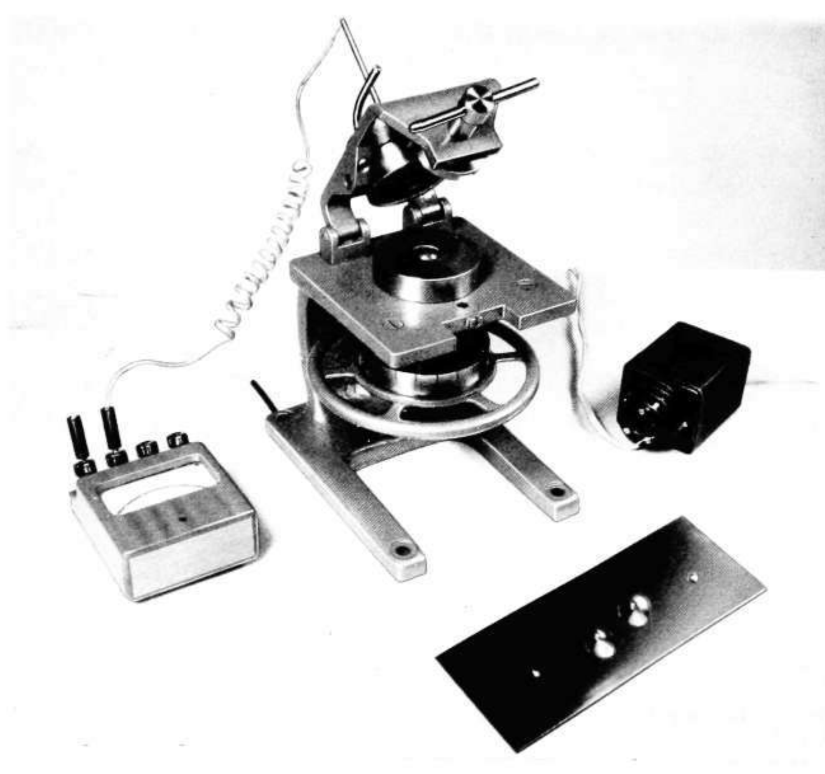


Fig. 1 X 6698

Lacquer tensometer

with milliammeter and transformer; in the foreground a plate, which has been tested in the tensometer

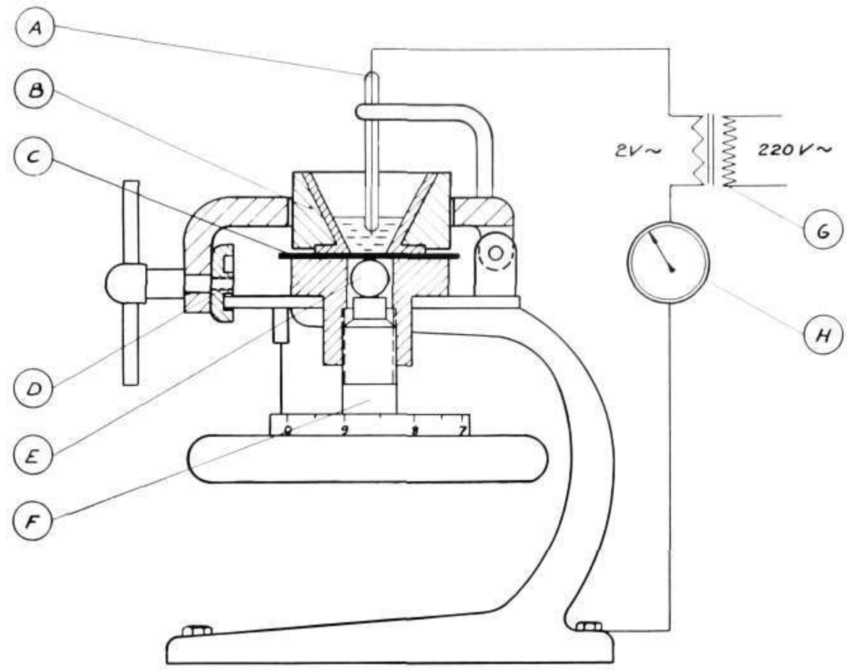


Fig. 2 X 6685

Principle diagram for test in lacquer tensometer

A platinum electrode
B electrolyte cup
C test plate
D locking device
E steel ball
F screw spindle
G transformer
H milliammeter

