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# To Commemorate the Centenary of Lars Magnus Ericsson's Birth 

1846 - May 5 - 1946

Memorial stone to Lars Magnus Ericsson set up at Värmskog Church on the centenary of his birth


The 5 th of May this year marked the hundredth anniversary of Lars Magnus Ericsson's birth. The centenary was celebrated both at Botkyrka churchyard in Södermanland where his remains rest and in his native parish of \armskog in Carmland, where a memorial stone was unveiled not far from the farmstead where he was born.

To commemorate its founder the firm of Telefonaktieholaget LME Ericsson has made donations amounting to half a million kronor. These include a foundation for the promotion of electro-technical research with a capital of 250000 kronor Its object is to grant stipendiums to engineers and students at Sweden's technical colleges who are desirous of carrying on scientific research at home or abroad in the domain of electro-technics that is of special interest for the activities associated with LM Ericsson.

Stipendiums for 1946 have been awarded to Engineer Torkel Wallmark for carrying on at the Royal Technical University supplementary research in the domain of electronics and to the licentiates of technology Bjorn Nilsson and Hans Werthén to enable them to study television and transmission in the domain of ultra high frequency in USA and Britain.

# New Series of Manual L. B. Switchboards with Cords 

ERIKI ENGQVIST, TELEFONAKTIEBOLAGET LM ERICSSON, STOCKHOLM
U.D.C. 621.395.33

The work of development that is constantly going on even in respect of manual telephone exchanges has now resulted in LM Ericsson's new series of extensible L. B. cord switchboards, differing rather considerably from those hitherto produced. By the introduction of brighter colours and softer lines, for instance, the character of the new switchboards as pieces of furniture has been brought out to a greater degree than was formerly the case. Moreover, as regards the component parts a distinct departure in respect of choice of material and methods of manufacture has taken place in the direction of modern moulding materials and die-casting practice. Lastly, the assembling into units of components organically associated has been still further developed. In this way there have been produced switchboards that are aesthetically attractive, durable, simple to operate and easy to extend.

The new series of LM Ericsson's L. B. cord switchboards comprises the following types of single position telephone switchboards:
wall switchboards for up to 50 lines,
floor switchboards > 》 > 100 》

$$
\ggg 200 \gg
$$

For multi-position telephone switchboards with up to 800 lines there will in addition be set up :
multiple switchboards, I-position, 2-panel,
multiple annex, combined with cable-turning section
The whole of the new series may be said to be based on fairly extensive new designing work in respect of the component parts, especially the calling and coanecting devices.

When this work of designing was started the goal set was the attainment of certain minimum requirements, which may be summarised as follows:

1) The calling and connecting devices of the lines to be assembled in units of to devices.
2) The equipment for a cord circuit to be assembled in a compact and easily manipulated unit.
3) All visual signals to be flush mounted but distinct and their restoration to be combined with other necessary operations.
4) The life of the cords to be lengthened by the introduction of plugs with protective spirals and if possible lighter pulleys.
5) Brighter surface finish of all woodwork to be introduced and particular attention devoted to form.
6) The advantages of bakelite to be taken into consideration for non-metallic parts requiring good insulation, hard-wearing surface or a complicated shape.
7) The complete switchboards, out of consideration for freight and customs charges, should be of small volume and light in weight.
8) The switchboards should be easy to erect and easy to extend.

In their present state the new series of L. B. switchboards very well fulfil the demands imposed.

Fig. 1
X 6215
Drop-indicator jack type RNE 15


## Components

The device that mainly sets its mark on the new L. B.-switchboards is undoubtedly the new drop indicator such as is used both as calling device on the lines or as clearing signal device on the cord circuit. The calling and connecting device for the lines has been made as a drop-indicator jack. Fig. I shows the new drop-indicator jack, which has been given the designation RNE 15. It comprises two main parts ; the calling indicator and the connecting jack.

The calling indicator magnetic field is the same in principle as earlier drop indicators. The winding space, however, has been diminished by about $25 \%$, thus making the whole indicator shorter. At the rear end the armature is pivoted on two guide pins and the width of stroke is determined by a lug bent out from the supporting flange of the coil frame.

The sensitivity is regulated by adjusting screw and spring in the rear of the indicator. The shutter itself has been given a form that allows it to lie flush and protected when the jack is fitted in its strip. In home position the shutter hangs on a hook formed on the front edge of the armature, while at the same time it keeps the alarm contact open. When the armature is attracted


Fig. 2


Fig. 3
X 4446
Clearing indicator type RNA 17


Fig. 4
Key type RMA 10
the shutter is released and falls by its own weight, on which the alarm contact is made. Restoration is done automatically when a plug is inserted in the jack. The calling indicator is normally wound with o.10 TE, giving app. zooo turns and 500 ohm . It works reliably for a delivered power of app. o.o4 W .

The comecting jack is built up in the usual manner with insulation inset of pure bakelite. The alarm contact is built on to the jack and has had its soldering tags so shaped that bare-wire connection between adjoining indicator jacks is possible. The connecting jack is attached to the indicator by a single screw: The jack is only made for $5.76 \times 23.8 \mathrm{~mm}$ plug, which is our present standard.

A special strip has been designed for the mounting of the indicators jacks. It is moulded of bakelite and holds ro jacks. For each indicator jack there is a circular hole for the jack sleeve and a rectangular opening for the shutter. The indicator jack is fixed in the strip by two screws. The so calling devices in a strip are always numbered from o to o. The figures are engraved and filled up with white.

Fig. 2 shows the complete indicator jack assembly, which has been given the designation R.VE 50. The dimensions of the front piece are: length 281.5 mm , height 36 mm , depth so mm . The assembly is therefore 12 mm lower than the old one. The weight of the complete indicator jack assembly is 830 g and a single indicator jack weighs $70 \mathrm{~g}, i . c$... half the weight of the old one.

The clearing indicator, with designation RN:A 17, is built up in principle like the calling indicator for the indicator jack. There has had to be arranged, however, a special alarm contact which, in view of the indicator's vertical position in the cord pair strip must also serve as tension spring for the shutter, which of course cannot in this case fall by its own weight. Moreover the armature has been so shaped that it prevents the release of the shutter by jars or knocks. Fig. 3 shows the appearance of the clearing indicator.

