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CONTENTS

On cover: LM Ericsson's new conference telephone, type DYA

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Conference Telephone, Type DYA

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The conference telephone is commanding ever greater appreciation for the facility it gives of rapid direct communication between those persons in a concern whose daily work requires them tho be able to contact each other quickly. For many years now L M Ericsson have included in their production a conference telephone of very attractive construction, for which there is an increasingly lively demand.

Nevertheless, business executives and office managers, recognising the great merits of these installations and the facilities they offer for more efficient internal communications, have expressed a desire for equipment adapted to smaller installations and for installations that can cover more extensive duties in large concerns.

In view of this demand, Telefonaktiebolaget L M Ericsson have endowed the market with yet another conference telephone. The traffic facilities, operation and construction are described in the following article.

The new conference telephone, which has been allotted the type designation *DYA*, consists mainly of a key base on which the telephone instrument is placed, Fig. 1, and a relay set. Generally the main instrument is also furnished with microphone, loudspeaker and amplifier, see Fig. 2.

Traffic Facilities

The system has been designed both as regards diagramatical and mechanical respects in such a way as to meet the most varying requirements with regard to traffic facilities. This flexibility in the system makes it possible for any concern to acquire a conference telephone suited to its particular form of organization. As, moreover, the lines may be made comparatively long, communication can be established between premises scattered over an extensive area. (Further details under *Circuit network*, page 14).

Fig. 1 X 6470
Main station DYA 1025 with telephone instrument DBH 2502

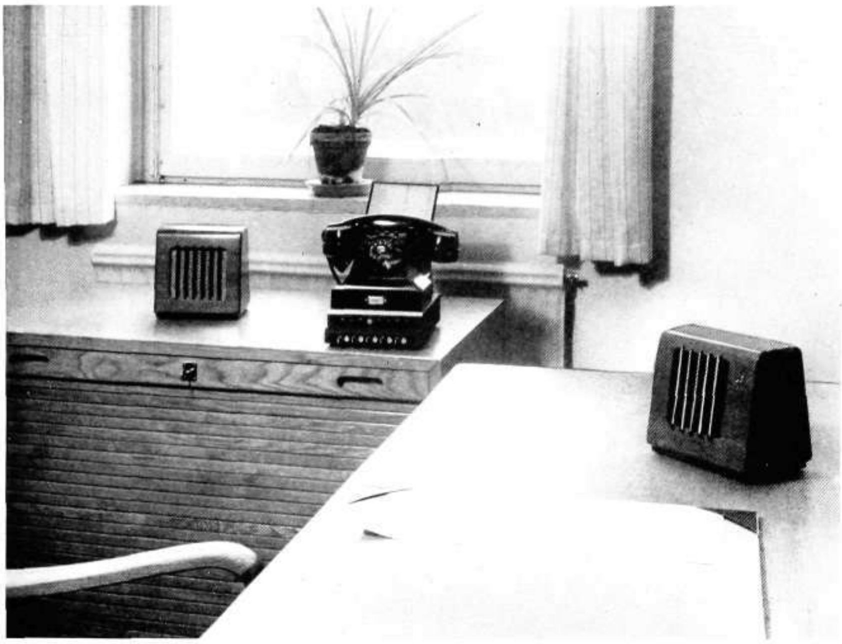


Fig. 2 X 6480

Conference telephone

Left to right: loudspeaker, main station with telephone instrument, microphone

The block diagrams, Fig. 3, show some different types of installations. The diagram to the right of the figure, however, in no way represents any upper limit to the size of an installation, and it is possible to arrange installations of considerably larger scope without difficulty.

An installation may consist of only one main station and a number of sub-stations, though the main station may also be part of a large installation of which it only constitutes an integral part. In the larger installation the main station may have connection to sub-stations, other main stations and manager's table, type *AEC*[1], Fig. 4.

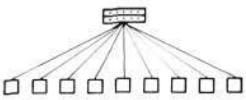
The installations may be entirely internal or all or some of the main stations may be connected to a private branch exchange or to the public exchange. For instance, the *Swedish Royal Telegraph Administration* has approved the conference telephone, type *DYA* (as previously they approved type *AEC*) for connection to the national telephone system for manual or automatic CB operation.

[1] The conference telephone type AEC was described in Ericsson Review No. 4/1945. Since that description was written the manager's tables type AEC 10—18, have been partially re-designed and now have the type designation AEC 200.

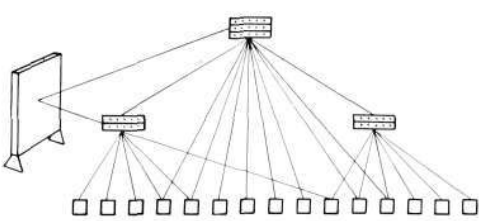
Fig 3 X 7554

Block diagrams of conference telephone installations in some different combinations

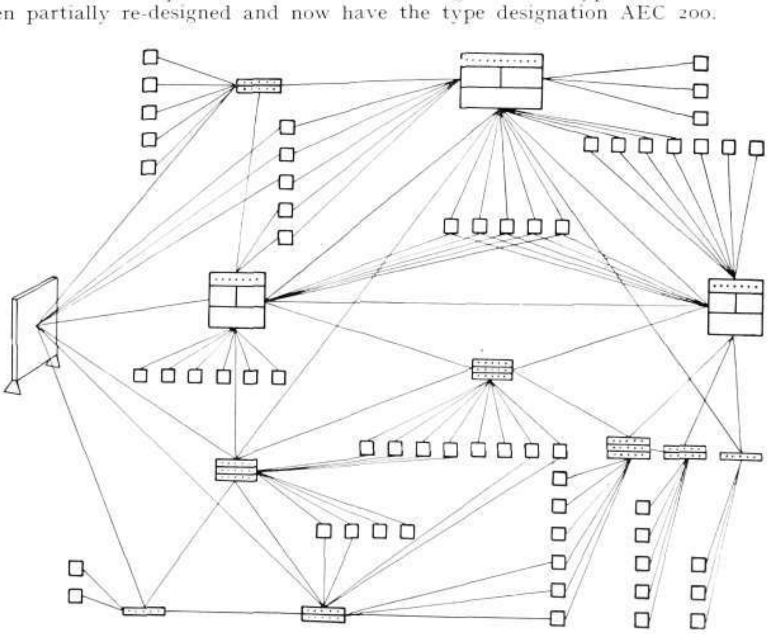
- A installation with one main station and a maximum of 15 sub-stations
- B the installation contains main and sub-instruments connected to one or more main stations; to every main station max. 15 main and sub-stations can be connected. Two of the main stations are connected to a telephone exchange.
- C the installation contains manager's table, main and sub-stations certain of which are connected to a telephone exchange. To every main instrument a max. of 15 manager's tables, main instruments and sub-instruments can be connected.



A



B



C

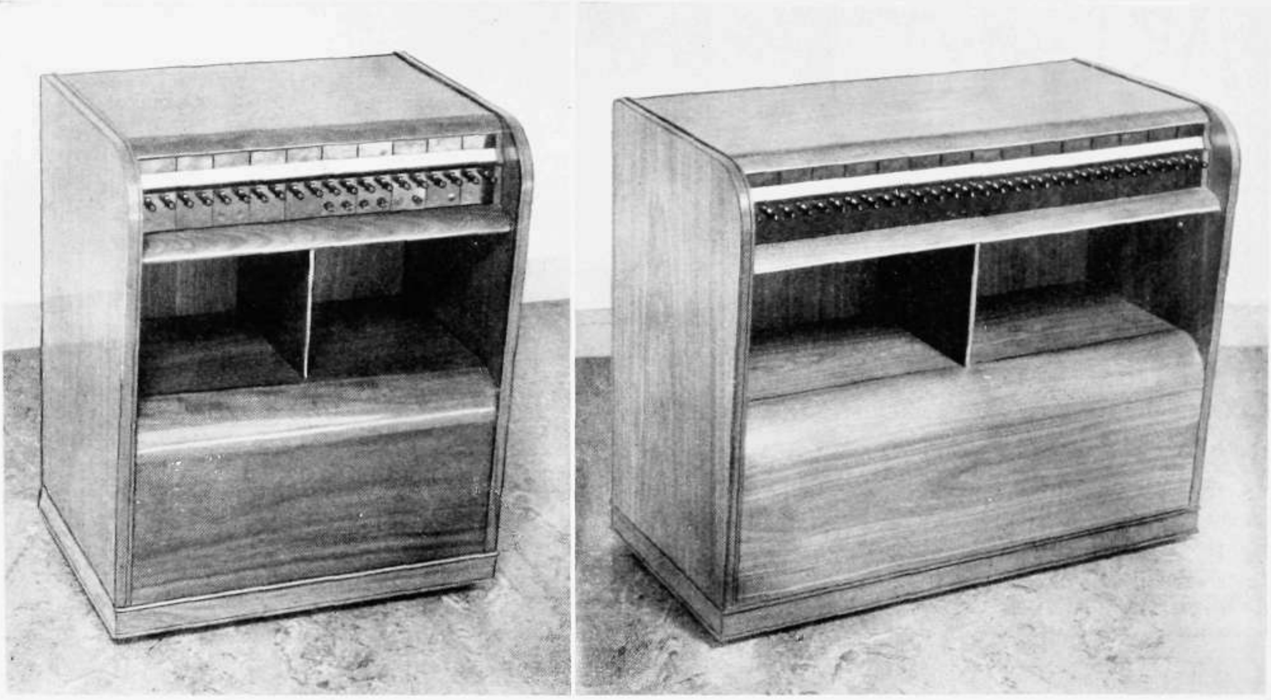


Fig. 4 X 7561
Manager's table
left: AEC 2000 for max. 20 lines, right: AEC 2001 for max. 30 lines

Operation

An installation as per Fig. 5 is provided with complete loudspeaker telephone equipment and is connected to a branch exchange. In this case all calls, even if established by the switchboard, are carried on over the microphone and loudspeaker which are connected in simultaneously. No talk-listen switch, restricting freedom of movement when talking, need therefore be employed. Nor is an echo suppressor required which allows speech only one way at a time.

If at any time it is desired that other persons in the room should not hear what is said at the main station, it is possible — even while speech is proceeding — to switch over to the handset and carry on the conversation in the usual manner. The microphone—loudspeaker is then automatically shunted. It is also possible to switch over from the handset to the microphone—loudspeaker during a call.

The main station may also be entirely without amplifier equipment and have only a telephone instrument, see Fig. 6. Such an installation will be entirely local and have no connection whatever to a switchboard.

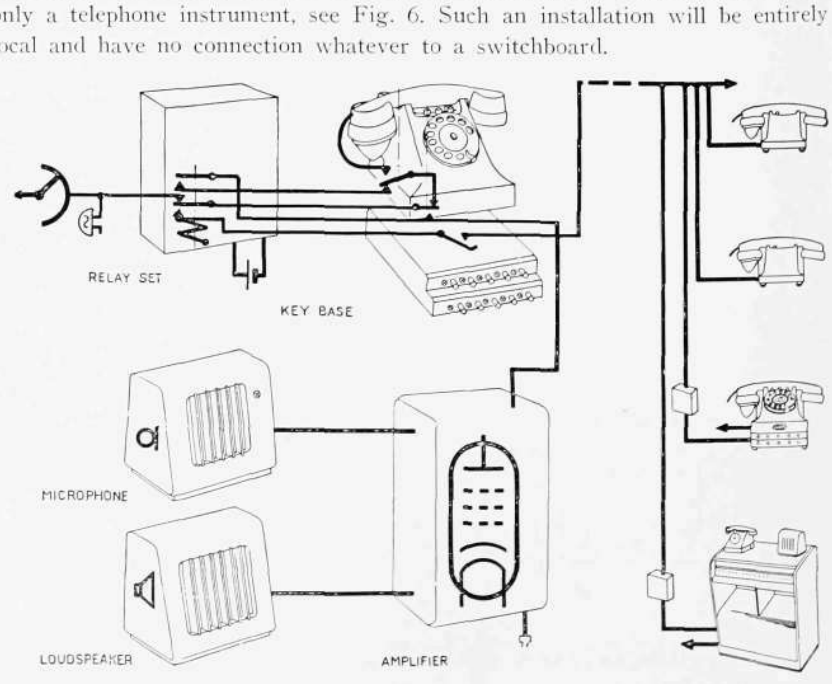


Fig. 5 X 6465
Main station
with microphone—loudspeaker and connected to telephone exchange

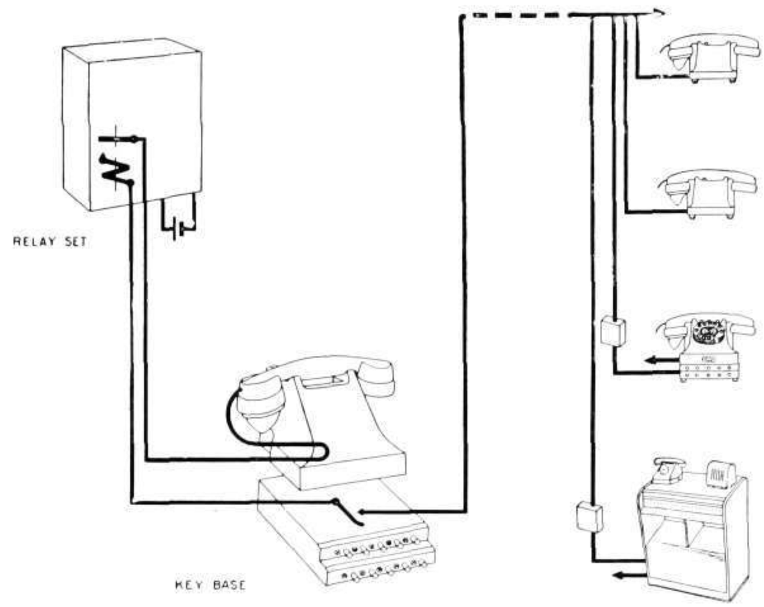
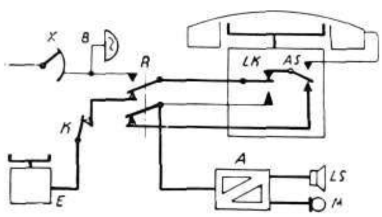
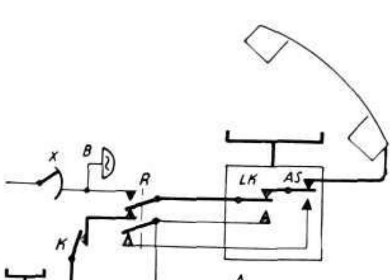


Fig. 6 X 6466
Main station
with telephone instrument only



Microphone—loudspeaker



Handset

Fig. 7 X 4655

Block diagram of call to extension

When one of the main station's buttons K is depressed the telephone instrument and amplifier are switched over to the extension line by the relay set R. The bell B is connected for receiving calls from the exchange.