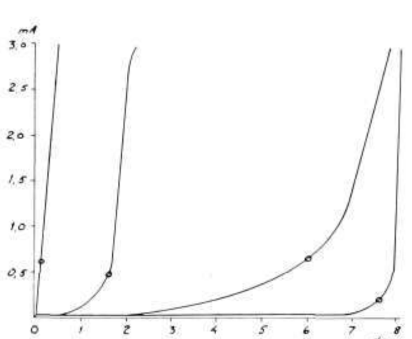


Fig. 3 X 4799

Diagrams

showing the relationship between current and depth of indentation for tests with lacquer tensometer. The points of the diagrams indicate the positions where it was possible to see cracks in microscope.

Principle

In the tensometer a steel ball *E* is pressed up against a horizontally clamped plate *C* producing an indentation in the plate. The upper surface of the plate is coated with a thin film of the material which is to be tested. As the indentation increases, the lacquer film extends to cracking. The test plate is firmly pressed against the bottom of a cup *B* containing an electrolyte. The inside and bottom of this cup is rubber covered and electrically insulated from the electrolyte and the test plate. The lacquer film will now act as an insulator in a circuit between the electrolyte and the test plate. The circuit, Fig. 2, also contains a power supply, *i.e.*, transformer *G* giving 2 V, the milliammeter *H* and the platinum electrode *A*. When cracks start to develope the insulation resistance is reduced and the current in the circuit is checked on the ammeter. The ball is pressed upwards by a screw fixed on wheel *F*, the latter being calibrated to indicate the depth of the indentation. For routine tests the indenting is proceeded with until the ammeter reads 0.5 mA and the depth of the indentation is then a measure of the quality of the lacquer film. If the depth of indentation and the corresponding current values are continuously recorded during the test the relationship between these values may be plotted in a diagram similar to Fig. 3. On the diagrams shown in Fig. 3, which are typical, points have been indicated where cracks can be discovered by microscope. The electrical indication method is apparently considerably more sensitive. The results obtained by visual inspection in microscope at 50 times enlargement agree throughout very well with those registered electrically. The depth of indentation at which the first cracks become visible in the microscope coincides with the region of the diagram where the current is showing a considerable increase. The electrical method of indicating the origin and progress of the cracking is preferably applied when more detailed information is required regarding the porosity, tensibility, cracking and adhesion of the film.

Application

The test is carried out in the following way. The test plate is placed with the film layer upwards and underneath the electrolyte cup, which is pressed against the plate and secured by the locking device *D*. The insulated cup is filled with electrolyte up to the platinum electrode by means of a pipette with rubber ball.

By turning the wheel slowly the steel ball is pressed against the plate until a reading is obtained on the ammeter. The meter should initially be adjusted for maximum sensitivity in order to discover the first small cracks. It should then be readjusted to a measuring range, which allows reading without readjusting up to the highest values to be covered by the test. Before removing the test plate the electrolyte is pumped out of the cup by means of the pipette.

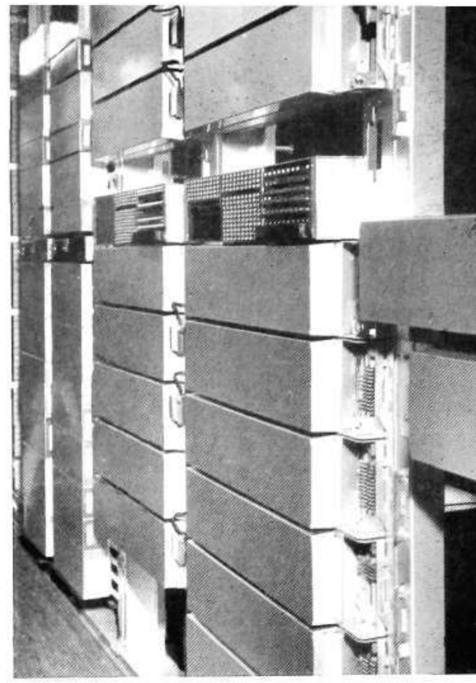
It is also possible to use the tensometer in conjunction with visual inspection of the film during the test by placing a microscope over the indentation and inspecting the cracks. Another method is to make a series of indentations to different depths which afterwards are inspected. It can then be established between which depths of indentation the cracking has commenced. These methods will, however, as mentioned above never reach the same accuracy as the electrical method.