The key. Fig. 4. is of our normal execution type R.1.t 1o. An imnovation is that the frame is now die-cast in zine thus producing a more rigid frame with greater precision of construction than formerly. The pivoting of the lever arm has also been improved and as regards the switch handle plastic material has been adopted.

The plug and cord, Fig. 5, have abo been re-designed. The chief change in appearance consists in the addition of protective spiral. The shape and size of the plug itself have been retained, but the method of manufacture has been changed, moulding now being employed. A new method has been applied for the attachment of the cord to the plug, no screw being now required. The new plug, which has been given the number $R P R$ 3526, is always made three-pole. Despite the addition of the protective spiral, the length is no more than 90 mm and the diameter app. 10.5 mm .

The equipment for a cord circuit has been combined in one unit, called the cord circuit strip, Fig. 6. The frame of the cord circuit strip is moulded of bakelite and space is provided for the following devices, counting from the front:

1 clearing indicator
I speaking and ringing key
1 lamp (not shown on Fig. 6)
2 plugs
2 cord clip terminals.
The elearing indicator has been furnished with an iron sheath to prevent crosstalk. A mechanical coupling has been arranged between shutter and key enabling restoration of the shutter by means of the key.

Fig. 5
Cord (above) and plug RPR 3526

The cord circuit strip $R N N 10$ has the following dimensions: length 185 mm , width 25 mm , depth 85 mm . The weight of a complete unit is app. 300 g .

Fig. 6
Cord circuit strip type RNN 10

Fig. 7
Wall switchboard ABH 1605
for 50 lines and 10 cord circuits; left, with back open

## Wall switchboard

The smallest size single position telephone switchboard, see Fig. 7, is normally made for mounting on a wall. It has a capacity of 50 lines and 10 cord pairs. The switchboard is of light oak and all corners and edges are rounded. The front is dominated by a vertical panel for the line units and the position set, together with a projecting inclined table for the switching sets. The back consists of a hinged door, strengthened to meet the stresses when suspending the switchboard on the wall. In exceptional cases where local conditions do not permit of hanging on the wall the switchboard may be placed on a special stand, see Fig. 8.

The o-line unit, Fig. 9. comprises a completely wired unit for the calling devices of ten lines. It consists of an indicator jack assembly RNE 500I a terminal block NEM IOOI with screw terminals and a connecting cable. All the o-line unit - in the wall switchboard are alike, both in respect of the numbering of the jacks and of the form of cable.



Fig. 8
Wall switchboard ABH 1605
on stand

The switching set, Fig. ro, contains the fixed parts of a cord circuit. It consists of a cord circuit strip RNN IOOI, containing clearing indicator, key and cord clip terminals, together with a connecting cable terminating in a 20 -pole plug. Corresponding 20 -pole jacks are located on the position set. Connecting up of a switching set can therefore be done by simple plugging, without the employment of soldering irons.

The position set, Fig. 11, consists of a wood panel covered with paper bakelite, on which all components common to the switchboard are fitted. On it will be found the hand generator and the night bell, the keys for connecting in the pole-changer and the bell, the keys for ringing on and insulating the answering cord, together with terminal block for the handset and dial if any. In addition the position set contains the above-named 20 -pole jacks, which may be said to comprise the assembly bars for the switching sets. Connections to batteries, pole changer and additional bell are drawn to a separate terminal block. The operator's telephone is an ordinary handset with key, attached to the switchboard.

The terminal strips for 10 -line units and position set are located on the rear door of the wall switchboard, which also provides good space for incoming cables.

The new wall switchboard has been given the designation ABH 1605. The dimensions are:
height 490 mm (with cords and pulleys 870 mm )
width 335 mm (excl. crank and handset)
depth 415 mm .
The net weight of a fully assembled switchboard is app. 25 kg .
The floor stand for the wall switchboard has been given the designation $B A R 2510$. It is 480 mm high and weighs app. 7.5 kg .

## Floor switchboards

The single position floor switchboards are made in two sizes, one with a capacity of 100 lines, Fig. 12, one with a capacity of 200 lines, Fig. I3, both of them with a maximum of 20 cord pairs. Variants are obtained by placing a low or a high upper part on the same lower part.



Switching set

Fig. 11
X 7417
Position set
for wall switchboard, right seen from behind


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Fig. 12
X 6210
Floor switchboard ABK 2010
for up to 100 lines and 20 cord circuits, at right with back removed


Fig. 13
Floor switchboard ABK 2020
for up to 200 lines and 20 cord circuits


The switching set for the floor switchboard is exactly the same as for the wall switchboard, see Fig. 10.

The position set, Fig. 14, for the floor switchboard is in the main the same as the unit for the wall switchboard. For practical reasons, however, the hand generator has been taken out and placed in front in the desk top. In addition, the connection of the operator's telephone has been made with 4 -pole plug, located at the left under the desk top. The floor switchboard is normally delivered with the new headpiece transmitter-receiver, but of course a handset can also be used.

The terminal blocks for the 10 -line units and position unit are fitted so that they are easily accessible from the back of the switchboard.

The new floor switchboard has been given the designations. ABK 2010 and $A B K 2020$ for the 100 och 200 line switchboards respectively. The dimensions are: height 11 to mm and 1290 mm resp. width 634 mm depth 765 mm .

The net weight for a switchboard $A B K 2010$ with 100 lines and 12 cord circuits is app. 66 kg . The corresponding switchboard $A B K$ 2020 is app. 5 kg heavier. while an $A B K 2020$ with 200 lines and 19 cord circuits weighs app. 86 kg .

As stated earlier, all these switchboards are capable of extension. Consequently in a switchboard not completely fitted up the unoccupied space must be covered in one way or another. For this purpose special covering strips of bakelite have been designed, one for a to-line unit and one for a switching set.

## Circuit diagram

The switchboards without multiple, i. c., wall switchboard ARH 16 and floor switchboard $A B K 20$ are connected up according to the same diagram, Fig. 15. The dial $D$ and the relay $D R$ are not normally comprised in the switchboards. They are provided only in those isolated cases when the switchboard is to be equipped with exchange lines to automatic main exchange, in which event the dotted connections are also fitted.