A amplifier
AS switch
B bell
E sub-station
K main station key
LK left-hand button of telephone instrument
LS loudspeaker
M microphone
R relay set
X telephone exchange

All calls are secret, *i. e.*, nobody can listen in on a conversation unless he has been connected *to* the main station. At this station it is always possible to note the number of lines in connection. For each connected line there is a corresponding lamp with a numbered lens, which lights up when the instrument at the other end of the line is connected in.

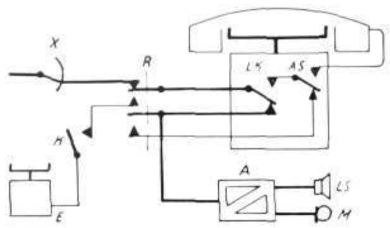
A call from the main instrument is made by pressing to the bottom *(ringing position)* the key corresponding to the wanted sub-station. A buzzer sounds in the sub-station as long as the main instrument key is kept depressed. When the key is released a spring carries it back to its middle position *(speaking position)* and when the sub-station answers the lamp corresponding to the depressed key lights up. At the same time the pilot lamp in the microphone is lighted.

At the close of the conversation the key is drawn out and when the sub-instrument's handset is replaced the lamp goes out. If the lamp is still burning after the call is concluded this indicates that the sub-station handset has not been replaced. (When a key is pressed in, it turns and one can see from the position of the white line on the key that the key has been pressed.)

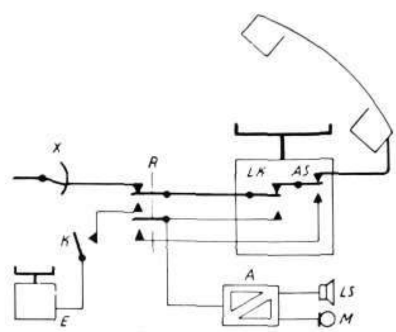
When the handset of a sub-station is lifted the light in the main instrument corresponding to that sub-station lights up. Then, when the spring key on the sub-station is depressed, the buzzer of the main station sounds. To prevent inadvertent calls no signal can be transmitted from the sub-station until the handset has been lifted. The buzzer stops and the call is answered when the key on the main station is pressed in.

Calls between two main stations proceed in the same way as described above. Immediately a main station is called by another main station the corresponding lamps light up in both instruments and they remain alight until both keys have again been drawn out.

When a manager's table is called there is no need to hold the key down in the ringing position. No matter how long the key is held pressed in that position only *one* signal sounds in the manager's table. The lamp corresponding to the line lights up in the table and when the switch is pressed down the connection is established. When a call is initiated from a manager's table the called station's key is pressed down, this causing an intermittent ring signal to be sent out to the main station, while the latter's call lamp is simultaneously switched on. The corresponding lamp at the manager's table also lights up as soon as the called main station answers. As in the previous case the lamps are extinguished only when both key and button have been reset.



Microphone loudspeaker
The button *LK* of the telephone instrument is depressed

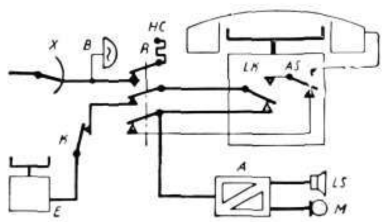


Conversation is carried on over the switch *AS*

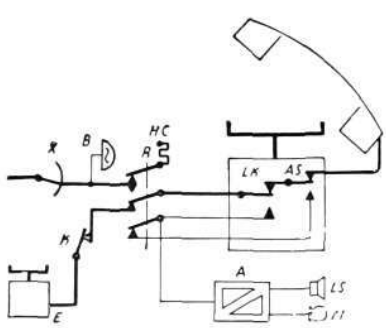
Fig. 8 X 4657

Block diagram of calls over the telephone exchange

- A amplifier
- AS switch
- B bell
- E sub-station
- HC holding resistance
- K main station key
- LK left-hand button of telephone instrument
- LS loudspeaker
- M microphone
- R relay set
- X telephone exchange



Microphone—loudspeaker



Handset

Fig. 9 X 4656

Block diagram of inquiry

The main station makes an inquiry to extension *E*. The call over the exchange is held by the holding resistance *HC* and the bell *B* is reconnected in case of a call from the switchboard operator.

Designations, see Fig. 8

If a call from the manager's table receives no answer, it is possible to send out from the table a holding marking by throwing up the switch, which lights the calling lamp of the manager's table in the main station. The called subscriber will then see on returning to his instrument that he is wanted to call the manager's table.

Marking can also be arranged from a main station to a sub-station if the sub-station is provided with a marking relay (see under Marking Relay, page 11). With the main stations that are connected to a PBX, *i. e.*, have complete loud-speaker telephone equipment, a call is initiated via the PBX by first depressing the instrument's left-hand key and, after receiving dialling tone, dialling the number in the usual way. If in addition the right-hand key is depressed stronger amplification of the incoming speech is obtained, which may be necessary, as in the case of long distance calls. When the call is finished, only the middle key needs to be depressed a moment and the call is disconnected. Return to normal amplification is obtained by depressing the left-hand key an instant.

Incoming calls via the PBX are initiated by means of a bell in the usual way. The telephone instrument's left-hand key is depressed on answering the call. If in the course of such a call, there is need to make an inquiry of one of the extensions to the main station, one simply presses the key for the said extension. When the extension answers the line to the PBX is held and there is no possibility of listening to the conversation between the main station and the extension. At the end of the inquiry the key is again drawn out and the conversation via the PBX can be resumed.

A number of extensions can be connected simultaneously for conference. All these are then connected for conversation among themselves and with the main station.

Construction

Unlike the conference telephone, type *AEC*, where all the necessary equipment is located in the manager's table itself, the various components of the new conference telephone constitute separate units which are fixed separately on the wall, at the back of a telephone table or other convenient spot. The equipment for a main station consists in simple cases of a key base with a telephone instrument placed on it and a relay set. The greater the demands that are subsequently placed on the installation the larger the number of devices required. Thus, for example, if the installation is to be connected to a PBX, amplifiers will be required as will also microphone, loudspeaker and signalling devices.

This means that the most complete installation takes up a certain amount of wall space, but on the other hand each installation will only comprise the equipment indispensable to meet the demands placed on it. This construction with separate units enables the most varying requirements in respect of the installation's operation to be satisfied.

Main Stations

The key base, Fig. 10 and 11, is available with terminals for 5, 10 and 15 extensions, and those for 5 and 10 extensions may in addition be furnished with a row of keys for engaged and service signals. The different key bases have the specification numbers stated in the table below.

Article number	Number of extensions	Engaged and service signals
DYA 1018	5	without
DYA 1022	5	with
DYA 1025	10	without
DYA 1032	10	with
DYA 1033	15	without

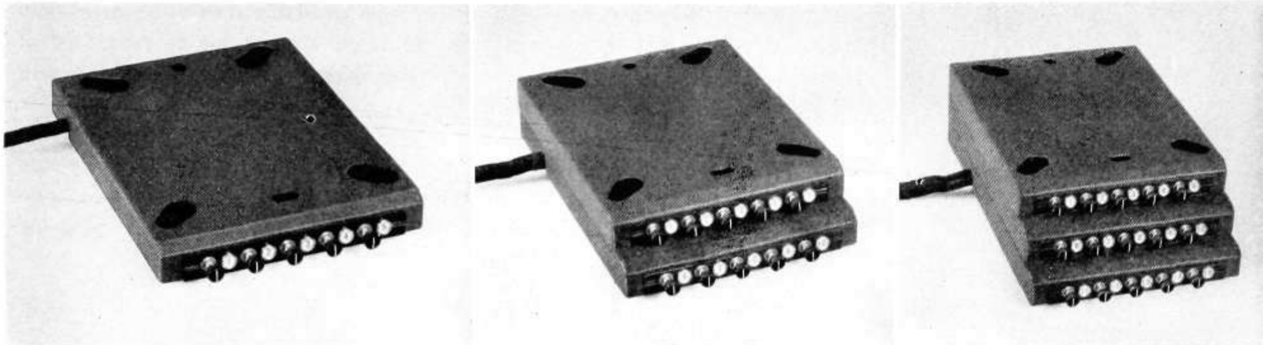


Fig. 10 X 7556
Main stations
for extensions only ; left: DYA 1018; centre: DYA 1025: right: DYA 1033

The keys are arranged in one to three rows one above the other, these being staggered so that the keys are easily accessible and more easily read.

To the right of each extension key there is a corresponding call lamp provided with the number corresponding to the number of the extension.

The case of the main station is of green enamelled sheet metal. The top of this case has holes to take the feet of the telephone instrument, ensuring very steady fixing to the key-base.

The main station is furnished with a terminal box equipped with screw terminals to which the station is connected by means of a 2.5 m (8 ft) long flex cord.

Relay Set

Each main station has a relay set *KFB 1503*[1], Fig. 12, which, in addition to relays for switching and current feed, also contains signal devices, connecting jacks for telephone instrument and amplifier and finally a terminal block for connection of signal repeater and various circuits.

Amplifier

The amplifier, see Fig. 13, is connected direct to the electric mains via a wall socket and is independent of the nature of the mains current. It is adjustable for voltages 110—130 V, 135—150 V and 220 V. The current can be cut off by the switch on the front of the amplifier. The lamp at the right of the switch lights when the current is on.

The amplifier — a balanced 2-way amplifier with one amplification stage for each microphone and loudspeaker circuit — is provided with ordinary radio receiving valves, these being stand-by connected when the amplifier is not in use. In this way the life of the valves is lengthened and the power consumption is reduced, while the amplifier is always ready for immediate use. The amplifier

[1] KFB 1503 is used for all local installations and for those main stations that are connected to 24 V PBX systems with 400 + 400 ohm feeding coils or systems with other working voltages and feeding coils which give the same maximum feed current to the telephone instrument's transmitter. We can also supply relay sets as also telephone instruments for connection to PBX with other feed conditions.

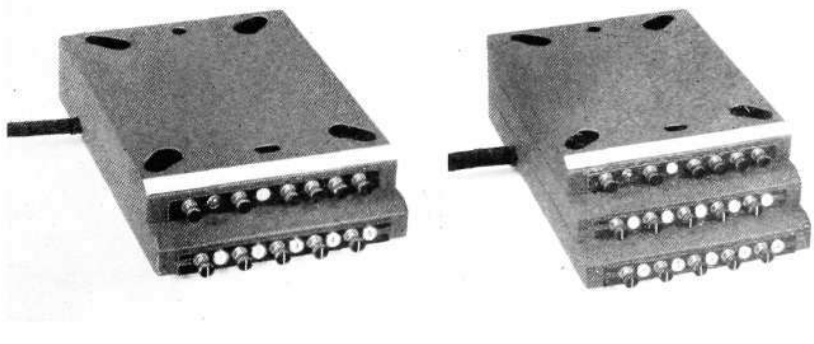


Fig. 11 X 6472
Main stations
for extensions and engaged and service signals; left: DYA 1022; right: DYA 1032

is provided with protectors (with a spare set available inside the case) and in general it is made to comply with the latest stipulations of the Swedish Electrical Control Institute. A more detailed description of the amplifier will be found in Ericsson Review No. 3/1945.

The same amplifier is employed for the L M Ericsson conference telephone with manager's table, type *AEC*, differing only from the loudspeaker telephone amplifier only in that the latter has a connecting cord and a 20-point plug for connection to relay set *KFB 1503*.

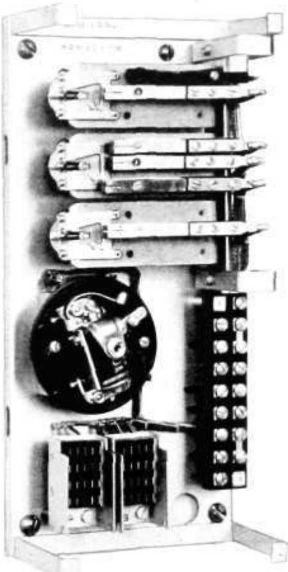


Fig. 12
Relay set KFB 1503
with cover removed

X 4661

Microphone and Loudspeaker

Microphone and loudspeaker, Fig. 14, are mounted in polished cases of wood and are of the same construction as for L M Ericsson's loudspeaker telephone.

The microphone is furnished with a pilot lamp which shines when the microphone is connected. A detailed description of microphone and loudspeaker will be found in Ericsson Review No. 3/1945.

Telephone Instruments for the Main Station

For installations with connection to a PBX[1], subscribers sets *DBH 2402* are used for PBX switchboards and *DBH 2502* for PABX switchboards. As may be seen from Fig. 15 these instruments differ from ordinary instruments only by the presence of three push buttons in the upper part of the case, for the operation of the amplification equipment when talking via the PBX. Connection is made direct to the relay set *KFB 1503* via a 20-point plug.

The same telephone instrument is used together with manager's table *AEC 200*.

For intercom installations without amplifier equipment, telephone instruments *DBH 6001*, see Fig. 15 left, are employed.

Sub-stations

The sub-stations, see Fig. 16, are provided with a signal button for calling the main instrument. The signal button only acts when the handset is lifted.

Instrument with one Circuit to the Main Station

This instrument is fitted with buzzer for call from the main station.