To obtain uniform and definite test results a carbon steel plate of a special quality should be used as a base for the paint. This steel plate, which will be supplied on request, is 0.3 mm thick and 80 mm wide and withstands an indentation depth of 8 mm without breaking which is sufficient for the majority of tests. The plate should be stored with care, as it must not show any signs of corrosion. The plate should be thoroughly degreased before use with cellulose thinner or other degreasing agent.

The thickness of the film should not exceed 0.03 mm as in certain cases thicker films will give more variable results. Lacquers which dry by evaporation of the solvent, *e.g.*, nitro-cellulose lacquers, should not be tested earlier than one week (preferably two weeks) after the application. Airdrying oil varnishes should be left to dry at least two weeks, whereas for baking varnishes one or two days will suffice. Test plates which are to be compared should, therefore, be of the same age and have been subjected to the same treatment.

Suitable electrolyte is prepared by disolving 44 grammes calcium chloride (crystals) and 14 grammes ferro chloride (crystals) in 100 grammes water. If this solution is used the addition of a wetting agent will not as a rule be required. If, however, bad contact between the liquid and the film is suspected owing to variable results on identical test objects a wetting agent soluble in water may be added.

Ericsson LM NEWS *from* *All Quarters of the World*



International Trial Networks for Semi-Automatic Telephone Traffic

Automatic operation of telephone traffic between different countries has for a long time been the subject of an active interest of the International Telephone Consultative Committee (CCIF). As a result the Committee has worked out very detailed proposals for international semi-automatic telephone traffic and have recommended the telephone administrations to carry out trials under actual working conditions. Such trials are now in progress, on the one hand in a Western European network and on the other in a Scandinavian network. In the Western European network a one-frequency as well as a two-frequency system is tested for the signal transmission on the lines. This network connects Amsterdam, Brussels, London, Paris, Zürich and Milan. Between Zürich—Milan the two-frequency system only is used.

The Scandinavian trial network employs the two-frequency system only and contains three lines for each of the traffic routes Stockholm—Copenhagen, Stockholm—Oslo, Stockholm—Helsinki and Copenhagen—Oslo. The first trials on this network were carried out in January 1951 when equipment was completed to enable automatic switching from a trunk operator in Copenhagen straight through to subscribers in Stockholm.

The first call over this new international system was interchanged between Mr. N. E. Holmblad, Engineer-in-Chief at the General Directorate of Posts and Telegraphs in Copenhagen and Mr. Sven Nordström, Engineer-in-Chief of the Royal Board of Swedish Telegraphs in Stockholm. Most of the lines between the Scandinavian capitals were actually put into operation in 1951. The trial traffic to Helsinki was, however, not started until the autumn of 1952. From Copenhagen a line is connecting Amsterdam joining, in fact, the Scandinavian and the Western European networks.

The equipment in Stockholm, Helsinki and Copenhagen has been supplied by L M Ericsson and has been developed in close cooperation with the telephone administrations in the countries concerned. The trial installations are provided with a considerable number of control devices for the supervision of the traffic. The observations are reported to CCIF in order to enable the experiences to be incorporated in the recommendations for further extensions.

By means of the system now introduced an operator, in Copenhagen for instance, can obtain connection with a subscriber in another of the Scandinavian capitals by dialling the number of the required subscriber on a key set. No operator is required in the called country to assist in establishing the connection. This semi-automatic operation results in shorter waiting time for the subscribers and effects considerable economies for the telephone administrations as the number of operators taking part is reduced.