The connecting proces for the establishment of a call is in the main as follows:
The suscriber calls the exchange by turning the crank of his telephone instrument. The ringing current thereby produced causes the calling indicator Cl to drop, this providing a distinct visual signal for the operator. If the key NB is operated, there is also given at the same time an audible signal from the bell $B$. The operator takes an unoccupied cord circuit, connects the speaking and ringing key in position $S K$ and plugs the answering plug $A P$ in the calling

Fig. 14
X 6214

## Position set

for floor switchboard

Fig. 15
X 6218
Circuit diagram
for ABH 16 and ABH 2 C

| AP answering plug with cord |  |
| :--- | :--- |
| B | bell |
| EB | extra bell |
| Cl | calling indicator |
| J connecting jack | combined indicator |
| HG | hand generator |
| IC | speech transformer |
| La-Lb subscriber line |  |

answering plug with cord
xtra bell
calling indicator | combined indicator
connecting jack $\mid$ and jack
hand generator
IC speech transformer
-Lb subscriber line
MB microphone battery

NB night bell key
RB ringing back key
$\begin{array}{ll}\text { RK } & \text { ringing key } \\ \text { SK } & \text { speaking key }\end{array}$ 3-position key
RP ringing plug with cord
$R V$ ringing visual
splitting key
clearing indicator
pole-changer key

subscriber's connecting jack $J$. The action of plugging restores the drop indicator automatically, this being disconnected at the same time from the subscriber's line. The operator is now in connection with the calling subseriber and answers in appropriate manner.

Having received information of the line wanted, the operator by a quick glance sees what is the situation with this. If the line is busy, the subscriber is notified and disconnection takes place. If it is unoccupied the operator inserts ringing plug $R P$ in the jack $I$ of the wanted line and rings up.

Ringing may be done in two ways. One is, with the key thrown to position $S K$. to turn the crank of the switchboard's generator $H G$. whereupon ringing current is automatically transmitted over the ringing cord to the subscriber.


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The other way, which requires that a pole-changer is connected, is to throw the key from position $S K$ to position $R K$ and keep it there as long as ringing signal is to be transmitted. In both cases the ringing visual shows white as sign that the line loop is closed and that ringing current is being transmitted. When ringing signal has been transmitted in one of these ways the key is restored to home position and the connection is established. On account of the poor supervision occurring with all L. B. switchboards the operator, however, should after 8-10 s break in on the cord circuit to make sure that the called subscriber has answered and that the call is proceeding.
During conversation the cord circuit clearing indicator is connected in between the speaking wires. Consequently when one of the subscribers rings off at the close of the conversation the clearing indicator falls, giving the operator a distinct visual signal and, if connected, an audible one as well. The operator connects herself in for a moment on the cord circuit by throwing the key to position SK, thereby restoring the clearing indicator. After the operator by listening has made sure that the call really is terminated disconnection may be carried out.

The above-tescribed connecting process may be regarded as the normal. Its feature is that the operator speaks only with the A-subscriber and rings only to the B-subscriber. In exceptional cases, however, the operator may need to speak with the B-subscriber without the A-subscriber hearing and this is made possible by the splitting key $S$. In some cases it may be necessary for the operator to ring up the A-subscriber again and this is possible with the ring back key $R B$.

## Accessories

A manual L. B. telephone switchboard of the kind described above is not complete without certain accessories, mainly current supplies of various kinds. Thus for the operator's speaking device there is required a microphone battery of 3 V . suitably made up of dry cells.
For the alarm circuit and pole-changer, if any, there is further required a signal battery of 4.5 V , this too consisting of dry cells. Pole-changer for producing the necessary ringing current is not absolutely necessary for the functioning of the switchboard, but it facilitates operation so considerably that it is advisable.

## Packing

Owing to the extent to which the principle of units for lines, cord circuits and position equipment has been carried out, it is a very simple matter to fit up a telephone switchboard. It is also more easy to rationalise the manufacture of units and the keeping of stocks is facilitated very much, as in future it will not be necessary to hold complete switchboards in stock but the switchboards can be delivered in parts. The assembly of the switchboards can easily be done by a fitter with no other tool than a screwdriver.
A telephone switchboard with cords will in future be delivered in the following parts:

1. a switchboard frame, whole for wall switchboards and in two parts for floor switchboards;
2. a number of ro-line units, each one in its own carton ;
3. a number of switching sets, likewise in cartons;
4. a position set, either packed in separate carton or inserted in the switchboard frame;
5. a number of cords and pulleys wrapped in parcels:
6. a carton with the requisite cover strips, handset hook, generator crank, screws etc.
-. miscellaneous accessories such as microtelephone, batteries, pole-changer etc.
The whole outfit is packed together in a suitable case. The new method of packing will also reduce risk of breakage in transport.

# New Single Channel Carrier Frequency Telephone System for Open-wire Lines 

E EKLUND.<br>TELEFONAKTIEBOLAGET LM ERICSSON<br>STOCKHOLM

U.D.C. 621.395.44 bolaget LM Ericsson. This system replaces the older system ZL 400, described in Ericsson Review No 2 1936, 250 equipments of which have been delivered to 11 countries By the application of advanced technics of filter design and modern elements of construction the dimensions and weight of the new system have been reduced considerably compared with those of older systems. The system ZAF 11 will hereby turn out more economical even for such a short distance as about 58 km . The range is 700 km without intermediate repeaters when using an open-wire circuit of copper wires with a diameter of 3 mm .

## Frequency Allocation

The frequency allocation of the new system is almost the same as for the older system ZL foo. The frequency allocation is shown in Fig. 1. The carrier frequencies which are 6.3 and $10.2 \mathrm{kc} / \mathrm{s}$, are suppressed by the modulators. On the line only the lower side bands are transmitted corresponding to the voice frequency range $200-2700 \mathrm{c} / \mathrm{s}$. Thus the frequency bands are, transmitted by A-station $3.6-6.1 \mathrm{kc} / \mathrm{s}$, transmitted by B-station $7.5-10.0 \mathrm{kc} / \mathrm{s}$. The low-pass branch of the line filter has a cut off frequency of $3.0 \mathrm{kc} / \mathrm{s}$.