Instrument with Circuits to two Main Stations

This instrument has three buttons, the middle one being a signal button and the two others belonging to the respective main station loops. An incoming

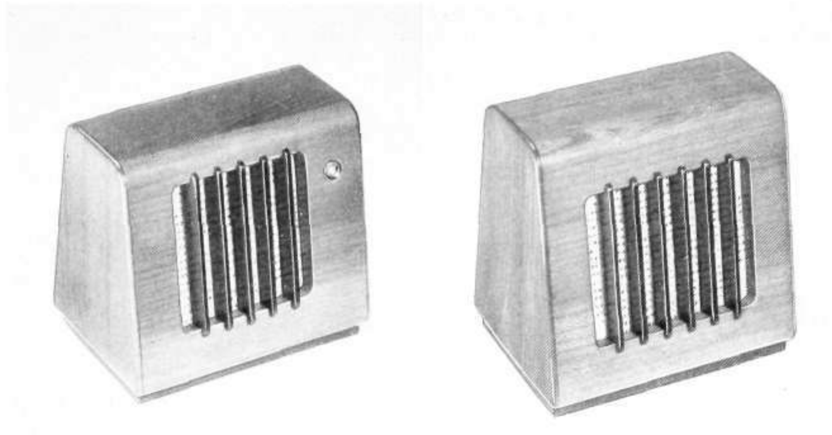
[1] See note [1] on previous page.

Fig. 13
Amplifier ZGA 1005
right with cover removed

X 6473

Fig. 14 X 6474

Microphone RLC 1001 (left) and loudspeaker RLE 1001 (right)



call is answered when the answering button is pressed. To show which main station is calling, the two circuits have different signal devices; one has a buzzer and the other a bell.

Call to a main station is made by pressing the key for the wanted station and preferably also the signal key as well. When the keys are released the circuit key remains down, while the signal key is moved up by spring action and the signal stops. If a call is to be made to one main station immediately following a call to the other station, however, it is not necessary to replace the handset first. Instead the required station button can be depressed, whereupon the other key is released and its station disconnected.

The sub-station cannot connect in the two main stations together. If conference is to take place between the main stations and the sub-station, connection is made between the two main stations and between one of them and the sub-station.

A call proceeding between one main station and a sub-station can thus not be listened to inadvertently from another main station.

Signal Devices

In the relay set *KFB 1503* there is a signal device (buzzer) which signals the calls coming from sub-stations and manager's table. For calls from other main stations, however, a separate signal device must be employed. According to the number of main stations connected the signal devices listed below are used:

Fig. 15 X 7557

Telephone instruments for the main stations

left: DBH 6001 for local installations; centre: DBH 2402 for manual CB system; right: DBH 2502 for automatic CB system

*

Fig. 16 X 6475
Sub-stations
left: DEK 1102 for one extension; right: DEH 2911 for 2 extensions

Number of main instruments connected	Signal device	
	Article number	Fig.
1	KLD 1005	17
2—4	KLD 9001	18
5—8	KLD 9002	18

Fig. 17 X 4663
Bell KLD 1005

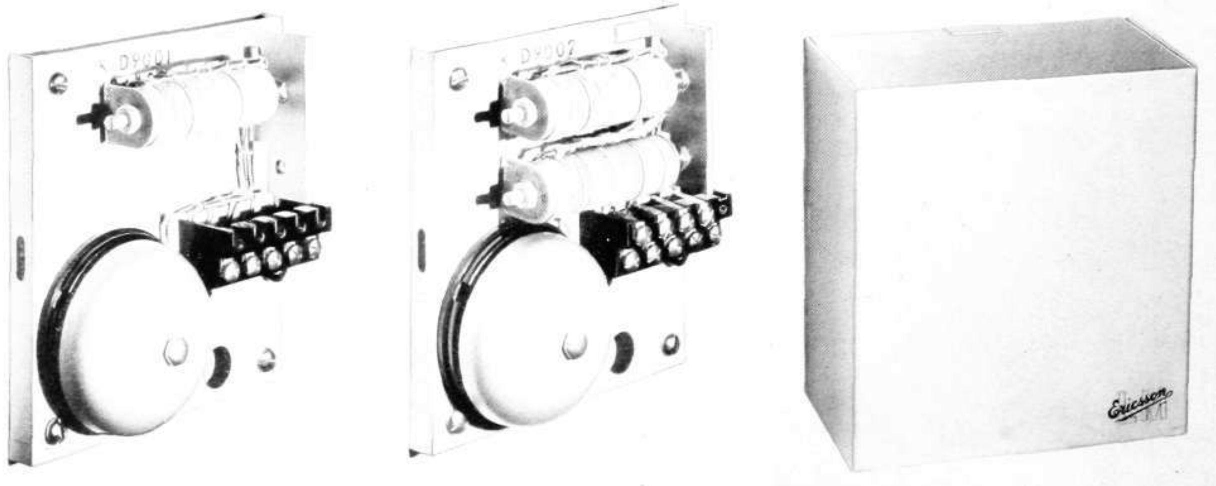
For a main station connected to a PBX the bell KLA 2124, Fig. 20, is used for signalling from the PBX.

Signal Repeater

An installation which is connected to a PBX with periodical ringing signal can be equipped with a signal repeater, which automatically connects the signal over to another instrument if the call is not answered in a given time. In this way the calling subscriber can get an answer to his call and give or receive the message he wishes.

For an incoming call, the first two signals sound in the main station only. The third and subsequent signals are heard in both the main instrument and the other one, and the call can also be answered by the latter. Once a signal has thus been repeated, the first signal in a succeeding call goes at once to the sub-station. Not until after the main station has again come into use is the signal repeater restored and the sub-station disconnected. It is not possible to listen in on the main station's calls from the sub-station.

Fig. 18 X 7558
Bell, type KLD 900
left: KLD 9001; centre: KLD 9002; right: with cover



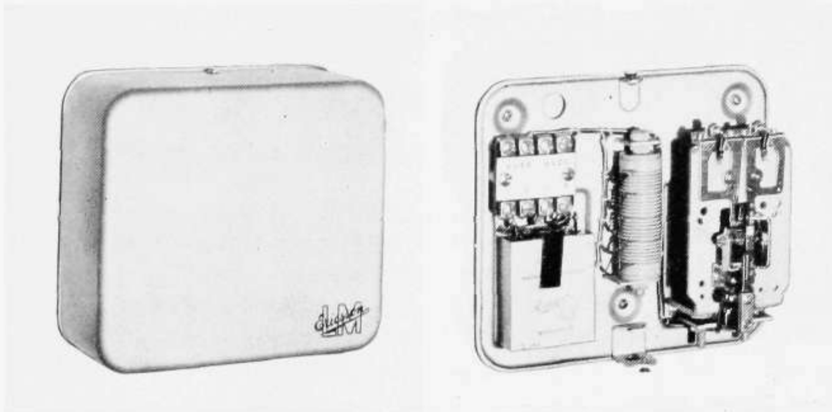


Fig. 19
Signal repeater KFB 1001
right: with cover removed

X 6096

The signal repeater, Fig. 19, has the same mechanical construction as the signal repeater described in Ericsson Review, Special Number 1945, but differs in its interconnection. The signal repeater *KFB 1001*, besides the above-described cases, can only be used in conjunction with L M Ericsson's loudspeaker and manager's table type *AEC*.

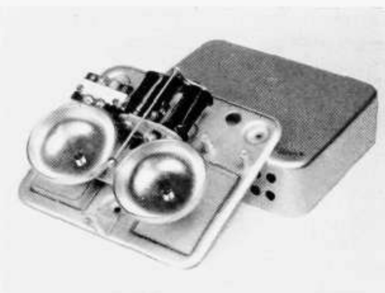


Fig. 20
Bell KLA 2124

X 4662

Marking Relay

In the case of secretaries, doorkeepers and other employees who are often compelled to leave their posts, it is advisable to provide the sub-station with a marking relay, Fig. 21, which marks any calls during their absence. It is convenient for the person at the main station to be spared having to ring repeatedly without receiving an answer. He only needs to call such a sub-station once and if he does not receive an answer he can calmly await a call from that station, as the called person will see immediately on returning that he is wanted to ring the main station.

When the sub-station is called a lamp is lit in the marking relay and this remains lit until the sub-station handset is raised.

Fig. 21
Marking relay KFB 1211
right: with cover removed

X 6477

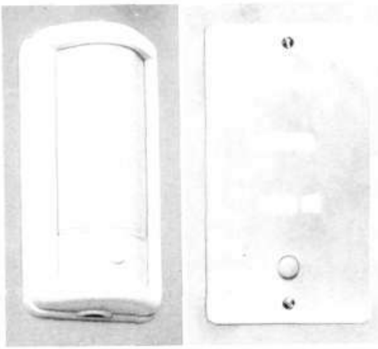


Fig. 22 X 4668

Wall indicator board

left: type KNH 830 for external mounting, right: type KNH 940 for flush mounting. The signal texts can be supplied in any language desired.

The marking relay, which consists of a double relay with mechanical holding and electric restoration and a lamp, is set up on the wall close to the sub-station.

Engaged and Service Signals

PHONING marking may be connected to any main station. The signal text or signal lamp set up outside the door prevents the person telephoning from being disturbed by people coming into the room. Callers are asked to wait outside — a visitor cannot in any case be attended to before the telephone conversation is finished and he is spared the uncomfortable feeling of entering and disturbing a call which may be important or even strictly confidential.

Wall indicator boards with ENGAGED, WAIT and COME IN signals, Fig. 22, set up outside the doors can be connected to the main stations *DYA 1022* and *DYA 1032*. As may be seen on Fig. 23 there are 6 press buttons of which the 4 to the right have spring resoration and the two to the left have locking when pressed, whereupon the pilot lamp alongside shines. Reckoning from left to right, the buttons have the following functions:

ENGAGED signal (with red pilot lamp)

Permanent COME IN signal (with white pilot lamp)

Momentary COME IN signal with buzzer

WAIT signal (which also lights up during telephoning)

The remaining two buttons may be used for calling a secretary and a messenger.

The buzzer which sounds when a visitor presses the button outside the door has a tone that is distinct from the other signal devices. The buzzer is fitted in the connecting box of the main instrument.

As may be seen from the diagram, Fig. 24, the WAIT and the permanent COME IN signals are disconnected when the ENGAGED signal button is pressed.

Fig. 23 X 6471

Key row on main station

The upper row contains keys for engaged and service signals. The lower row contains keys and lamps for five extensions.

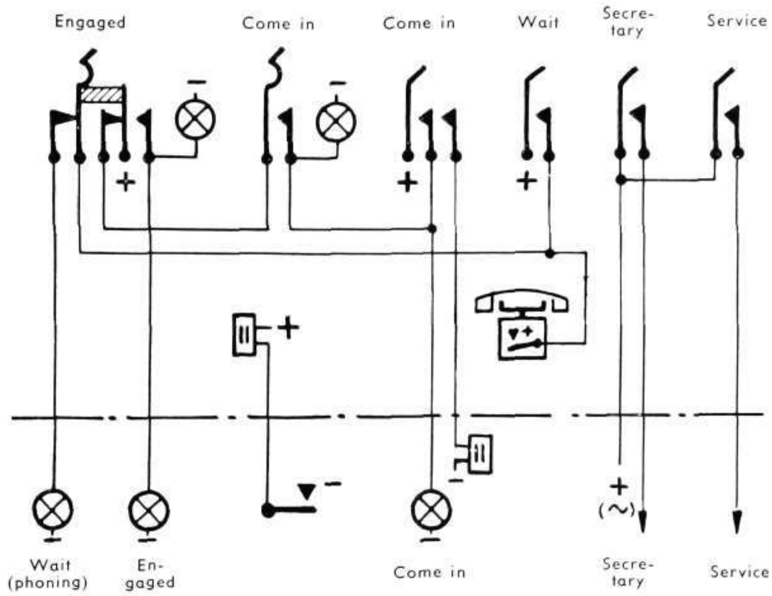


Fig. 24 X 6484

Diagram of engaged and service signal installation

Owing to the arrangement of the diagram, most signal installations of other makes than L M Ericsson's can be connected to the main instrument, so that existing signal installations may be employed without modification.

Line Network

The wall terminal of the main instrument contains all necessary terminal screws for connecting up the network, Fig. 25. For large installations it is most often advisable to use dispersion boxes as well, or possibly a simple cross connection panel.

Junction Circuits

Junction circuits in this connection mean circuits between two main stations or between main station and manager's table. The number of junction circuits that can be connected to a main station is equal to the number of circuits available in it. With a manager's table, however, the number of circuits that can be connected is smaller than the console's maximum capacity (18 and 23 junction circuits can be connected to manager's tables type *AEC 200* for a maximum of 20 and 30 circuits respectively).

A junction circuit from a main station must be provided with a repeater, see Fig. 26. The repeaters are, for circuit

between main station and main station = *KFB 1504*, and

between main station and manager's table = *KFB 1505*.

The repeater may be inserted at any point in the circuit where it is most convenient in order to suit local conditions.

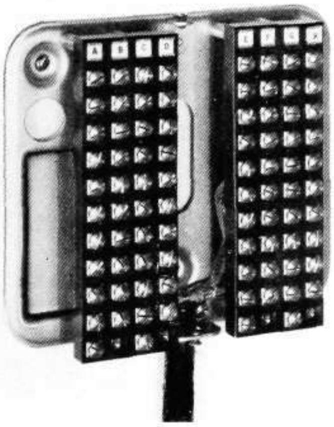


Fig. 25 X 6479

Wall terminal

with cover removed; the number of terminal blocks varies with the number of extensions at the main station

Number of conductors per circuit and maximum line resistance

Circuit between main instrument and	Number of conductors	Highest permissible		
		Resistance per conductor, Ω	length	
			in km (0.5 mm wire)	in 1 000 feet (24 A.W.G. or B.&S.)
Sub-station	4	180	2	7
Sub-station with marking relay	5	180	2	7
Main station	3*	150	1.7	5.8
Manager's table	3*	250	2.8	9.8

* If there is no common current source, a further conductor is required.

Power Supply

The operation of the installation requires 24 V direct current. This is taken from a mains connection unit, which like the amplifier is connected to the electric mains. The mains connection unit is adjustable for 110, 127 and 220 V alternating current. Consequently a converter or batteries must be used if the mains are DC.

The type of unit to be used will depend on the size of the installation. If the main stations are located close to each other, it is advisable to employ a mains connection unit common to all the main stations or to a group of them.