In case of language difficulties between the operators and the subscriber the operator throws a special key connecting an assisting operator in the called country. The calling operator indicates by this manipulation that the English, French or German language is desirable. For the Scandinavian countries the conversation with the assisting operator is as a rule carried out in the language of the called country.

The illustrations show: left switchboard in Stockholm and above to the right relay equipment.

L M Ericsson Installation for the Stockholm New Underground

The picture above shows the photoelectric system for the moving staircase in the Underground station at Fridhemsplan.

Swiftly and comfortably the passengers are transported to the platforms of the new Stockholm Underground with the assistance of the moving staircases which during rush hours are running continuously. In the day-time when traffic is slack, the passengers are automatically starting the stairs by means of photoelectric cells. These are shown in the illustration above and have been supplied by L M Ericsson who have over 10 years experience in this field. One of the first installations of this kind was the moving staircase at Skansen in Stockholm which is over 43 m long. This staircase, which is also controlled by photo cells, was opened 1938.

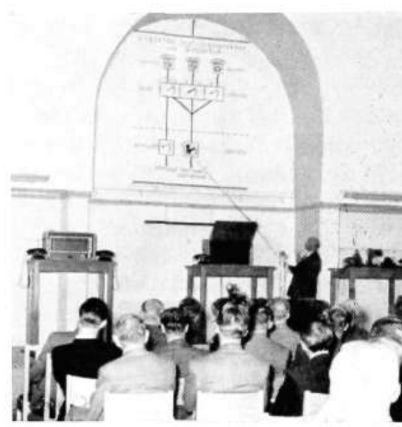
The Underground is also provided with an extensive alarm system supplied by L M Ericsson. Each ticket box is equipped with concealed signal push buttons conveniently accessible for the ticket attendant, who can summon the police in case of emergency. The alarm signals are transferred over various control boards.

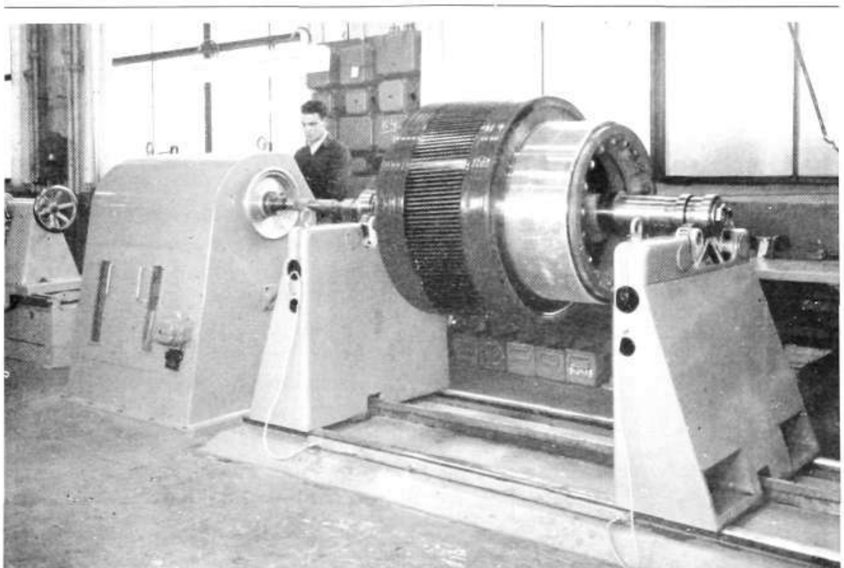
L M Ericsson's Signal Company has supplied a fair amount of material of railway engineering nature. Thus the company has delivered all point machines, all permanent signals, impedance connections, cables, cable fittings, frequency converters for converting 50 cycles to 75 cycles A.C. as well as signal transformers.

The loudspeakers fitted in the Underground carriages are also L M Ericsson products being produced by Svenska Radioaktiebolaget.

New Crossbar Switch Exchange in Holland

The Rotterdam telephone network was during the war very badly damaged. For one thing two district exchanges were bombed and totally destroyed. For a few years back an extensive building program has been carried out and it is calculated that the 115,000 subscribers in the city will be connected to the automatic exchanges during 1954. At the end of September one of the district exchanges was opened and with that the first crossbar switch exchange in the Rotterdam telephone district was put into operation. The illustration below shows the telephone director Mr. H. Meijer Drees demonstrating the new system for persons specially invited. The wall tableau illustrated the circuit for the first call.