## Transmission Properties

An over-all attenuation curve is shown in Fig. 2 referring to the carrier frequency communication. Apparently the over-all attenuation is practically constant within the frequency range $200-2700 \mathrm{c} / \mathrm{s}$.
The range or repeater section respectively is given below, calculated for copper wire lines and for a maximum line attenuation of 5 nepers:

| conductor dianeter mm | range km |
| :---: | :---: |
| 2.5 | $500-550$ |
| 3.0 | $600-700$ |
| 4.0 | $750-850$ | carrier frequency system, type ZAF 11



Fig. 2 Z 21025
Over-all attenuation from fork to fork


## Main Properties

The main propertics of the new system is given below:
number of carrier frequency commu-
nications . ........................ $=$ I
transmitted voice frequency band $\ldots=200-2700 \mathrm{c} / \mathrm{s}$
frequency range on the open-wire line $=3.6-10.0 \mathrm{kc} / \mathrm{s}$
output level on the line $\ldots \ldots \ldots$. $=$ alternatively $+2.0+0.7$ or $\pm 0$ nepers
lowest admissible input from the line $=-3$ nepers
range or repeater section alternatively
when using a 3 mm copper line.$=700 \mathrm{~km}$
maximum line attenuation of a re-
peater section $\ldots \ldots \ldots \ldots \ldots$........... $=5.0$ nepers
imput and output impedances $\ldots . .=600$ ohms

## The Equipment of the Terminal Station

The simplified block schematic of Fig. 3 shows the design of a terminal station and how it is connected to the line and the subscriber.

Having passed the four wire termination equipment consisting of a relay equipment and a resistance bridge the voice frequency currents of the subscriber's set CC pass a variable attenuation A on the transmitter side, see Fig. 3. Thereafter the currents pass the transmitter band pass filter $S_{t}$ which admits the frequency band $200-2700 \mathrm{c} / \mathrm{s}$. By this the modulator is protected against the ringing currents which may eventually enter the transmitter part of the apparatus. The modulator consists of copper oxidule rectifiers. Here the voice frequencies are molulated with a carrier frequency of $6.3 \mathrm{kc} / \mathrm{s}$ in the A-station or of $10.2 \mathrm{kc} / \mathrm{s}$ in the B-station.

The carrier frequencies are suppressed by the balanced modulator bridge and only the lower side band passes through the transmitter band filter $S 2$. This side band is $3.6-6.1 \mathrm{kc} / \mathrm{s}$ in the A-station and $-.5-10.0 \mathrm{kc} / \mathrm{s}$ in the B-station. The transmitted side band is then amplified by the transmitter amplifier which is negatively fed back and is by this given a correct frequency response and stability. The transmitter amplifier may be regulated to three different amplifications which give an output level of $0,+0.7$ or +2.0 nepers. After having passed another transmitter band filter $S_{3}$ the side band passes a compensating network and the line filters on to the line.

Fig. 3
X 6224
Block schematic of terminal station
A variable attenuator
B balance
CC carrier frequency communication
Dem demodulator
G four-wire termination
HF transmitter amplifier
LF low frequency amplifier
M receiver filter
Mod modulator
O oscillator for 3 frequencies
P compensating network
PhC physical channel
S transmitter filter


Fig. 4
Z 21027
Oscillator stability at variable anode voltage (a) and variable temperature (b)


The incoming side band passes the line filters, the compensating network and a band pass filter $1 / I$ on the receiver side. After this a variable attenuator is passed containing ro $\times 0 .+$ nepers and one more receiver band filter $\mathrm{M} / 2$.

Aiter the demodulator the voice frequency currents produced therein pass a low pass filter and are amplified in a low frequency amplifier with its amplification variable in 10 steps of 0.1 nepers. After the low frequency amplifier the currents pass the four-wire termination equipment on to the subscriber's set. It is possible to disconnect the four-wire termination equipment and run the system as a four-wire circuit.

The ringing is done according to the same principles as used in LM Ericsson's normal voice frequency ringing system with a constant frequency of $500 \mathrm{c} / \mathrm{s}$. The voice frequency ringing receiver is combined with the low frequency amplifier. The rectified ringing tension gives an augmentation of the anode current in one of the valves of the amplifier which is connected in series with a relay. This relay transmits an A . C. current with a frequency of $20 \mathrm{c} / \mathrm{s}$ to the subscriber's set.

The ringing voice frequency $500 \mathrm{c} / \mathrm{s}$ is produced by an oscillator comprising one single valve. Moreover this oscillator gives the two necessary carrier frequencies 6.3 and $10.2 \mathrm{kc} / \mathrm{s}$. The frequencies are stabilized by means of currentpiloted resistances. This makes the oscillator more independent of alterations of the characteristical properties of the valve and stabilizes the output power. The oscillator coils are made with temperature-compensated dust iron cores. The stability curves of the oscillator are shown in Fig. 4 .

## Intermediate Repeater

A simplified block schematic of an intermediate repeater is shown in Fig. 5. The repeater contains only one single amplifier which is common for both directions.

After having passed the line filters, where the physical channel is separated from the carrier frequency channel, the incoming frequency band of the direction $A$ to $B$, from left to right in Fig. 5, passes the directional filter $A B I$ and enters the imput transformer of the common amplifier via a variable attenuator with 10 steps of 0.4 nepers. The input transformer is designed as a differential transformer in order to make the two directions independent of the impedances of one another. Besides the variable attenuator of $10 \times 0.4$ nepers there is a push button switch by which an attenuation of 0.2 nepers may be connected in or out. The amplification may thus be regulated in steps of 0.2 nepers. The maximum amplification is 5 nepers.


Fig. 5
X 6225
Block schematic of intermediate repeater
$A$ variable attenuator
$A B 1, A B 2$ band-pass filter direction $A-B$
$B A 1, B A 2$ band-pass filter direction $B-A$
PhC physical channel

Fig. 6 Z 21029
Attenuation of low-pass branch of line filter

Fig. 7
Z 21030
Attenuation of high-pass branch of line filter


The amplifier contains two valves and is negatively fed back. Thus the production of harmonics is very small and the stability great. After the amplifier the frequency band passes the directional filter $A B 2$ and thereafter through the line filters on to the line.

In the opposite direction $B$ to $A$ the progress is analogous.