The following suitable types of unit are available, see Fig. 27:

Article number	Nominal current A
BMN 2021	0.2
BMN 2111	0.5
BMN 2112	1
BMN 2211	2
BMN 3201	3

X 6476

Fig. 26
Repeaters
left: KFB 1504; right: KFB 1505

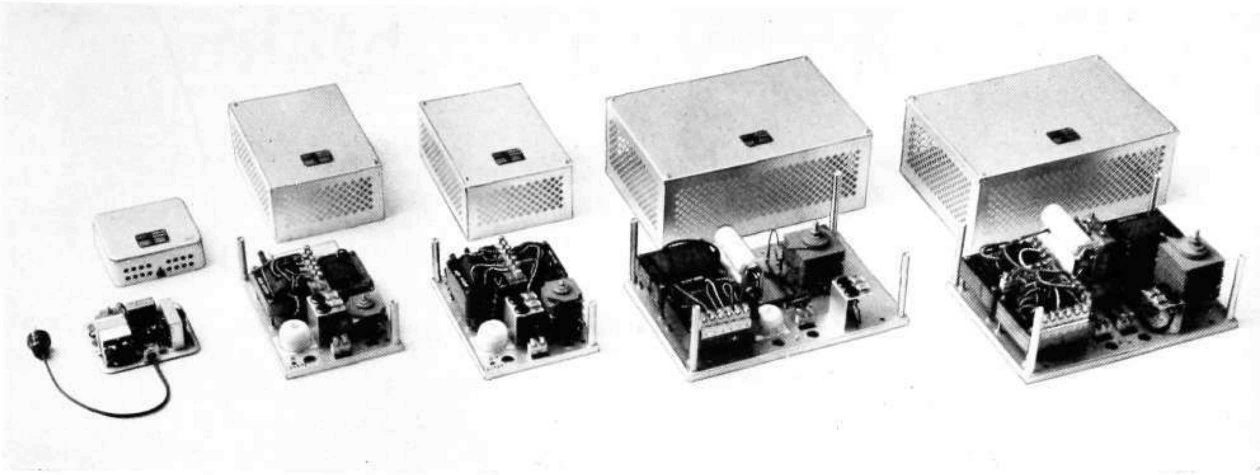


Fig. 27 x 7559

Mains connection units

left to right: BMN 2021: BMN 2111, BMN 2112, BMN 2211 and BMN 3201

For a main station which has nothing but extension circuits about 0.2 A is required.

If there is either a PHONING signal and/or an engaged signal a further 0.2 A or so is necessary. Finally if the signalling installation is so connected that a permanent COME IN signal is arranged, still another 0.2 A is required. If a fairly large number of main stations is fed from the same unit, however, one can count on a lower value for each station.

Mains connection units can be dispensed with if 24 V DC is available from another source, e. g., from the PBX storage battery. This is particularly advisable if it is very important that the installation shall operate even on interruption of the electric current supply, as with a power station operations office or for a military plant.

The Binding Wire Lightning Arrester — a New Form of Lightning Protection for Telephone Open Wire Lines

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U.D.C. 621.316.933.1

As long as telephone lines have been in use the damage caused to installations by atmospheric discharges has represented a source of trouble for telephony experts. Many different forms of protection against these voltage surges have been designed, but an entirely satisfactory solution of this difficult and significant problem cannot be said to have been found hitherto. Every suggestion which is likely to advance the matter in any way must therefore be of interest to telephone engineers. As a step in L M Ericsson's constant endeavours to improve the quality of telephone installations in every conceivable manner, we now present the lightning discharge binding wire arrester which constitutes a method for protecting bare conductors against atmospheric voltage surges in a simple and cheap manner.

The method was invented and developed by the engineer, K. V. Jörgensen of the Jydsk Telefonaktieselskab of Denmark. Briefly stated, it consists in forming a spark-gap between the extended end of the binding wire and an earthed insulator bolt, for example, at a number of points along the line, in conjunction with the attachment of the conductor to the insulator with binding wire. By this means a diversion of the dangerous voltage surges is obtained out on the line, so that by the time such voltage waves reach the telephone instrument, the cable or the exchange, their magnitude is reduced to relatively harmless limits. Thus the binding wire arrester is not intended to protect the equipment by itself but forms a means for reducing lightning voltage surges so that the protective equipment located at the ends of the line can both be designed more simply and will also be called upon less frequently to function in such a way that the intervention of the operating staff becomes necessary.

In order to obtain a theoretical description of the problem involved, L M Ericsson has applied to the professor for technical installations at Chalmers Technical College, Ragnar Lundholm, who, in the following article gives an account of the origin of atmospheric voltage surges in bare conductors and explains the method for calculating the magnitude of the voltages and currents set up, and finally, describes the protective action of the binding wire arrester under varying conditions.

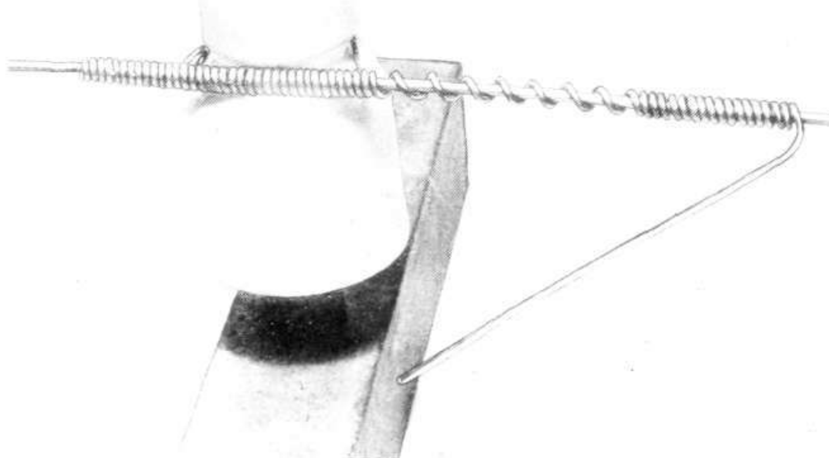


Fig. 1 X 6469

Binding wire lightning arrester

fastened to porcelain insulator on steel angle cross arm

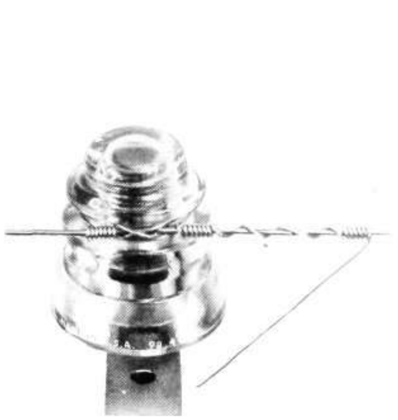


Fig. 2 X 4660

Binding wire lightning arrester

fastened to glass insulator on steel angle cross arm

The binding wire arrester consists in principle of a spark-gap having a needle gap character, mounted across a telephone insulator the supporting pin of which is earthed. Its purpose in the event of a high voltage surge is to allow a flash-over to take place in the spark-gap and discharge the surge, whereby its effects on telephone installations will be restricted. Binding wire arresters are mounted at a distance of 1 to 1.5 km apart in the first 5 to 6 km from each end of an overhead route.

The arrangement is illustrated in Figs 1—3. The spark-gap electrode mounted on the telephone line consists of binding wire 1.5—2 mm thick, bent in a suitable manner. The costs are extremely low if the device is installed concurrently with the installation of the telephone line but will, of course, be higher when added to a line already completed.

Lightning Voltage Surges on Telephone Lines

Voltage surges may either be caused by a line *being struck directly by lightning* or by *electrostatic or electromagnetic induction* from lightning discharges in the vicinity of the line.

Fortunately, direct lightning strokes are not of very frequent occurrence in Sweden amounting to 4 or 5 per 100 km annually. The induced voltages are far more common. The frequency of induced voltages having a magnitude sufficient to cause a flash-over in a 20 kV power line for example, amounts to about 20 per 100 km annually, and the number increases appreciably as the level of the insulation is reduced. Thus, in the case of telephone lines *induced* voltage surges play the leading part and hereafter we shall only refer to such voltages.

When a voltage surge is set up in a line two things may happen:

I. The voltage surge is too low to produce a flash-over (across the insulators or in the binding wire arresters).

II. The voltage surge is great enough to produce a flash-over.

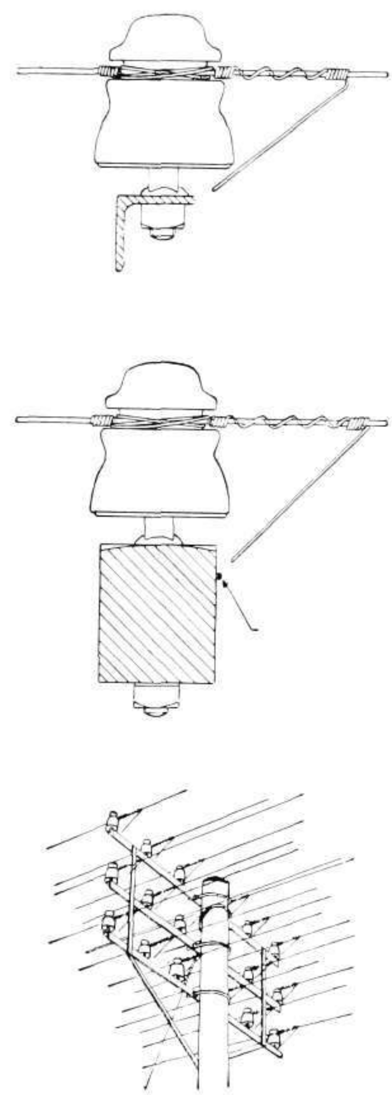


Fig. 3 X 7055

Binding wire lightning arrester

top: on steel angle cross arm, centre: on wood cross arm with earthing wire, below: open line bunch protected by binding wire lightning arresters

In case I the highest possible amplitude of the voltage surge is somewhat less than the flash-over voltage. The duration (length of the voltage wave) may be considerable, or of the same order of magnitude as that of a lightning discharge. A single lightning stroke usually lasts for as much as a few hundred μs (whereas the total discharge process in a multiple stroke may last much longer, up to about 1 second, but in this case each discharge may be regarded as a separate voltage surge). Since the damage that may be caused by a lightning voltage wave on reaching the telephone installation not only depends on its amplitude but also on its duration, it will be clear that in case I very dangerous voltage surges may be set up in an unprotected line in which the flash-over voltage across the insulator is approximately 60 kV (for a voltage surge of normal form, time form $^{1}/_{50}$). If the line is equipped with binding wire arresters the surge voltages of class I can only attain the flash-over voltage (10 to 15 kV with a 10 mm spark-gap) at the most and will thus be of a far less serious nature.

In case II the conditions are more complicated and the size of the pole earthing resistance plays an important part.

Measurements made with steel bars on low tension lines have disclosed that in conjunction with a flash-over very heavy currents of the order of 1 000 A may be set up in the line. It can be proved theoretically that *if* these currents are due to *electrostatically* induced voltage surges, the voltage would have to be

$$I\,(z + 2\,R)\ \mathrm{V}$$

where z = the wave resistance, and R = earth resistance at the point of the fault.

Assuming that $z = 600$ and $R = 0$, voltage surges of $1\,000 \cdot 600 = 600\,000$ V will be found. It is not probable that induced voltages will attain such high values but it cannot be regarded as entirely out of the question. (Professor Harald Norinder at the Institute for High Tension research in Uppsala has measured induced voltage surges up to 400 000 V after reflection and doubling at the open end of a line). On the other hand, it can be shown theoretically (see appendix) that very heavy currents may be set up in the line by *electromagnetic* induction from adjacent lightning paths which are more or less in parallel with the line.

It will be seen from the appendix that under otherwise similar circumstances an electromagnetically induced over-current J increases somewhat considerably with the specific resistance of the ground (roughly, it is approximately proportional to the square root of this resistance). Furthermore, it becomes increasingly difficult to obtain a low earth resistance R_1 and R_2, the more the specific resistance increases. In consequence of these circumstances it is found that in districts with poor ground conditions, such as rock with a thin layer of loose soil as is the case in large tracts of Central and Northern Sweden and in Småland, it is not possible to obtain such satisfactory results in the reduction of the voltage in the event of a flash-over in the binding wire fuses as in level country such as is found in Skåne and Denmark where there is a thick layer of mould mixed with clay, which constitutes a good electrical conductor.

The Principle of the Binding Wire Arrester's Operation with Lightning Voltages

It is characteristic both for electrostatically and electromagnetically induced voltage surges that all wires in a bunch receive approximately the same voltage (the latter is slightly greater for the higher than for the lower wires in the bunch however). This is a fortunate circumstance since on account of it, the induced voltage surges between the parts of a telephone apparatus will only be of the order of 10 % of the voltage discharge to earth.

Let us assume that a voltage surge reaches a telephone apparatus protected in the ordinary way by a spark-gap (carbon lightning arrester) and fuses, see Fig. 4. Two series-connected spark-gaps are located between the parts and the middle point is connected to the frame of the telephone instrument and is therefore grounded through a more or less satisfactory earth having the resistance Rj. To begin with, it is assumed that the line, which is taken to be a bare conductor, is not equipped with binding wire arresters. The two similar voltage waves, one of which has, let us say, 10 % greater amplitude than the other, see Fig. 4, will reach the telephone instrument at the same time. As the front of an induced wave is not very steep and the spark is only slightly delayed at the gap, the flash-over at the spark-gap will take place long before the voltage tops of the waves have reached the apparatus, and subsequently the voltage of the instrument frame to earth would be at the most $I_{max} \cdot R_j$, where I_{max} is the current impulse due to earth. If the spark-gaps were to function absolutely simultaneously, the voltage between the telephone instrument terminals prior to the flash-over would only be 10 % of the spark-gap's flash-over voltage and subsequently 0. It is not possible to count on absolutely simultaneous operation of the two spark-gaps however, and therefore for a very brief interval (after one of the spark-gaps has functioned but not the other) a voltage surge = the spark-gap flash-over voltage, will be set up between the telephone terminals and between one of the latter and the frame. The telephone instrument should be constructed in such a manner that it is capable of withstanding this extremely short and moderate voltage surge, in which case the result will either be that nothing at all happens or that the fuse melts. A 3-A fuse has a resistance of about 0.1 ohm and about 1 Ws is ne-

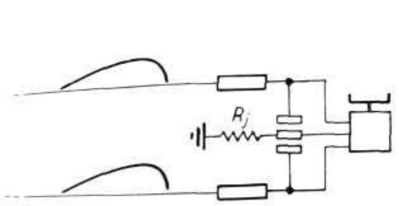


Fig. 4 X 4664

Protected telephone instrument threatened by voltage surge cessary to melt it. With a wave resistance of 600 ohms and a voltage wave of 60 000 V the current in the fuse will be

$$\frac{60\,000}{600} \cdot 2 = 200\ \text{A}$$

and the energy will be

$$200^2 \cdot 0.1 \cdot 0.001 = 4\ \text{Ws}$$

that is to say, the fuse will melt.