Balancing Machines for Heavy Rotors

The range of balancing machines produced by L M Ericsson's Mätinstrument AB (Ermi) has recently been extended by two types for heavy rotors with a maximum weight of 1,000 and 5,000 kg and rotor diameters of 1,000 and 1,900 mm resp. The machine of the larger type illustrated to the left has recently been delivered to ASEA Västerås, where it is used to balance rotors for railway motors. A machine of the same type has also been shipped to the Swedish Railways' central works in Örebro.

The Brinell tester which in 1905 was delivered to Kohlswa Iron Works.

The smaller picture shows a modern Brinell tester.

Fifty Years Hard Work on Hardness

Some time ago a Brinell tester was sent to AB Alpha for a minor adjustment. When the tester was inspected it was found that it carried serial No. 2. From old records it was found that it had been manufactured in 1905 and that it had been sold the same year to the Kohlswa Iron Works. The customer stated that the tester had been in constant use for almost fifty years not only in the laboratories but also in various workshops.

About 1900 J. A. Brinell presented a paper to the Swedish Engineering Society publishing the result of his investigations regarding the hardness of metals according to the method which is referred to as Brinell's ball test and which has been accepted as standard for hardness testing.

During the following years AB Alpha designed a machine in cooperation with Brinell and the first of these were delivered in 1905. Alpha's Brinell testers can now be found all over the world and the company is still as 50 years ago the only Swedish supplier of any importance in this field.

National Fair at Tromsoe

A/S Elektrisk Bureau, a Norwegian Company cooperating with Telefonaktiebolaget L M Ericsson, took part in the national fair at Tromsoe with an interesting exhibition. The fair attracted great attention and was visited by 60,000 persons during the 12 days it was open. Among the visitors were also a few Laplanders who made acquaintance with modern engineering studying the exhibited products thoroughly. The photographer has above captured two Lapps at the exhibition stand of Elektrisk Bureau.

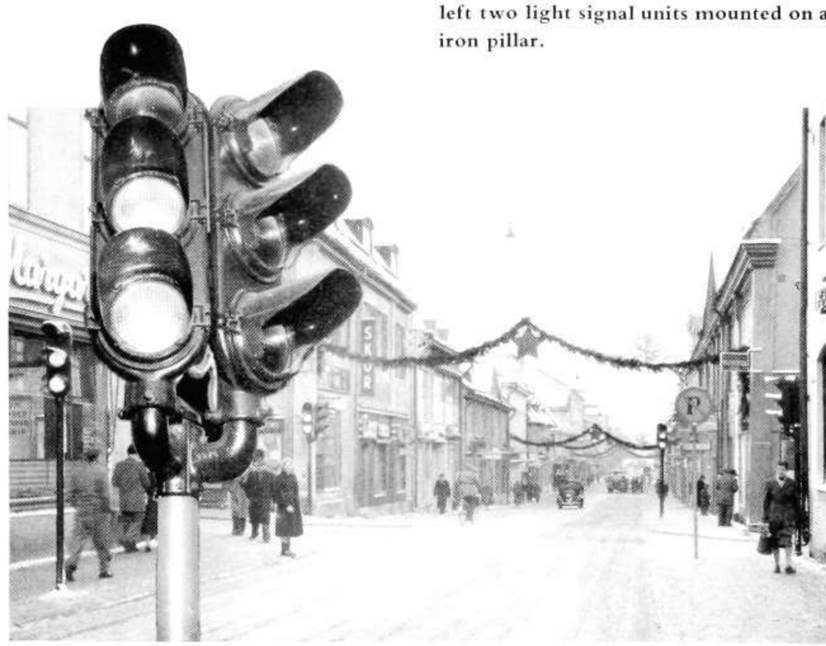
New Delivery of Vehicle Operated Traffic Signals to Västerås

Ericsson Review No. 1, 1951, contained a description of vehicle operated progressive traffic signals developed by the Signal Company and installed at four street crossings along Stora Gatan in Västerås. This system has now been in operation since May 1951 and has been working very satisfactory indeed at the same time as it has increased the traffic capacity and reduced accidents in the signal operated area.