## Equalizing Equipment

The line attenuation varies with the frequency. It will be equalized in the receiver amplifier of the terminal station as well as in the repeater station by making the negative feed back and thus the amplification dependent of the frequency by suitable design of the feed back elements. In the receiver amplifier as well as in the amplifier of the intermediate repeater tuned resonant circuits are used in the feed back equipment. These resonant circuits will compensate for the augmentation of the attenuation in the vicinity of the cut off frequencies. Besides the slope of the amplification curve can be varied by connection of condensers.

## Line Filters

The low-pass branch of the line filter has a cut-off frequency of $3 \mathrm{kc} / \mathrm{s}$. The attenuation curve is shown in Fig. 6. The high-pass filter has a cut-off frequency of $3.45 \mathrm{kc} / \mathrm{s}$. The attenuation curve is shown in Fig. 7.
The balancing filters are always delivered. They are necessary in the terminal stations as well as in the repeater stations when the physical circuit will be repeatered. Also filter imitations and the corresponding balancing devices are always delivered. They are necessary when the system serves on one side circuit of a quad. All these filter devices are built-in in the terminal equipments as well as in the intermediate repeater equipment. The line transformers can also be connected inside the line filters. The line filter equipment of the system Z.AF $I I$ is shown in Fig. 8. Every terminal station has one and every repeater station such filter equipments.


Fig. 8
Z 21031
Line filter equipment and connection to line transformers

A to compensating network and directional filters
$\mathrm{B}_{1}$ to line balancing network 1
$B_{2}$ to line balancing network 2
BF VF balancing filter
C to switchboard or two-wire repeater
F filter compensation
FB to phantom-balancing network
$\left.\begin{aligned} & \text { HP } \\ & \text { LP }\end{aligned} \right\rvert\,$ line filter
$L_{1}$ to line 1
$L_{2}$ to line 2
$T$ line transformers


## Supervisory Arrangements

All tensions, levels and anode currents may be measured by one common instrument by means of a switch. This switch has positions for the measurement of filament voltage, relay voltage, anode voltage, the anode current of every valve, transmitted level, received level, carrier frequency level in the transmitter and in the receiver.

Moreover a handset makes it possible by means of some switches to communicate with the subscribers at near and far ends of the carrier frequency communication as well as of the physical communication. It admits also monitoring.

By means of a U-link strip it is possible to execute special measurements directly on the line side as well as on the subscriber's side. Finally alarm is given if the mains voltage fails or if any fuses are blown.

## Power Supply

The single channel system Z.AF 11 may be delivered with or without a mains supply set to deliver the necessary working voltages: 130 V anode voltage, 24 V relay voltage and 21 V A. C. voltage for the filaments. The mains supply set which is shown in Fig. 9 and 10, is built so that it may be mounted in the equipment or taken away very simply without any soldering.


Mains supply set with emergency converter
seen from below

Terminal equipment
left type ZAF 11, right the older type ZL 420

When the mains fail a built-in relay connects automatically the 24 V station battery. The filament current $21 \times$ is got by means of a series resistance from the battery and the anode voltage by means of a built-in converter 24 V D.C./ 130 V D.C. The mains supply set may be switched to match the mains voltages $110 \mathrm{~V}, 150 \mathrm{~V}$ and 220 V of $50 \mathrm{c} / \mathrm{s} \mathrm{A}$. C. It has a magnetical voltage regulation device and is therefore within large margins independent of the mains voltage variations.


| workin |  |  | terminal | repeater |
| :---: | :---: | :---: | :---: | :---: |
|  | on | A.C. mains | 40 VA | 35 VA |
| \% | \% | 24 V battery | 1.4 A | 1.3 A |
| 》 | 8 | 24.1 and 130 | 24 V 0.40 A | 0.40 A |
|  |  |  | 130 V 0.03 A | 0.02 A |

## Mechanical Design

The terminal equipment as well as the intermediate repeater are fitted in cast metal hoxes of aluminium alloy of the size: width 451 mm , height 530 mm , depth 190 mm . The weight incl. mains supply is 56 kg .

All control devices are placed on the front side as shown in Fig. II to the left. The boxes are designed so that they may be mounted in normal bays by means of iron bands on their rear side. The compact but surveyable mounting of a terminal equipment is shown in Fig. 12.

## Valves

In the system only one valve type is used, RTR $41 \not 2^{2}$, with the following characteristics:

| ament voltage》 current | $\begin{aligned} & 5.25 \text { V } \\ & 0.380 \mathrm{~A} \end{aligned}$ |
| :---: | :---: |
| anode voltage | 130 V |
| current | 15 mA |
| grid bias | -8 ${ }^{-}$ |
| slope | $2.0 \mathrm{~mA} / \mathrm{l}$ |
| internal res | $0.1 \mathrm{M} \Omega$ |

The terminal equipment has four and the intermediate repeater two valves coupled in series.

## By-Pass Equipments

If the physical channel is to be taken out at an intermediate station on the line but the carrier frequency channel has to pass, a by-pass equipment, type ZCT

Fig. 12
X 7419
Terminal equipment
left with, right without mains supply set
$120 I$ or 1202 , must be used. This consists of two normal line filters, the highpass filters of which are connected in series by means of a shielded transformer. The by-pass equipment also has a jack panel and a connecting panel.


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It is fitted in a cast metal box of aluminium alloy, which along with the terminal equipment can be mounted in normal bays. In case a two-wire repeater is inserted in the physical channel a similar by-pass has to be connected to its balance side.

## Catalogue Codes

| code | number of balancing filters | power supply | transmitter frequency range | kind of station |
| :---: | :---: | :---: | :---: | :---: |
| ZAF IIII | I | A. C. mains | $3.6-6,1 \mathrm{kc} / \mathrm{s}$ | terminal |
| ZAF 1112 | - | $50 \mathrm{c} / \mathrm{s}$ |  |  |
| ZAF 1113 | I | battery |  |  |
| ZAF 1114 | - |  |  |  |
| ZAF 112 I | 1 | A. C. mains | $7.5-10,0 \mathrm{kc} / \mathrm{s}$ |  |
| ZAF 1122 | - | $50 \mathrm{c} / \mathrm{s}$ |  |  |
| ZAF 1123 | I | battery |  |  |
| ZAF 1124 | - |  |  |  |
| ZAF 1131 | 2 | A. C. mains | - | intermediate repeater |
| ZAF 1132 | - | $50 \mathrm{c} / \mathrm{s}$ |  |  |
| ZAF 1133 | 2 | battery |  |  |
| ZAF 1134 | - |  |  |  |

Example:
ZAF 1111 is a terminal station with the transmitted frequency range $3.6-6.1$ $\mathrm{ke} / \mathrm{s}$ provided with a balancing filter for the use of a two wire repeater on the physical circuit and designed to be supplied with A. C. current from the 50 c/s mains.