If on the other hand the line is protected by binding wire fuses, the voltage wave will be reduced to, say, 15 000 V and the energy in the fuse to 0.25 Ws, therefore the fuse will not melt.

The melting of the fuses is the commonest fault in a telephone installation and always gives rise to considerable disturbances in the service, so that a form of protection which is capable of appreciably reducing the number of burnt-out fuses finds full justification for its use. It is from this fact that the binding wire arrester derives its great importance.

The binding wire arrester carries out this duty all the more effectively, the closer together the arresters are placed in the line and the lower the resistance to earth is for the earthing of the arresters, that is to say, the greater the lightning current the arresters are capable of carrying off per km length of the line (see appendix) and finally, the shorter the spark-gap in the arresters is. A discussion follows concerning the most suitable way of coordinating these data from a theoretical and practical point of view.

The Constructional Form and Efficiency of the Lightning Protector

Length of the Spark-gap

As will be realized from the foregoing discussion, it is always necessary to reckon with the possibility that surge voltages with an amplitude up to the flash-over voltage of the spark-gap will not be affected by the binding wire lightning arrester, and that such surge voltages are quite common. On this account the importance of making the spark-gap as short as possible will be appreciated. In the original design a 1 cm spark-gap was employed, which corresponds to a 10 to 15 kV flash-over voltage (with a long normal wave, surge form $^1/_{50}\ \mu s$). The spark-gap has since been reduced to 7 mm. Experience will show whether this increases the risk of insulation faults through the bridging of the gap by semi-conductors (insects, dead leaves and the like).

In what follows it is assumed that the spark-gap is reduced to 7 mm and that the flash-over voltage may then be estimated at about 8 kV.

From the calculations in the appendix which are, it is true, of a very approximate nature, it will be seen to what extent a voltage wave generated in the line by an electromagnetically induced current of 1 000 A is reduced after it has passed over a varying number of binding wire arresters and caused a flash-over in them. If the resistance to earth is 200 ohms for each arrester, according to these calculations it may be anticipated that the wave on each side of the flash-over voltage's point of generation will jump across 4 binding wire arresters, or alternatively, that a flash-over will take place in a total of 8 arresters and that the wave which passes on has an amplitude of about 3 800 V. With an earthing resistance of 100 ohms a flash-over will occur in a total of 4 arresters and a residual voltage wave of about 5 000 V will be obtained.

It is clearly possible to reckon with the fact that when the voltage wave has passed across a sufficient number of binding wire arresters it will be reduced to a maximum value = the flash-over voltage of the fuses. The residual voltage after the last flash-over may be considerably lower however, and the probability of a low value being attained will be all the greater with a reduced earthing resistance. The fault statistics must improve, therefore, the lower the earthing resistance is at the poles.

A low earthing resistance is also of importance when a thunderstorm is in the vicinity, otherwise the number of arresters between the thunderstorm and the telephone exchange will be insufficient to obtain maximum reduction of the voltage. In such a case closer placing of the fuses may yield good results. It is obvious that in the case of a storm within a distance of less than 2 to 5 times the distance between the binding wire arrester poles (depending on the earthing resistance of the poles) it is not possible to rely on the full protective effect. From this it also follows that binding wire arresters fulfill their most important function with long open wire lines but are less effective for short open wire branch extensions.

Placing of the Binding Wire Arresters

From what has just been said the value of placing binding wire arresters close together near the telephone exchange will be appreciated. Nevertheless, for economic reasons the application of the arresters must be restricted to those poles at which earthing can be arranged without entailing heavy costs. With wooden pole lines (and telephone lines are mostly carried on wooden poles) stayed poles chiefly come into consideration where the stays can be employed as down conductors. Where poles in fields and meadows are in question the buried anchoring plates for the stays constitute good earthing electrodes. For poles in fields a down conductor along the pole and an earth taking the form of an iron pipe driven into the ground are likewise relatively cheap. In the case of poles set up on obstructions or on rock on the other hand, an earthing electrode with a relatively low ohmic value will be too expensive an arrangement.

Operating Experience

Since the binding wire arrester is a Danish invention it has been tried for a long time in that country with good results. In view of the fact that the earthing conditions are very favourable in the Danish agricultural soil, this is not very surprising.

In Mexico too the binding wire arresters have been tested with satisfactory results, although the lines in question passed over territory where the soil is very bad as regards its conductive capacity. The thunderstorm season sets in during the rainy period, however, when the conductive capacity improves. Experiments with binding wire arresters have been in progress since the summer of 1948 in the Borås district of Sweden. The ground here, consisting of rock with a low conductivity, is as unsuitable as possible for the installation of an effective binding wire lightning protection, as will be realised from what has been said above. The fault statistics have not yet been completed but no clearly marked improvement appears to have been achieved.

Summary

Apart from the relative infrequency of direct lightning strokes on the lines, electromagnetically induced lightning voltages are most troublesome for weak current lines. The protective action of binding wire arresters with voltages of this kind has been investigated.

The general conclusions drawn from the investigation and the experience gained in service hitherto is that in flat country binding wire arresters render an obvious service, whereas judgment must be reserved for the timebeing concerning their protective effect in territory consisting of rocky ground.

Binding wire arresters for lightning protection are of greater significance for long open wire conductors than for short branches from cables.

Electromagnetically Induced Currents and Voltage Surges

No claim is made for the theoretical inviolability of the following particulars which merely represent a roughly approximate description of the course of events.

A lightning stroke over a telephone line, Fig. 5, causes a flash-over at two points on the telephone line. The resistances at the fault points are r_1 and r_2, that of the line being r. Between the flash-over points the line is regarded as an inductance L with an internal resistance r; outside these points, however, the line is regarded as a wave resistance z. The resulting impedance at one fault point will then be:

$$R_1 = \frac{r_1\, z}{r_1 + z} \qquad\qquad R_2 = \frac{r_2\, z}{r_2 + z}$$

Notation:

$I = I\,(t) =$ lightning current

$J =$ the current which circulates in the telephone wire between the fault points

$L =$ self-inductance in the wire between the fault points

$M =$ mutual inductance between the path of the lightning and the line between the fault points

If we neglect the reaction of J on the path of the lightning, the following will apply:

$$(R_1 + r + R_2)\, J + L\frac{dJ}{dt} = -M\frac{dI}{dt}$$

If $R = R_1 + r + R_2$, the solution will be:

$$J = -e^{-\frac{R}{L}t}\left[\int_0^t e^{+\frac{R}{L}t}\,\frac{M}{L}\frac{dI}{dt}\,dt + C\right]$$

If $t = 0$, $J = 0$ $\quad\therefore\; C = 0.$

According to the first law of mean values, it is then found that:

$$J = -e^{-\frac{R}{L}(t-t')}\cdot\frac{M}{L}\cdot I$$

where t' is time between 0 and t. For low values of the exponent, that is to say, for low values of R and t:

$$|\,J\,| \simeq \frac{M}{L}\, I$$

Generally speaking, $e^{-\frac{R}{L}(t-t')} < 1.$

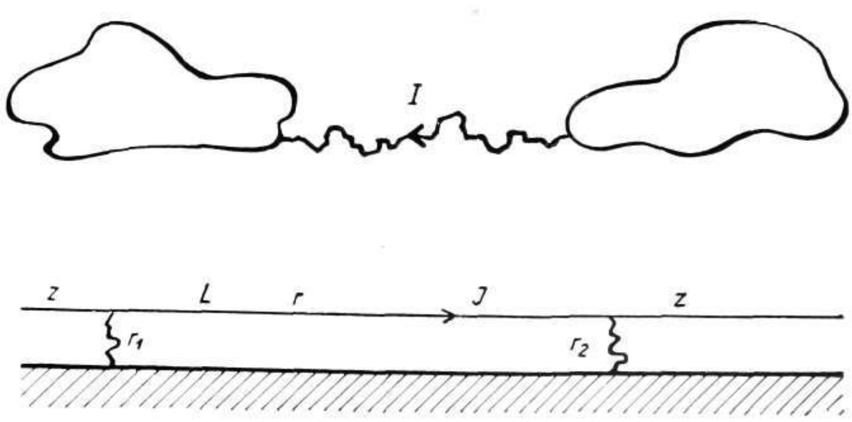


Fig. 5 X 6468
Lightning discharge between two clouds over a telephone line

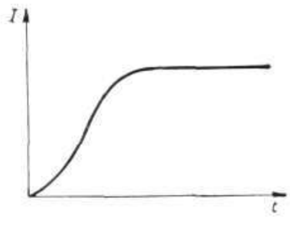


Fig. 6 X 4658

Characteristic shape of the current curve of lightning at the lightning stroke instant

The inductance coefficient may be estimated as follows.

Let it be assumed that the wave front of the lightning current, Fig. 6, has a steepness corresponding to a front time of 2 μs, Fig. 7. This front steepness corresponds approximately to a sine wave with a period of time $\simeq 8\ \mu$s or the frequency $\simeq \frac{10^6}{8} = 125\,000$ c/s. For such a current, the inductance coefficient may be taken as a return current to earth at a depth of

$$A_0 = 658 \sqrt{\frac{\varrho}{125\,000}} \text{ m}$$

below the image of the line under the surface of the ground.

In this formula ϱ is the specific resistance of the ground in ohms x m. For rocky ground this may be assumed to be $= 10\,000$ ohms x m and for moist ground $\simeq 100$ ohms x m, from which figures it is found that:

$$A_0 = 186 \text{ to } 18.6 \text{ m}$$

If H is the height of the line above the ground, which we assume to be 6 m, the vertical distance between the wire and the suggested current return will be:

$$A = A_0 + 2H = 198 \text{ to } 30.6 \text{ m}$$

For a wire with a diameter of 4 mm, $r = 0.002$ m, we then get an inductance per km of

$$L = 10^{-4}\ 2 \ln \frac{A}{r} = 10^{-4} \cdot 4.6 \log_{10} \frac{(198 \text{ to } 30.6)}{0.002} =$$

$$= 0.0023 \text{ to } 0.0019\ H/\text{km}.$$

Let it be assumed that a lightning discharge 1 km in length is parallel to and lies 500 m above the surface of the ground parallel with the line and that the flash-over takes place at two points immediately under the two end points of the lightning. The mutual inductance between the path of the lightning and the line circuit can then be calculated, for $A = 198$ m $= 0.198$ km, as follows:

$$M = \frac{1 \cdot 1 \cdot 10^{-4}}{(0.5 - 0.006) \cdot 1.21} - \frac{1 \cdot 1 \cdot 10^{-4}}{(0.5 + 0.192) \cdot 1.13} =$$

$$= (1.68 - 1.28) \cdot 10^{-4} = 0.40 \cdot 10^{-4} \text{ henry}$$

For $A = 30.6$ m it is found that

$$M = \left[1.68 - \frac{10^{-4}}{(0.5 + 0.0246) \cdot 1.20}\right] \cdot 10^{-4} = (1.68 - 1.586) \cdot 10^{-4} =$$

$$= 0.094 \cdot 10^{-4} \text{ henry}$$

Using the notations of Fig. 5, we get $J \simeq \frac{M}{L} I = \frac{0.40}{23} \cdot I = 0.017\ I$ and $J \simeq \frac{0.094}{19} \cdot I = 0.005\ I$.

In this case, therefore, the current in the line will be, in round figures, 1.7 to 0.5 % of the lightning current. If, for example, this is taken as 60 kA, approximately 1 000 to 300 A will be obtained in the line.

The higher the specific resistance of the earth is, the greater will be the mutual inductance between the path of the lightning and the line, other circumstances being equal. The self-inductance will also increase with the resistance, but by no means in the same proportion. Consequently J will increase with the specific resistance.

From the current J which flows along the line between the flash-over points, a part

$$J_r = \frac{z}{r_1 + z} J$$

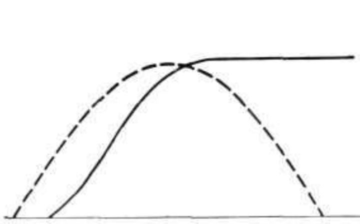


Fig. 7 X 4659

Comparison between a lightning current and a sinusoidal current with approximately the same derivative $\frac{dI}{dt}$

will pass through the earthing resistance and the remainder

$$J_z = \frac{r_1}{r_1 + z} J$$

will flow out in the line beyond the point of flash-over.

The current wave will therefore be reduced at the point of flash-over in the proportion,

$$\frac{r_1}{r_1 + z}$$

The voltage wave which passes out on the line from the fault point 1 will be

$$E_1 = J_z \cdot z = \frac{r_1 z}{r_1 + z} J$$

This voltage wave moves away to the next binding wire arrester and if it is high enough, a flash-over will also take place there, whereupon the wave passing on will be

$$\frac{2 \dfrac{z r_3}{z + r_3}}{\dfrac{z r_3}{z + r_3} + z} \cdot E_1 =$$

where r_3 is the resistance in the third earth connection for the binding wire arrester

$$= \frac{2 r_3}{2 r_3 + z} E_1 = \frac{2 r_3}{2 r_3 + z} \cdot \frac{r_1 z}{r_1 + z} J$$

Ex. Let it be assumed that the binding wire arresters are mounted at a distance of 1 km apart, that $J = 1\,000$ A and that $z = 600$ ohms and $r_1 = r_2 = r_3 \ldots = 200$ ohms. It is then found that

$$R_1 = \frac{r_1 z}{r_1 + z} = \frac{200 \cdot 600}{800} = 150 \text{ ohms}$$

$$E_1 = 150 \cdot 1\,000 = 150\,000 \text{ V}$$

When this outgoing wave reaches the next arrester it will be reduced in the proportion

$$\frac{2 \cdot 200}{400 + 600} = 0.4 \text{ to } 60\,000 \text{ V}$$

At the next binding wire arrester it will again be reduced in the proportion 0.4 : 1 to 24 000 V, and so on.

It is found, therefore, that $r_1 = r_2 = r_3 \ldots = 200$ ohms

at	the	first	arrester	150 000 V
»	»	second	»	60 000 V
»	»	third	»	24 000 V
»	»	fourth	»	9 600 V
»	»	fifth	»	3 840 V

After this a flash-over is scarcely likely to take place in subsequent arresters.