From the beginning the system was planned for later extensions. At present signal equipment for two street crossings are being delivered. They are intended for cooperation with the system earlier installed.

The installation of the new equipment is estimated to be put into operation during the first quarter of 1953. A further extension of the system is already planned.

The illustration below shows the traffic signals at a few street crossings of Stora Gatan, Västerås. In the foreground to the left two light signal units mounted on an iron pillar.



Centuries and Seconds

Ancient and modern times are amply represented at the special exhibition "Centuries and seconds", which has been arranged at Nordiska Museet in Stockholm. Ingenious mechanical contrivances from the 17th century are ticking away side by side with robust grandfather clocks and graceful mantelpiece clocks. The development of the clocks and watches through the ages is completed by a presentation of the L M Ericsson speaking clock. In the illustration below the Swedish "Miss Time", Eva Ulvby, is standing at the side of the machine. Twenty years ago her voice was recorded on the discs which still are supplying the exact time.

The speaking clock, which was designed by Mr. Curt Ahlberg at L M Ericsson, transmits the time announcements from 90 basic recorded words, which in combination supply a total of 8,640 different time indications. The 90 words are photographically recorded on six round, flat discs in the same way as with sound film pictures and the transmission also takes place by the same method as that used on sound films.

New Telephone Exchange in Brazil

At Nova Friburgo — the beautifully situated Brazilian tourist resort — the automatic telephone exchange supplied by L M Ericsson has been put into operation. A few days before the opening the above photograph was taken of the front of the exchange premises in an interval in the work.

Turkish Visit to the L M Ericsson Main Factory

The director general and the technical director of P.T.T. in Ankara some time ago paid a visit to the main factory at Midsommarkransen. The photograph below was taken in the management dining room, where the director general Mr. Orhar Kubat is sitting in the middle of the sofa and to the right of him the technical director Mr. Enver Özkal. On the other side of the director general is Mr. Hans Thorelli, director for L M Ericsson, and Mr. Cornelius Berglund, chief engineer for the telephone department. To the extreme left is Mr. G. Åberg, chief engineer for the network department and standing Mr. Sven Ture Åberg, sales director.

The Five Millionth Telephone Instrument

As will follow from a separate article on page 100 in this issue a total of 5 million telephone instruments have now been produced in the Swedish L M Ericsson factories. In connection with this the employees with relations at the Karlskrona factory were invited to a party where among other things a recently completed film was shown which dealt with the production of telephone instruments and which was partly taken in the Karlskrona factory. The illustration above shows the final inspection of telephone instrument No. 5,000,000.

U.D.C. 621.395.721(091)

JOHANSSON, H: *Five Million Telephone Instruments.* Ericsson Rev. *29* (1952) No. 4 pp. 100—107.

Owing to the passing of the five million-mark during 1952 in the manufacture of telephone instruments a short summary is given of the development of the L M Ericsson telephone instruments.

U.D.C. 621.315.211.4

ÅBERG, G: *Gas Control on Telephone Cables.* Ericsson Rev. *29* (1952) No. 4 pp. 108—119.

The method of controlling the tightness of the sheathing in a telephone network by the application of a continuous over-pressure to the cable has been employed by numerous telephone administrations for many years past. In the article a brief report is given on the method and how it was applied as far back as the 1930s by L M Ericsson to the installations in Mexico together with the development of certain of the company's own methods, and also special materials and tools. A description of the novel features recently introduced in this branch.

U.D.C. 621.395.613.384

SÖDERSTRÖM, V: *Improved Telephone Headset.* Ericsson Rev. *29* (1952) No. 4 p. 120.

The telephone headset, type RLF 20, described in Ericsson Review No. 3/1940, has been redesigned. The article describes the advantages of the new design.

U.D.C. 621.395.721.5

PORSNER, S: *Battery Box for Portable Telephone Instruments.* Ericsson Rev. *29* (1952) No. 4 p. 121.