# Electric Interlocking Sakskøbing Station 



U.D.C. 626.257

Towards the end of 1945 a new electric interlocking plant was put into service at Sakskobing Station, and as the plant is the first in Denmark to use the all-relay interlocking machine of LM Ericssons Signalaktiebolag, Stockholm, the following description may be of interest.

Fig. 1
X 7416
Station lay-out


The employment of interlocking plants on the Danish private railways, which mostly consist of sections with small traffic, is rather unusual and a few years ago the Lolland Main Line, serving the market towns of Nakskov, Maribo, Sakskobing and Nykobing Falster was no exception to the rule, though this line has a comparatively large passenger and goods traffic. For instance, quite a number of special trains are run on the section in the sugar beet season, when the many thousands of tons of beet grown on the fertile fields of Lolland provide the line with large loads.

At the beginning of the war, when traffic and thereby the revenue of the line, after falling off for some years, began again to rise, the management of the line (Det Lolland-Falsterske Jernbaneselskab, the Lolland Falster Railway Co., at Maribo) decided the time was ripe for the introduction of interlocking plants at the more important junction stations. To begin with 3 rural stations were provided with mechanical interlocking plants of fairly simple design.

When the turn came of providing Sakskobing with interlocking plant it was originally proposed to continue with the same simple type of plant, but the urban character of the station involving considerable shunting and train marshalling, both during and outside the regular traffic, imposed such demands on rapid and labour-saving operation of the plant that this form of construction was not capable of satisfying the requirements of the traffic. Among other things it was required that some of the points could be shifted for train routes from the central apparatus, whereas those same points should be operated on the spot for train marshalling.

The only satisfactory arrangement therefore was the employment of electric interlocking plant and after negotiation with LM Ericsson A/S, Copenhagen, the decision was made for a plant with all relay interlocking machine and in general of about the same type as that of which the Swedish State Railways had ordered 25 in 1941.



Fig. 2
Point machine
with cover removed

Among the advantages obtained with the choice of this type of apparatus was that the central apparatus could be housed in the telegraph office with no other reconstruction than the addition of a window bay about 0.8 m deep, an arrangement that would in any case have been necessary to provide a view of the centrally operated points from the central apparatus.

## Execution

An idea of the track system and the lay-out of signals, points and track locks may be obtained from Fig. 1. The figure shows the track diagram for the station operating plan. As may be seen from the diagram the entrance signals are made as daylight lamp signals which can display »danger» and sclear». In these signals the Danish State Railways standardized 30 V 15 W lamps are used.

For central operation of the entrance points 102 and 112, the Signalbolaget point machines with built-in lock are employed. The local operation of these points is done from local switches fitted on stands beside each point. Before local operation can be undertaken release must be given from the central apparatus. Release is notified to the staff on the spot by a control lamp fitted in the local switch lighting up. The mounting of the point machine at the points may be seen from Fig. 2, showing the engine with cover removed.

The centrally operated points are protected against premature shifting in the usual way with insulated rail in connection with track relays that break the circuit to the operating relay of the point when the insulated rail is entered.

In addition to the insulated rails provided before the centrally operated points, protection against signal being given to a train route already containing train is provided by establishing track insulation of the main tracks I and II for the length of the platforms. By means of a track relay connected via the entrance point control relay contacts to the train route to which the points lead, the insulated track is in relation to the giving of signals, so that the signal can only be set at »clear» when the insulated section is unoccupied. As the insulation therefore is not continuous, the acting stationmaster is not freed from supervision of the train routes.

The fixing of the train routes is done by means of two supervisory current blocking relays - one for each signal - which break the operating and unlocking circuits when a signal is changed to »clear».

The train route unlocking is done automatically when the train entering has passed the track insulation at the entrance points and has entered the insulated train route track.

In selecting the method of locking for the individual points various considerations, both economical and technical in respect of tracks and safety, have had to be taken into account.

For points in the immediate neighbourhood of the interlocking machine and for points to sidings used comparatively seldom there is employed key locking on the wellknown key-lock principle by which the insertion of a master key at the interlocking machine ensures the correct setting and locking of the points. The points in the main line tracks are moreover provided with a Bruchsal point lock for fixing the point tongue setting.

For the other points in main line tracks use is made of electric locks of Signalbolaget's point lock type in conjunction with Bruchsal service lock, as may be seen from Fig. 3 where the electric point lock is shown with cover open.

Point lock
with cover open
Fig. 3

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Fig. 4
X 5442
Key locked points with electric key central

The rest of the centrally locked points are located in sidings and are of such design that fitting with point locks in conjunction with electric locks cannot be done in satisfactory manner, and as these points only occur as safety points, only traversed during shunting, it was decided in this case to have key locking without point locks. Owing to the remoteness of these points from the interlocking machine, however, it was not possible here to make use of the usual arrangement with locking by master key direct at the interlocking machine, and instead there was adopted an arrangement with locking under a lock controlled by electric block magnet (>electric key centrals), fitted in a box at the points concerned. The electric key central is thus connected with the interlocking machine in that the key for the points must be locked in the key central before signal can be given and it can only be taken out when the signal is again moved to sdangers and by operation of a contact at the interlocking machine the way has been cleared for unlocking. On Fig. 4 may be seen such a key-locked points with their electric key central.

## The Interlocking Machine and the Internal Equipment

A brief description will now be given of the interlocking machine and the internal equipment associated with it. A more detailed description of the interlocking machine itself, which as stated is of LM Ericsson's all-relay type. is not called for here, as the machine does not differ irom the press-button interlocking machine» used in Sweden, described in earlier numbers of this Review. It is sufficient to recall that the aim of the design has been to produce a central apparatus for small stations, giving the simplest possible operation, ensuring the interlocking advantages generally achieved with electric interlocking plants and taking up the smallest possible space.