If the earthing resistance had been $r_1 = r_2 = r_3 = 100$ ohms instead, the absorption coefficient would have been lower, or

$$\frac{2 \cdot 100}{200 + 600} = 0.25$$

$\therefore$ At the first arrester $1\,000 \cdot \dfrac{100 \cdot 600}{100 + 600} = 86\,000$ V

» » second » $= 21\,000$ V

» » third » $= 5\,350$ V

Aktiebolaget Rifa — L M Ericsson's New Capacitor Factory

S OLSTEDT, AKTIEBOLAGET RIFA, ULVSUNDA

U.D.C. 061.5 Rifa

As far back as 50 years ago — 1896 — telephone capacitors were first made at L M Ericsson's factory in Stockholm. The progress of telephone technique in succeeding years led gradually to increased employment of capacitors and stricter demands on their design and quality, causing the original modest manufacture to expand gradually to a considerable extent. When L M Ericsson acquired Aktiebolaget Alpha at Sundbyberg in 1929 the making of capacitors was transferred to that undertaking and remained there until the present factory of Rifa was established in Ulvsunda. The article below gives a brief description of this new factory.

The Swedish telephone industry has always been in a position to cover its capacitor requirements by home production. On the other hand, Sweden's growing radio industry had been compelled right from its start around 1925 up to the first years of the recent war to rely mainly on imports for capacitors. Consequently when this import gradually ceased as the war proceeded, the situation grew precarious for Sweden's radio factories. In 1942 the larger factories decided to join together in starting an establishment for the manufacture of electrolytic and mica capacitors, mainly for the needs of the radio industry. The result was the undertaking Radio Industrins Fabriks Aktiebolag, abbreviated to Rifa. Operations were confined to limited out-of-date premises on Kungstensgatan in Stockholm and could only be regarded as provisional. Thus when at the close of the war in 1945 the import channels were reopened the undertaking was thought to have served its purpose.

In 1946, the enterprise was taken over by Telefonaktiebolaget L M Ericsson in conjunction with ASEA who gave up their shares about a year later to L M Ericsson, however. It was considered that if Rifa's production were amal-

Fig. 1 X 6482
The newly erected capacitor factory at Ulvsunda

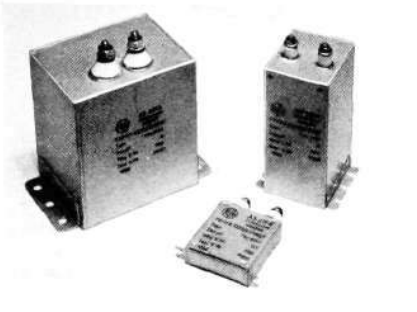


Fig. 2 X 4666

Paper capacitors

tropical type in hermetically sealed rectangular metal cans

gamated with the capacitor production of Alpha and with the manufacture of small capacitors carried on by other factories in Sweden belonging to the Ericsson group, there would be established a sufficiently broad basis to make it economically possible to set up a well equipped factory for small capacitors. Such a factory had hitherto been lacking in Sweden with its highly developed electrical industry. When the company was taken over it was given its present name — Aktiebolaget Rifa — and it was decided to equip a new factory in which the capacitor manufacture could be concentrated on the lines laid down. In addition, Rifa was to be provided with enough capital to furnish the resources for intensive development work in its special field and considerably augment its capacity of production. The aim was to establish an undertaking fully able to meet competition, and capable of supplying the demand of the Swedish market for capacitors besides entering the export market.

At the beginning, the question of premises constituted a difficult problem, owing to the existing building restrictions. Prolonged negotiations led to a long term agreement for premises jointly with another industrial undertaking in a factory building at Ulvsunda outside Stockholm, the foundations of which had been laid in January 1947. By the summer of 1948 a start could be made with moving in, so that by the beginning of 1950 Rifa's new factory was practically completed.

This new factory is equipped on up-to-date lines throughout. The premises are well lighted and ventilated, and the sanitary arrangements for employees are of high class. The building is seven storey high and Rifa has at disposal some two-thirds of the floorspace, about 9 500 m^2. Office premises take up about 1 200 m^2, the laboratory 800 m^2 and the workshops with stores and washing and changing rooms occupy about 6 500 m^2. The remaining space is given up to canteens, kitchen, boiler room, electric power supply etc.

The number of employees at present is about 120 staff including foremen and some 250 workers. Of the staff, about one third are engaged on work connected with development in the laboratory and drawing offices. The workshops are arranged to allow of considerable expansion of production beyond present levels and it is reckoned that the labour force will be progressively increased. Some 400—450 workers is the maximum that can be occupied in the premises.

Manufacturing Programme

The present manufacturing programme of Rifa comprises paper, mica, plastic foil and electrolytic capacitors, besides high stability carbon resistors. The production of ceramic capacitors is to be added in the near future.

The paper capacitor manufacture comprises two main types, *viz: tubular capacitors* and *capacitors in rectangular metal cans*. The only tubular capacitors in production at present are enclosed in plastic paper tubes, sealed with stone wax or bitumen and wax protected. There will be put on the market shortly a tropical type of tubular capacitor in porcelain tubes with the ends silvered and sealed with soldered metal caps. The immediate development programme provides for capacitors in aluminium tubes with end seals of laminated rubber-pertinax and also moulded tubular capacitors. Capacitors in rectangular metal

Fig. 3 X 6483

Electrolytic capacitors in aluminium tubes

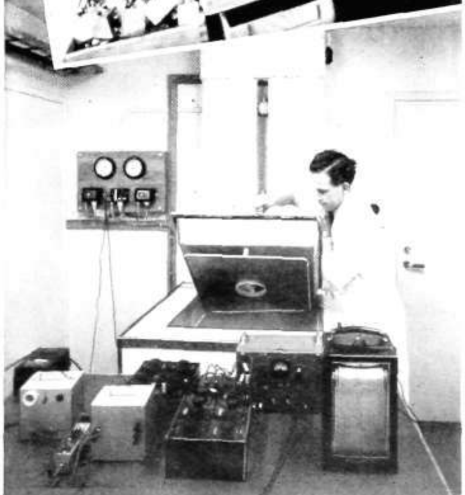
left: with soldering tags, right: with screw mounting, below: with octagonal socket

The newly erected capacitor factory at Ulvsunda

Left: Interior view of the winding shop for paper capacitors where nimble fingers are busy with the thin metal and aluminium foils — less than a hundredth of a millimetre thick — to run together in a smooth and beautiful winding

Below: The paper capacitors flow unceasingly from working place to working place.

Below: Interior view of the chemical laboratory; below: The laboratory is equipped with refrigerators where the function of the capacitors can be studied in a temperature as low as — 80 degrees centigrade.



Below: The machinery of the impregnation department for the paper capacitors embraces three floors. The capacitor windings are there dried and impregnated under high vacuum in various vessels and vats.

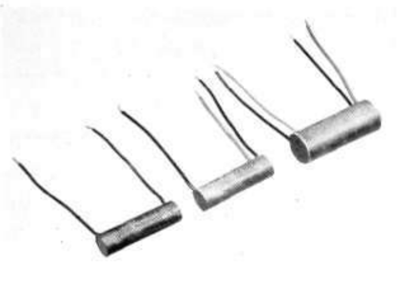


Fig. 4 X 4667

Radio interference suppressor capacitors

tubular type with end sealing of laminated pertinax

cans are made in hermetically sealed leakage-tight metal cans with ceramic terminals (tropical type), and in a simpler construction with bitumen sealing and pertinax lid or wholly closed metal cans not leakage-tight, for employment under conditions of normal temperature and humidity. There are various ranges of the above main types to suit different purposes. All types current in telecommunication and signalling practice are made and a particularly important feature of the programme is constituted by radio interference suppressor capacitors. Moreover Rifa manufactures power factor correction capacitors up to 7—8 KVAr and 750 V, those for fluorescent lighting fittings being the most interesting among these at present. The programme also includes ignition capacitors for internal combustion engines.

Mica capacitors are produced at present in two main types, a simpler type with a protective wax coating chiefly employed for broadcast receivers, and a moulded type for more exacting ranges of employment.

Electrolytic capacitors have recently been put on the market in entirely new all-aluminium series, both high voltage and low voltage, in aluminium cans or aluminium tubes, with end sealing of laminated rubber-pertinax. They are also made with moulded screw socket for one hole chassis mounting or with eight-pin base for fitting in valve holders (plug-in type). In addition, electrolytic capacitors are made in double rectangular metal cans, the internal can being entirely insulated from the external one, especially for use with telephone equipment and the like.

In the *plastic foil capacitors* the dielectric consists of polystyrene. These capacitors, which have only recently been put on the market, are distinguished by their relatively high stability and low losses, enabling them largely to replace the more expensive mica capacitors in high frequency telephone equipment and the like. They are supplied in paper tubes for assemblying together with other components for filters etc., and also in hermetically sealed metal cans.

High stability carbon resistors consist of ceramic tubes with graphite fired on and are employed where resistors of high stability and low noise level are required.

Workshops

The workshops are organized at present in six departments, *viz:* tool and mechanical department, four capacitor departments and resistor department. There is not space here to give a detailed account of these shops, but a few facts of interest may be mentioned.

The tool department is equipped for the making of special tools and special machines for the requirements of the factory. Such tools and machines cannot usually be bought and they must be designed and made at Rifa. The tool department has also an instrument section under the direction of the laboratory. In *the mechanical department* all the cans and other parts used in the assembly of the capacitors are made.

The paper capacitor department's winding shop with requisite paper store is divided off from the rest of the department and is equipped with air conditioning for constant temperature and humidity, very much facilitating the winding of the paper. The impregnation plant is installed in a three storey high room. The drying and impregnating vessels in which the capacitors are treated under heat and vacuum are on one level, the vacuum pumps on the floor below and the storage tanks for the different impregnating mediums on the floor above. All heating is done by high pressure steam. The plant is equipped for impregnation with any of the mediums currently used, and no efforts have been spared to ensure highest possible quality of the impregnation, which of course, is decisively important for the quality and length of life of the finished capacitor.

In *the electrolytic capacitor department* meticulous cleanliness is of the greatest importance for the quality of the product. Partly for this reason, the various operations of etching, formation, winding, impregnation and aging have been arranged in separate rooms, with tiles on floors and walls where necessary. To produce the large quantities of pure water used in the manufacturing processes here and to obtain it in the most economical manner, there has been installed a de-ionizer filter for the tap water. Silvered copper piping takes the purified water from storage tanks to the various places where used and to wash basins for the workers.

An interesting feature of the *manufacture of plastic foil capacitors* is the winding. This is carried out in special winding machines of patented design, which stop automatically when the winding reaches the desired capacitance value for which it has been set. The finished windings are »aged» in heat cabinets to ensure high stability.

In the *mica capacitor department* the mica sheets are silvered by spraying in an automatic machine with a silver dispersion, produced according to Rifa's own method, after which the solid silver coating is obtained by firing in an electric oven.

Laboratory

The manufacturing processes carried on by Rifa are of quite a special nature, giving rise to problems which are just as much chemical as electrical, and the laboratory therefore comprises both a chemical and an electro-physical section.

The chemical laboratory is well equipped for organic synthesis, microanalysis and structure determination, fractioning and fine distillation. There is also provision for metal analyses on both a micro and a semi-micro scale, both qualitative and quantitative. The electrophysical laboratory has available DC voltage up to 35 kV and AC voltage from 15 c/s to 50 million c/s and has a first-class measuring equipment. There is also an air-conditioned room for precision measurements. In many cases special apparatus not available on the market are required and these must be designed and built at Rifa.

For testing the capacitors under extremely varying conditions of climate and temperature the laboratory is furnished with test chambers in which tropical heat and humidity can be produced and there are special refrigerators which can produce arctic cold down to 80 degrees centigrade below zero.

The laboratory is also responsible for the extensive and strict inspection of raw materials, processes and products. Besides repeated testing during and after manufacture, samples are taken at regular intervals of the finished capacitors and these are subjected to very exacting tests in the laboratory. One of the most important tests is the life performance test, in which the capacitors are subjected to tests lasting years under conditions similar to those prevailing in practice. These tests are supplemented by accelerated life tests, with the capacitors made to work with excessively high voltages and temperatures, so that the whole of their life »is lived» in the space of a few hundred hours.

Svenskradio Table Gramophone

C FREDIN, SVENSKA RADIOAKTIEBOLAGET, STOCKHOLM

U.D.C. 621.396.621:681.848.5

The great news on the radio market is the Svenskradio 1506 — a small tastefully designed radiogramophone with the same size as an ordinary table gramophone. It delivers a very fine sound both for radio and gramophone reproduction, which can be intensified to a really impressive volume, for dancing purposes and the like. The new table gramophone is described in the following article.

The radio listener who does not want to spend money on or who has no room for a big radiogramophone, has hitherto had to be content with a combination of record changer and radio receiver or a portable gramophone. Such a combination often produces poor results owing to the various units not being suited to each other so that the receiver must be provided with extra accessories in the form of a filter suited to a pick-up. Moreover there is the trouble with loose wires which can get mixed up.

Mechanical sound production, as with a portable gramophone, is out of date and does not do justice to the excellent electrical recordings available these days, and besides it is not possible to regulate the volume. The heavy sound box wears out the records quickly — not to mention the trouble of winding up the clockwork of the gramophone.

The new Svenskradio table gramophone is free from all these drawbacks. Technically it is all that can be wished for, it has a good appearance, is convenient to operate and has a surprisingly good sound quality. Both Svenskradio 1506 V (AC type) and 1506 LV (AC/DC type) are executed in polished mahogany, elm or walnut. The dimensions are small — see dimensions in the table on page 31 — and the weight is as low as 9 kg.