A battery box of transparent plastic material with place for two cylinder batteries has been designed by Telefonaktiebolaget L M Ericsson to be used in the portable telephone instrument DPA 10—13. Previously a special dry cell battery was used for the power supply. The article describes the advantages of the new design.

U.D.C. 621.317.39:667.61

JONNERBY, E: *Lacquer Tensometer.* Ericsson Rev. *29* (1952) No. 4 pp. 122—124.

In order to meet the requirements of instruments for testing surface finishing with paints and lacquers AB Alpha in cooperation with the Swedish Mechanical Trade Institute and the Central Research Laboratory of the Swedish Paint and Varnish Industries has completed the development of the lacquer tensometer, an instrument for testing the tensibility and adhesion of paint. Short description of the construction and function of the lacquer tensometer.

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Syrie

Georgiades, Moussa & Cie *Damas*, Rue Ghassan Harika, tel: 10289

Thailand

Thoresen & Co. (Bangkok) Ltd. *Bangkok*, (Radio and Electric Appliances Dept.) Wat Yanawa, tel: 30730, tgm: thoresen-bangkok

Türkiye

Genel Sanayi Techizati T. A. O. *Istanbul*, P. K. Galata 1455, tel: 44510, tgm: telotomat-istanbul

AFRICA

British East Africa

R. W. Ketchley Engineering Ltd. *Nairobi, Kenya*, P. O. B. 5182, tel: 3230, tgm: bonzl-nairobi

Egypt

Swedish Industries *Cairo*, P. O. B. 1722, tel: 51408, tgm: ecoproduct-cairo

Ethiopia

Swedish Ethiopian Company *Addis Abeba*, P. O. B. 264, tel: 1447, tgm: etiocomp-addisabeba

Moçambique

J. Martins Marques *Lourenço Marques*, P. O. B. 456, tel: 5953, tgm: tins-marques-lourençomarques

Tangier

Elcor S.A. *Tangier*, Francisco Vitoria 4, tel: 2220, tgm: elcor-tangier

Union of South Africa and Rhodesia

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

AMERICA

Bolivia

Johansson & Cía, S. A. *La Paz*, Casilla 678, tel: 2700, tgm: johansson-lapaz

Costa Rica

Tropical Commission Co. *San José*, Apartado 661, tel: 3432, tgm: troco-sanjose

Curaçao N. W. I.

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

Ecuador

Ivan Bohman & Co. *Guayaquil*, Casilla 1317, tel: Centro 208, tgm: boman-guayaquil

Guatemala

Nils Pira, *Guatemala City*, Apartado 36, tel. 3311, tgm: nilspira-guatemala

Haïti

F. Georges Naudé *Port au Prince*, P. O. B. A 147

Honduras

Cía de Comisiones Inter-Americana, S. A. *Tegucigalpa D. C.*, P. O. B. 114, tel: 15-63, tgm: inter-tegucigalpa

Nicaragua

J. R. E. Tefel & Co. Ltd. *Managua*, Apartado 24, tel: 387-11 69, tgm: tefelto-managua

Panama

Productos Mundiales, S. A. *Panama, R. P.*, P. O. B. 2017, tgm: mundi-panama

Paraguay

H. Petersen S. R. L. *Asunción*, Casilla 592, tel: 268, tgm: pargtrade-asunción. (Agent of Cía Sudamericana de Teléfonos L M Ericsson S. A. *Buenos Aires*)

El Salvador

Dada-Dada & Co. *San Salvador*, Apartado 274, tel: 48 60, tgm: dada-sansalvador

Surinam

C. Kersten & Co. N. V. *Paramaribo*, P. O. B. 216, tel: 125, tgm: kersten-paramaribo

Venezuela

Electro-Industrial »Halven», O. L. Halvorssen C. A. *Caracas*, Apartado 808, tel: 53848, tgm: halven-caracas

AUSTRALIA & OCEANIA

New Zealand

ASEA Electric (N Z) Ltd. *Wellington C. 1*, Huddart Parker Building, tel: 42086, tgm: aseaburd-wellington