The interlocking machine at Sakskobing is mounted on a relay cabinet that is placed against the wall facing the platform in the window bay mentioned earlier, Fig. 5. In this way the apparatus takes up very little room in the telegraph office, while the arrangement provides a good view of the track system from the operating position in front of the interlocking machine and at the same time it is possible from the desks to keep an eye on the interlocking machine.

On the right hand side of the relay cabinet there has been provided place for a writing desk where the train journal may be kept.


Fig. 5
X 6208
The interlocking machine at Sakskobing


Fig. 6
X 4443
Interlocking machine and relay cabinet

The relay cabinet is constructed of light oak and is fitted with removable front and sides, so that with these removed a good view and easy access to the relays etc. in the cabinet is obtainable.

The operating and control relays, the auxiliary relays for the centrally operated point sand the track occupying relays are made as mantled relays and manufactured by L.M Ericsson, Stockholm. The other relays are supplied by $\mathrm{A} / \mathrm{S}$ Danske Signalindustri, Copenhagen, as unmantled relays designed for suspension on iron supports.

A- all the relays, resistances and fuses, as well as the various cable terminals are fitted in the relay cabinet, complete connecting up and testing of the central apparatus and the relay cabinet could be done at Dansk Signalindustri's factory in Copenhagen, thus reducing considerably the work of erection on the spot. Fig. 6 shows the relay cabinet and the interlocking machine before despatch from the factory:

## Current Supply

As regards the current supply plant it should be noted that the current for the point machine motors and point lighting is taken direct from the 220 V railway power network, whereas the other current consumption is provided by a $220 / 45 \mathrm{~V}$ converter, part of it direct over 24 V Nife battery coupled to the same converter. The delivery of current takes place over the distribution panel seen at the left of Fig. 5, from which the points lighting groups are also lighted.

The cost of electricity in Sakskbing being relatively high, special attention has been given when arranging the plant to keep the current down to a suitably small amount. Thus the daylight lamp signals are generally extinguished except at train times and only the train route lock relays have constant current. It is only when shunting and signalling are proceeding that the converter is run and the generator tension is kept regular in such a way that in addition to the current necessary for daylight lamp signals, control circuits ete. there is delivered suitable charging current to keep the battery charged. The starting and stopping of the converter is done by operation of a contact on the distribution panel in connection with an automatic starter, with a manually operated starter in reserve.

When the management of the line reached the decision to establish an electric interlocking plant at Sakskobing there was felt some doubt whether such a complicated and finely adjusted plant would operate with sufficient reliability. Now that the interlocking plant has been in service for about $3 / 2$ year, operating satisfactorily through the bad weather of winter with snow and frost, it is with full confidence and not without fundamental experience that a start is made with a plant of the same type for the next station on the line to be given interlocking plant, that is Maribo.

# Svenskradio 463 - New Radio Receiver in Estrade Model 

C FREDIN, SVENSKARADIOAKTIEBOLAGET, STOCKHOLM

I. D.C. 621.336.621

Svenskradio 463 is a new 4 -valve superheterodyne of Svenska Radioaktiebolaget's make, which in respect of sound quality and range will stand comparison with receivers of very much greater size. The strong construction, described briefly below, more than fulfils the demands on a highclass product, whether for the home or export market.

Svenskradio 463 is executed in highly polished elm or mahogany in shades that best bring out the grains of the woods.

Manipulation is the simplest imaginable. One switch, one knob for strength and character of the sound, another knob for tuning to areas and stations nothing more.

Svenskradio 463 V may be connected to $50 \mathrm{c} / \mathrm{s}$ mains, 463 LJ operates on any kind of current. Both types may be switched over to most usual voltages. The unusually low power consumption, app. 45 W , makes the receiver very cheap to run.

## Connections

In addition to the necessary tappings for aerial and earth there are terminal contacts for pickup. This last is connected in conveniently by the wave-length knob, the wireless part being disconnected at the same time. The high impedance of the input $-Z$ exceeds I II $\Omega-$ allows of the connection of the most varied type of pickup.


Fig. 2

The tapping for extra loud-speaker may be used in several ways. The extra loud-speaker - with app. $20 \Omega$ impedance - may be connected either in parallel or in series with the loud-speaker built into the receiver, and this latter may be disconnected by pushing one of the connecting plugs right in. And, finally, this tapping is also adapted for connection of earphones.

## Power Supply and Disturbance Protection

In the A. C. receiver the filament wires of the valves are coupled in parallel and are fed from a winding on the power transformer. Other windings deliver current to the rectifier D.C. valve working on the full-wave principle. The smoothing necessary after rectification is obtained by means of the loud-speaker field coil and electrolytic condensers of ample dimensions.

The valves in the universal current receiver all lie in series, after half-wave rectification the anode current is smoothed by electrolytic condensers and choke - the loud-speaker has permanent magnet.

Mains lines usually bring disturbances of high frequency nature. With a view to preventing these reaching the receiver's aerial circuit, a number of protective measures have been taken. In the power transformer the flash-over is prevented by an earthed copper screen between the primary and the secondary windings; Svenskradio 463 LV has a powerful high frequency choke for the same purpose.

## Protective Devices

Svenskradio 463 has been constructed to conform with the specifications drawn up by the Swedish Electrical Material Control Institute, SEMKO, and - after thorough tests - has been passed for the Institute's »S» mark.

Besides certain figures for insulation and wiring dimensions, the stipulations require that the power transformer shall be provided with a fuse that breaks the current should the temperature in the transformer for some reason rise above the tolerated figure. Corresponding protective devices in the universal current receiver consist of a rapid acting fuse in the filament current circuit and a delayed action anode fuse of thermic type ensuring break should the anode current go beyond a fixed maximum limit.

Finally there may be mentioned a protective device for the scale illumination lamps in Svenskradio 463 LV ; a thermo-relay which connects the lamps about ten seconds after switching on. It takes that length of time for the valves to get so warm that the initial high current delivery comes to an end and the current returns to its normal value.