Radio Receiver

The receiver is small in size but big in class. With the exception of some features related to the connection of the record changer, it is so like Svensk-

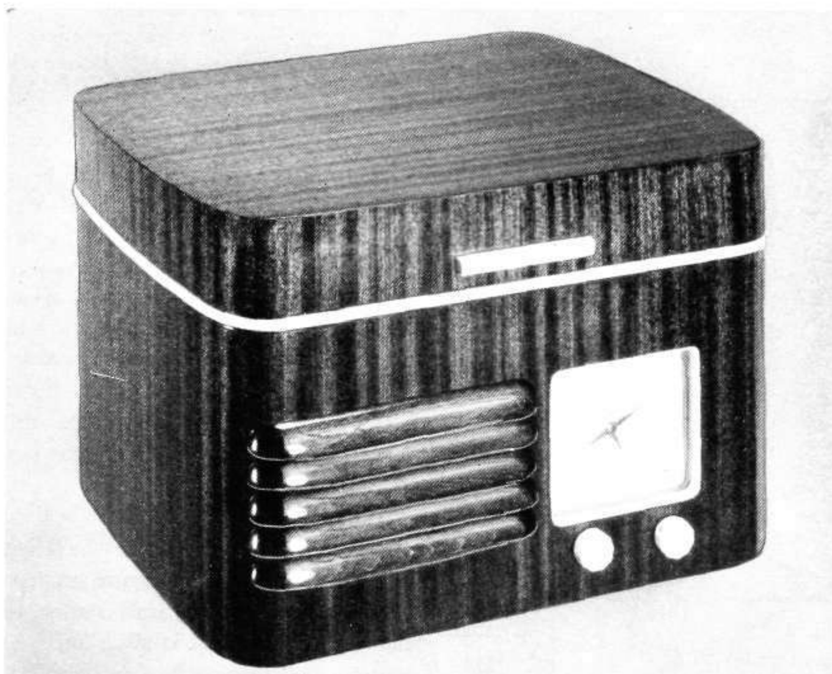


Fig. 1 X 6479

Svenskradio 1506

The left knob is combined switch and volume control. With the right knob you tune in the wave range desired and the station.

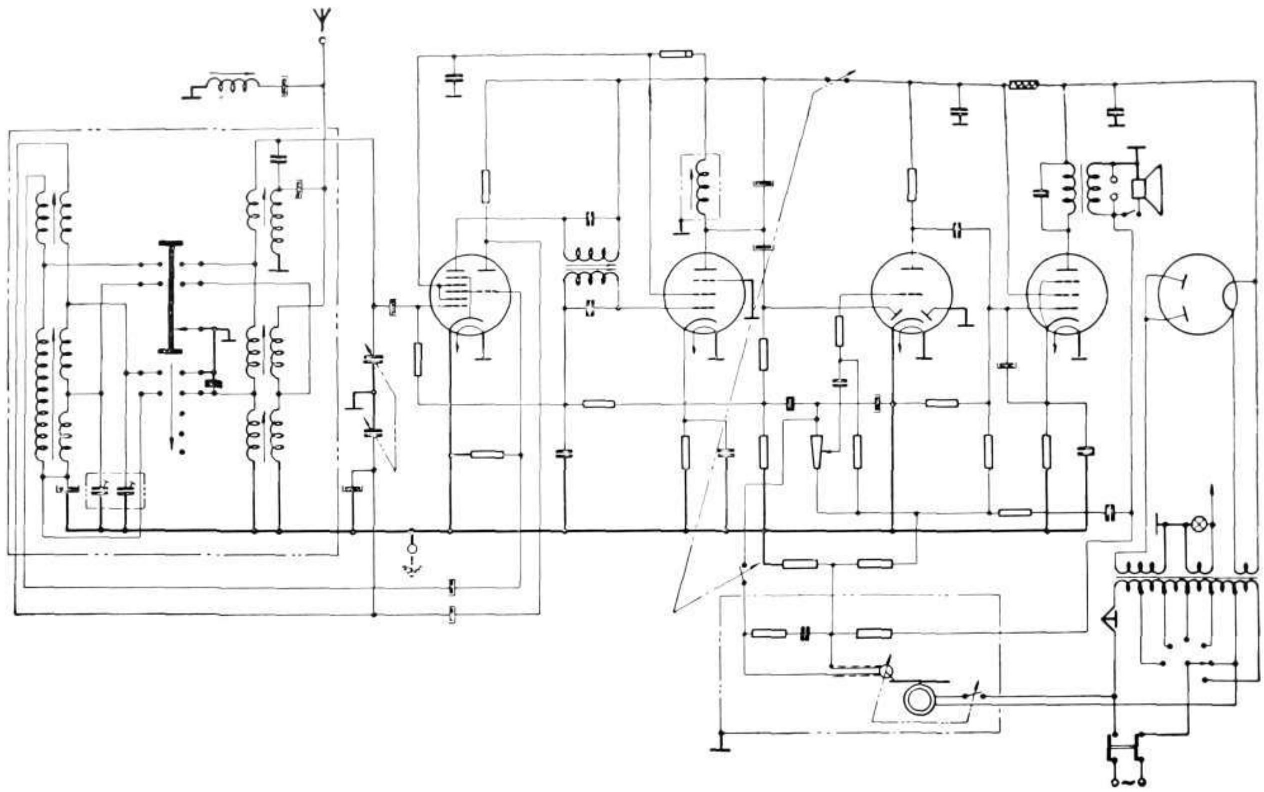


Fig. 2 X 7560
Circuit diagram for Svenskradio 1506 V

radio 1502 V that to describe it in detail would only be to repeat what has already appeared in a previous number of Ericsson Review. Briefly, Svenskradio 1506 is a 5 valve, 6 circuit superheterodyne with three wave ranges, gramophone—radio switch, built-in aerial and terminals for external loudspeaker. Further particulars are concentrated in the table on page 31, showing what the receiver comprises and what it can do.

There is some difference with the AC—DC receiver 1506 LV. The heaters of the valves are connected in series and they like the dial lamp are protected by the insertion of a resistance having negative temperature coefficient. There is a similar resistance parallel with the lamp, which comes into operation if any fault occurs in the lamp.

Fig. 3 X 4665
Svenskradio 1506
with the lid up

Record Changer

The record changer is protected by a lid which can be put down when playing ordinary 25 cm records. The less common 30 cm records, however, are played with the lid up. Before placing a large record on the plate, a support must be put up for the lid, to prevent the lid from falling down and damaging the record. The record changer is spring suspended thus protecting it against shocks when under transport. This arrangement also reduces the risk of audible connection between pick-up and the loudspeaker.

Playing is started by moving the pick-up arm to the right and putting it down on the record. An automatic stop device comes into operation when the whole of the record has been played.

In 1506 V the motor is of shunt type, but 1506 LV has a normal DC motor provided with an interference suppression device. Ordinary record changers are usually fitted with separate switch, this being hidden under the plate and often having a design that is more interesting to the technician than for the ordinary person, and because of its concealed position it is often forgotten. It can be expected that Svenskradio 1506, which is easy to carry about, will often be switched over for different voltages. In such cases the easily accessible switch of the table gramophone, operating in common for both gramophone motor and radio receiver is both convenient and reliable.

The pick-up has light needle pressure, moves very easily laterally and gives an even voltage over a wide frequency range. It is designed for the usual kind of needles. Excellent results are obtained with »His Master's Voice high fidelity long playing needles», a hard chromium-plated, plastic-coated needle lasting for 60 record sides.

On the record changer there is a radio—gramophone switch with which by a single movement the radio part can be disconnected and the record changer connected with its filter and amplifier and vice versa.

Technical data of Svenskradio table gramophones

	AC type Svenskradio 1506 V	AC/DC type Svenskradio 1506 LV
Number of valves	5	5
Valve functions	7	7
Det I and oscillator	MECH 42	MUCH 42
If amplifier	6BA6	MUF 41
Det 2 and Af amplifier	6AT6	MUBC 41
Output valve	MEL 41	MUL 41
Rectifier valve	MAZ 41	MUY 41
Dial lamp	6.5 V/0.2 A	6.5 V/0.1 A
Fuse	—	600 mA
Electrical data (for 220 V)		
Sensitivity (50 mW)	20 μV	30 μV
Band width for 40 dB	24 kc/s	24 kc/s
Output	3 W	3 W
Receiver's current consumption	30 W	34 W
Gramophone motor current consumption	15 W	22 W
Loudspeaker, type	HK 713	HK 1013
Magnetic field	7 000 gauss	10000 gauss
Useful cone area	80 cm²	80 cm²
Loudspeaker impedance Z =	20 ohm	4 ohm
Voltage ranges	110, 127, 140 155, 220, 245 V	110, 120—127 220 V
Wave length ranges		
Short wave	18.5—50 m	18.5—50 m
Medium wave	190—580 m	190—580 m
Long wave	690—2000 m	690—2000 m
Number of tuned circuits	6	6
Built-in aerial	x	x
Loop antenna for MW and LW	—	x
Weight	9.5 kg	8.4 kg
Dimensions: height	235 mm	
width	350 mm	
depth	300 mm	
Finished in	light elm, mahogany and walnut	

LM Ericsson Exchanges 1949

During 1949 the following exchanges on the LM Ericsson automatic telephone system with 500-line selectors have been put into service:

town	exchange		number of lines
Argentine			
San Juan		(extension)	1000
Tucumán		(extension)	2000
Brazil			
Itajai			260
Juiz de Fóra		(extension)	500
Rio de Janeiro	PAX		1000
Volta Redonda	PAX		500
Colombia			
Bogotá	Centro	(extension)	1000
Bogotá	Chapinero	(extension)	3000
Bogotá	Teusaquillo	(extension)	3000
Neiva			500
Ecuador			
Cuenca			1000
Finland			
Åbo		(extension)	1000
Iran			
Teheran	PABX		1100
Italy			
Alessandria		(extension)	500
Ancona	2 PABX		150
Brescia		(extension)	500
Caravaggio		(extension)	50
Cremona		(extension)	500
Genova	PABX		160
Milano	PABX		400
Napoli	Museo		5000
S. Dona di Piave		(extension)	80
Treviglio		(extension)	80
Venezia	Lido	(extension)	500
Mexico			
Guadalajara		(extension)	1500
Mérida		(extension)	500
México D. F.	Piedad	(extension)	1500
México D. F.	Portales	(extension)	500
México D. F.	Roma	(extension)	3000
México D. F.	San Angel	(extension)	500
México D. F.	Santa Maria	(extension)	500
México D. F.	Valle	(extension)	500
México D. F.	Victoria	(extension)	2500
Morocco			
Tanger		(extension)	500
Netherlands			
Rotterdam	3 PABX		590
Norway			
Halden		(extension)	500
Lillehammer		(extension)	1000
Sweden			
Bollnäs		(extension)	1000
Borås		(extension)	1000
Göteborg	Group exchange		7500
Göteborg	Hisingen	(extension)	5500
Göteborg	I-circuit exchange		200
Göteborg	Mölndal	(extension)	1500
Göteborg	Sävedalen	(extension)	1000
Göteborg	4 PABX		800
Hälsingborg		(extension)	2500
Kalmar			6500
Kinna		(extension)	500
Kristianstad		(extension)	1000
Linköping		(extension)	2000
Lund		(extension)	1500
Skellefteå		(extension)	1000
Stockholm	Enskede	(extension)	5000
Stockholm	Huddinge	(extension)	1000
Stockholm	Södra Vasa	(extension)	5000
Stockholm	5 PABX		780
Stockholm	19 PAX, PABX	(extension)	760
Sölvesborg		(extension)	500
Trollhättan		(extension)	1000
Tumba			1100
Uddevalla		(extension)	1000
Uppsala		(extension)	2000
Various places	13 PABX		1200
Various places	12 PAX, PABX	(extension)	1500
Turkey			
Ankara	Bahçelievler	(extension)	1000
Ankara	Merkez Santral	(extension)	1500
Izmir	Karşiyaka	(extension)	740
Izmir	Merkez Santral	(extension)	3000
		Total	98000

During 1949 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	30	6240
Switchboards with 100-line selectors, system AHD	79	8300
Switchboards with 25- and 12-line selectors, system OL	656	15384
Total	765	29924

Ericsson Technics No 48, 1950

Christian Jacobæus: A Study on Congestion in Link Systems

In this work the author has sought to provide easily handled expressions and rules for the design of connecting devices and lines in those device groups in telephone exchanges which are generally classified together as link systems. These have been used in telephone systems for some tens of years, but have come into particular prominence recently. This is because exchanges using crossbar switches, which have been developed and applied in Sweden and in the United States, use the link principle as a grouping method almost without exception. The design rules have been obtained by using the method which is most convenient for telephone technique, the calculation of the congestion in the system. This is the fraction of the total traffic presented which cannot be handled because of a lack of connecting devices. The congestion is a function of the traffic presented to the system and of the arrangement of the link system.

The work begins with the definition of a link system, and in this connection gives examples of different types of link systems. The basic conception of the link system is the grouping of two or more associated selector stages one after the other. It is shown, however, that from the point of view of the congestion many other systems can be compared with such a group. It is particularly worthy of note that a connection system with common groups can be treated as a link system. This opens a way to be a practical treatment of the congestion problem in common group systems.

The mathematical treatment of the congestion problem begins with a study of the principles which are applicable in the derivation of the congestion formulas under different traffic conditions. Congestion occurs in a link system (with two selector groups) when a connection cannot be provided by free links reaching free outlets in the wanted route. An expression for the congestion can be obtained by calculating the probability of each such congestion combination, and then summing the probabilities. A deciding factor in the result is the distribution function used for the traffic loading of the device groups. The distribution functions in question are here the Erlang function for the loading distribution in a busy signal system and the Bernoulli function. An examination is made in succeeding chapters of the function to be used for the different arrangements. The expressions obtained for the congestion are in almost all cases simple, and are particularly well suited for application in practice. In addition to expressions for the usual time congestion, expressions are also given for the call congestions where this is not the same.

Analogously with the result obtained by O'dell for normal grading based on principles given by Erlang, formulas have been derived for the traffic problem of a link system combined with grading. Unlike the results obtained with normal grading the congestion here also depends on the loading on the incoming lines.

Expressions are also derived for the cases with more than two selector groups in tandem in a link system.

The theoretical part contains an analysis of the characteristic properties of the congestion functions and of the main errors to which the method of calculation may be subject. This part finishes with a comparison between a conventional telephone system with grading and a link system. A method not previously used for the comparison of group selectors with different numbers of groups has been applied here. In the second part of the work it has been possible to verify the formulas given. The first comparison is with the design tables used by the British Post Office for double preselector systems. The agreement between the tables and the congestion predicted by the formulas is very good.

Extensive measurements of traffic and congestion have been made on a link system with cross-bar switches installed in the public network in Helsinki. Measurements were made for different common traffic conditions. The statistical examination of the results shows close agreement between measurements and theoretical values. For some traffic conditions the agreement is very close if certain corrections are made to the measured values for reason which are discussed.