## Electrical Functions

In the preliminary circuits, mirror frequency and other undesirable signals are prevented from reaching the control grid of the mixing valve. The oscillator circuit follows the aerial circuit tuning frequency with a constant frequency distance of $+467 \mathrm{kc} / \mathrm{s}$. The intermediate frequency signal of that value formed in the anode circuit of the mixing valve is separated in the intermediate frequency filters from other signals of neighbouring frequency. Following amplification in the intermediate frequency valve, rectification takes place in the diodes of the output valve.

The D.C. voltage, negative in relation to the valve cathodes, is filtered and redelivered to the control grids of the first valves (automatic volume control). The low frequency component is returned to the triode part of the intermediate frequency valve where it is amplified and finally impressed on the control grid of the output valve. The output valve delivers a maximum of 3.5 W power, transformed in the output transformer to a suitable impedance.

## Low Frequency Amplifier and Loud-speaker

The low frequency amplifier characteristic is carefully adapted to the loudspeaker and the acoustic build-up. Correcting elements in the return connection circuit, together with the return connection changed according to the sound intensity, gives a sound that is as true as possible to nature for each grade of intensity

The loud-speaker, field fed in 463 V and permanent in 463 LJ , has an effective cone area of $200 \mathrm{~cm}^{2}$ - an unusually large acting area. The suspension resonance, entirely attenuated electrically by the negative feedback, comes lower than $90 \mathrm{c} / \mathrm{s}$.

The fidelity curve, which in the bass register in the vicinity of $60 \mathrm{c} / \mathrm{s}$ takes on a rise of to dB , runs straight in the middle register to the treble register where at $+000 \mathrm{c} / \mathrm{s}$ it has been attenuated 6 dB for full register. The treble can be attenuated by tone control a further 30 dB .

## Technical data for Svenskradio 463

Table model in elm or mahogany.
Superheterodyne with + valves, 3 wave-length ranges and 6 tuned circuits. Intermediate frequency $467 \mathrm{kc} / \mathrm{s}$.

Type $f^{63} l^{\circ}$ for 50 cycle mains. Type $f^{63}$ LI for all currents,
Connections for aerial, earth, pickup and extra loud-speaker.
Controls: Left knob for regulating sensitivity, pitch and band width. Right knob for tuning to stations, ranges and gramophone. Separate power switch.

Scale, 300 mm long with names of stations for medium and long wave, direct reading range indicator.


Other technical data for Svenskradio 463

| D a ta | 463 V | 463 LV |
| :---: | :---: | :---: |
| Sensitivity (for 50 mW output) $\mu \mathrm{V}$ | 10 | 20 |
| Power consumption at 220 V W | 48 | 38 |
| Do at iro V W | $4^{8}$ | 28 |
| Max. output at 220 V W | $3 \cdot 5$ | $3 \cdot 5$ |
| Do at 110 V W | $3 \cdot 5$ | 0.6 |
| Starting up time s | 20 | 40 |
| Loud-speaker | HF 6I8 | HP 918 |
| Loud-speaker effective cone area $\mathrm{cm}^{2}$ | 200 | 200 |
| Valve Equipment |  |  |
| Mixing valve | MECH 21 | MUCH2 |
| Intermediate frequency and low frequency valve | MECH 21 | MUCH 21 |
| Detector and output valve | MEBL 21 | MUBL2 1 |
| Rectifier valve | MAZ ${ }_{\text {I }}$ | MUY ${ }_{\text {I }}$ |
| Scale illuminating lamps | $6.5 \mathrm{~V}, 0.15 \mathrm{~A}$ | $6.5 \mathrm{~V}, 0.10 \mathrm{~A}$ |
| Mains Voltages V | 110 | 110-120 |
|  | 127 |  |
|  | 140 | 130 |
|  | 155 | 150 |
|  | 220 | 220 |
|  | 245 |  |
| Weight |  |  |
| Receiver with valves, net kg | 10. 5 | 8.8 |
| Receiver complete, packed kg | 13.1 | 11.4 |
| Dimensions |  |  |
| Height mm | 306 |  |
| Width mm | 470 |  |
| Depth mm | 242 |  |

Enggvist, E: New Serics of Manual L. B Switchboards with Cords. Ericsson Rev. 23 (1946) No. 3 pp. $250-258$.
The work of development that is constantly going on even in respect of manual telephone exchanges has now resulted in LM Ericsson's new series of extensible L.B. cord switchboards, differing rather considerably from those hitherto produced. By the introduction of brighter colours and softer lines, for instance, the character of the new switchboards as pieces of furniture has been brought out to a greater degree than was formerly the case. Moreover, as regards the component parts a distinct departure in respect of choice of material and methods of manufacture has taken place in the direction of modern moulding materials and diecasting practice. Lastly, the assembling into units of components organically associated has been still further developed. In this way there have been produced switchboards that are aesthetically attractive, durable, simple to operate and easy to extend.
U.D.C. 621.395.44

Eklund, E: New Single Channel Carrier Frequency Telephone System for Open-Wire Lines. Ericsson Rev. 23 (1946) No. 3 pp. 259-266.
A new single channel frequency system ZAF it has been developed by Telefonaktiebolaget LM Ericsson. This system replaces the older system ZL 400 , described in Ericsson Review No 2/1936, 250 equipments of which have been delivered to 11 countries. By the application of advanced technics of filter design and modern elements of construction the dimensions and weight of the new system have been reduced considerably compared with those of older systems. The system ZAF 11 will hereby turn out more economical even for such a short distance as about 50 km . The range is 700 km without intermediate repeaters when using an open-wire circuit of copper wires with a diameter of 3 mm .

## U.D.C. 656.257

Gotzsche, O: Electric Interlocking Plant at Sakskobing Station. Ericsson Rev. 23 (1946) No. 3 pp. 267-270.
Towards the end of 1945 a new electric interlocking plant was put into service at Sakskobing station. The plant is the first in Denmark to use the all-relay interlocking machine of LM Ericssons Signalaktiebolag, Stockholm.
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U.D.C. 621.336.621

Fredin, C: Suenskradio 463 - New Radio Recciver in Estrade Model.
Ericsson Rev. 23 (1946) No. 3 pp. 271 - 274.
Svenskradio 463 is a new 4 -valve superheterodyne of Svenska Radioaktiebolaget's make, which in respect of sound quality and range will stand comparison with receivers of very much greater size. The strong construction more than fulfils the demands on a highclass product, whether for the home or export market.