The data from a large scale study of congestion conditions in a common group system in the Östermalm exchange in Stockholm have been placed at the disposal of the author for comparison with the formulas given. A study shows that for these traffic conditions the agreement between theory and experiment is good: if the theoretical values are multiplied by 0.82 there is complete agreement over the whole range of data studied.

U.D.C. 621.395.97

THAMES, G: *Conference Telephone, Type DYA*. Ericsson Rev. 27 (1950) No. 1 pp. 2—15.

Telefonaktiebolaget L M Ericsson has enlarged its manufacturing programme with a new type of conference telephones, which has been given the designation DYA. It is intended to be used in small as well as large installations. The traffic facilities, operation and construction are described in the article.

U.D.C. 621.316.933.1

LUNDHOLM, R: *The Binding Wire Lightning Arrester — a New Form of Lightning Protection for Telephone Open Wire Lines*. Ericsson Rev. 27 (1950) No. 1 pp. 16—23.

The article gives a description of the bindning wire lightning arrestor, a method for protecting bare conductors against atmospheric voltage surges in a simple and cheap manner. The method which has been invented and developed by the engineer, K. V. Jörgensen of the Jydsk Telefonaktieselskab of Denmark, consists briefly stated in forming a spark-gap between the extended end of the binding wire and an earthed insulator bolt for example, at a number of points along the line, in conjunction with the attachment of the conductor to the insulator with binding wire. By this means a diversion of the dangerous voltage surges is obtained out on the line, so that by the time such voltage waves reach the telephone instrument, the cable or the exchange, their magnitude is reduced to relatively harmless limits.

The article also gives an account of the origin of atmospheric voltage surges in bare conductors and explains the method for calculating the magnitude of the voltages and currents set up, and finally, describes the protective action of the binding wire arrestor under varying conditions.

U.D.C. 061.6 Rifa

OLSTEDT, S: *Aktiebolaget Rifa — L M Ericsson's New Capacitor Factory*. Ericsson Rev. 27 (1950) No. 1 pp. 24—28.

A short description in words and pictures of L M Ericsson's new capacitor factory erected in 1948 at Ulvsunda, Stockholm.

U.D.C. 621.396.621:681.848.5

FREDIN, C: *Svenskradio Table Gramophone*. Ericsson Rev. 27 No. 1 pp. 29—31.

Description of Svenskradio 1506 — a small tastefully designed radio-gramophone with the same size as an ordinary table gramophone.

The Ericsson Group

Associated and Cooperating Enterprises

EUROPE

Danmark L M Ericsson A/S	*København V*, Trommesalen 5
Telefon Fabrik Automatic A/S	*København K*, Amaliegade 7
Dansk Signal Industri A/S	*København-Vanløse*, Skaibakken 10
Deutschland Ericsson Verkaufsgesellschaft m. b. H.	*Kronberg in Taunus*, Parkstrasse 1
España Cía Española Ericsson, S. A.	*Madrid*, Conde de Xiquena 13
France Société des Téléphones Ericsson	*Colombes* (Seine), Boulevard de la Finlande
Great Britain Swedish Ericsson Company Ltd	*London, W.C. 1*, 329 High Holborn
Production Control (Ericsson) Ltd	*London, W.C. 1*, 329 High Holborn
Ericsson Telephones Ltd	*London, W.C. 2*, 22 Lincoln's Inn Fields
Italia Setemer, Soc. per Az.	*Milano*, Via dei Giardini 7
SIELTE, Soc. per Az. — Società Impianti Elettrici e Telefonici Sistema Ericsson	*Roma*, C.P. 24 (Appio)
F. A. T. M. E. Soc. per Az. — Fabbrica Apparecchi Telefonici e Materiale Elettrico Brevetti Ericsson	*Roma*, C.P. 25 (Appio)
S. E. T. Soc. per Az. — Società Esercizi Telefonici	*Napoli*, C.P. 274
Nederland Ericsson Telefoon-Maatschappij, N. V.	*Rijen* (N. Br.)
Norge A/S Elektrisk Bureau	*Oslo*, P. B. Mj 2214
A/S Industrikontroll	*Oslo*, Teatergaten 12
A/S Norsk Kabelfabrik	*Drammen*
Suomi O/Y L M Ericsson A/B	*Helsinki*, Fabianinkatu 6
Sverige Telefonaktiebolaget LM Ericsson	*Stockholm 32*
AB Alpha	*Sundbyberg*
AB Ermex	*Solna*
AB Rifa	*Ulvsunda*
AB Svenska Elektronrör	*Stockholm 20*
L M Ericssons Driftkontrollaktiebolag	*Solna*
L M Ericssons Försäljningsaktiebolag	*Stockholm*, Kungsgatan 33
L M Ericssons Mätinstrumentaktiebolag	*Ulvsunda*
L M Ericssons Signalaktiebolag	*Stockholm 32*
Mexikanska Telefonaktiebolaget Ericsson	*Stockholm 32*
Sieverts Kabelverk	*Sundbyberg*
Svenska Radioaktiebolaget	*Stockholm*, Alströmergatan 12

ASIA

India Ericsson Telephone Sales Corporation AB	*Calcutta*, P.O.B. 2324
Indonesia Ericsson Telefoon-Maatschappij N. V.	*Bandoeng*, Harmsenweg 13

AMERICA

Argentina Cía Sudamericana de Teléfonos L M Ericsson S.A.	*Buenos Aires*, Belgrano 894
Corp. Sudamericana de Teléfonos y Telégrafos S.A.	*Buenos Aires*, Belgrano 894
Cía Argentina de Teléfonos S.A.	*Buenos Aires*, Belgrano 894
Cía Entrerriana de Teléfonos S.A.	*Buenos Aires*, Belgrano 894
Cía Comercial de Administración S.A.	*Buenos Aires*, Belgrano 894
Industrias Eléctricas de Quilmes S.A.	*Buenos Aires*, Julio A. Roca 733
Brasil Ericsson do Brasil Comercio e Indstria S.A.	*Rio de Janeiro*, C.P. 3601
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Chile Cía Ericsson de Chile S.A.	*Santiago*, Casilla 2118
Colombia Cía Ericsson Ltda	*Bogotá*, Apartado Aéreo 4052
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Soc. Telefónica del Peru, S. A.	*Arequipa* Casilla de correo 112
Uruguay Cia Ericsson S.A.	*Montevideo*, Uruguay 1258
United States of America Ericsson Telephone Sales Corporation	*New York 17*, 100 Park Avenue
Venezuela Cía Anónima Ericsson	*Caracas*, Apartado 3548

Agencies

EUROPE

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Grèce »ETEP», S.A.	*Athènes*, 41 Rue W. Churchill
Ireland E. C. Handcock, Ltd	*Dublin, C 5*, Handcock House, 17 Fleet Street
Portugal Sociedade Herrmann Ltda	*Lisboa*, Calçada do Lavra 6

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CONTENTS

On cover: Operator at an L M Ericsson manual private branch switchboard with cords, type ADF 14

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Manual Private Branch Switchboards with Cords

ERIK I ENGQVIST, TELEFONAKTIEBOLAGET LM ERICSSON, STOCKHOLM

U.D.C. 621.395.23

Manual switchboards of all sizes, and particularly boards requiring one operator only, are still in great demand among L M Ericsson's customers. The development, previously made on the L M Ericsson LB-switchboards and described earlier in Ericsson Review No. 3, 1946, has, therefore, quite naturally, been extended to CB-boards. This development is now, in the main, completed and has with regard to private branch switchboards resulted in a range of cord switchboards, which seem to cover all reasonable requirements as regards appearance and performance of a modern manual switchboard.

The new range of the L M Ericsson manual private branch switchboards covers the following types:

Wall switchboard for a maximum of 40 extensions and 6 exchange lines;
Floor switchboard for a maximum of 80 extensions and 12 exchange lines;
Floor switchboard for a maximum of 180 extensions and 12 exchange lines.

The new range of switchboards has been developed on the same fundamental principles as those applied to the L M Ericsson new LB-boards. The frame work is exactly the same. The calling and connecting equipment for the lines are collected in units for 10 lines. Each cord circuit is assembled to a convenient switching set. The common equipment has been combined to a position set. The relay equipment for the exchange lines is fitted in a separate frame outside the switchboard. The units are in other respects designed in such a way that a complete switchboard may easily be built up from the units, which for this reason in many cases have been provided with plug and jack connections.

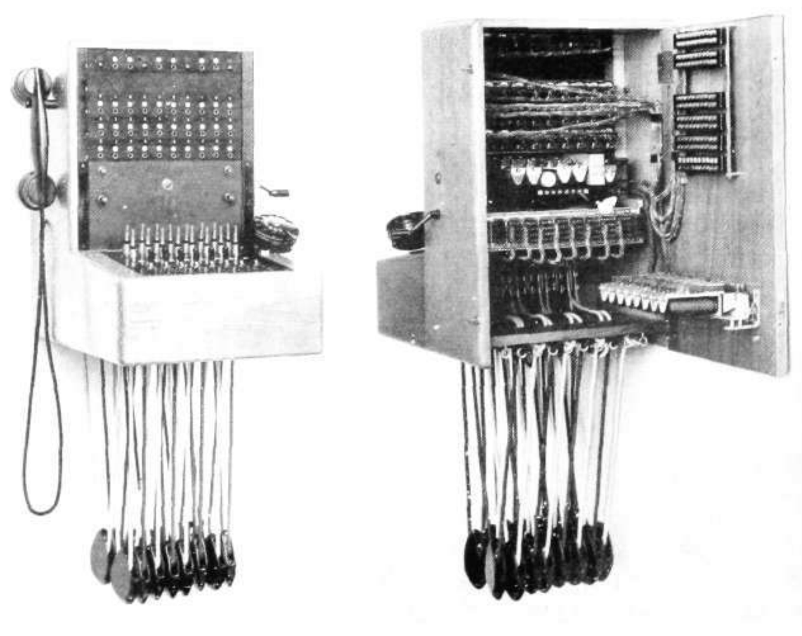


Fig. 1 X 6499

Wall switchboard ADE 1205

for 30 extensions, 6 exchange lines and 8 cord circuits. (right) Opened from base.

The following circuit features may be mentioned:

1. All signalling takes place by means of lamps, and extension lines are, therefore, provided with line relays operating even with comparatively high line resistance.
2. The cord circuit is similar to that used on the LME older switchboards with the exception that the key has been provided with a ringing position.
3. The switchboards are wired in such a way that they may be connected to a manual or automatic exchange immaterial of what type. By a minor alteration in the wiring of the relay set for the exchange line, connection may be made to an LB-exchange.
4. Automatic holding of the exchange lines is obtained for incoming exchange calls, enabling inquiry and transfer connections to be performed for such calls.
5. Night connection may be carried out with ordinary cords, irrevelant circuits being made ineffective by means of special keys.
6. The extension instruments are fed from the switchboard battery even for exchange calls, improving transmission in case of high line resistances.

Fig. 2 X 4669

Wall switchboard ADE 1205 on floor stand

The Wall Switchboard

The smallest type of switchboard, Fig. 1, is normally made for wall mounting. The capacity of this board is 40 + 6 lines (the first figure indicating number of extensions and the second figure number of exchange lines) and 10 cord circuits. The wood work is in light oak with resin glued joints, all corners and edges being rounded. Certain parts inside the board are made in beech wood.

The front side consists of a vertical panel for the line unites and the position set and a projecting, slightly inclined panel for the switching sets and the dial. The receiver has as usual been provided with a hook on the left hand side of the board, and the generator has been placed on the right hand side. The rear consists of a lid on strong hinges and reinforced to take up the strain caused, when the board is mounted on a wall. The lid is fitted with the connection strips required for the incoming lines and below these a row of cord circuit relays.

In some cases wall mounting may be difficult to arrange or not convenient for other reasons. Convenient wall space may, for instance, not be available, en-

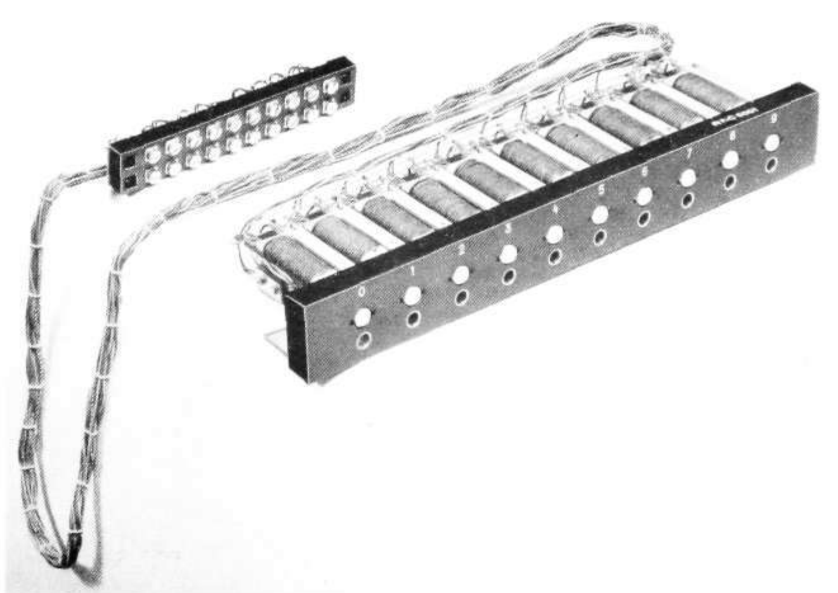


Fig. 3 X 6490

Line unit for ADE 12

vironment may be unsuitable for wall mounting or the operator may have other duties to perform requiring a certain position for the switchboard. In such cases a fixed or movable mounting on the floor may be preferable. For this purpose a special floor stand has been designed. Fig. 2 illustrates the smallest switchboard mounted on such a stand.

The line unit, Fig. 3, comprises a completely wired unit for the line equipment of ten extension lines. The individual calling device is a so called relay-jack, which will be described below. Ten relay-jacks are assembled on a moulded bakelite strip. On the front of this strip only the jack sleeves and the lamp apertures are visible, whereas the relay in the relay-jack is concealed behind the strip. A cable form is run to a terminal strip with ten pairs of terminal screws. All line units contained in a wall switchboard are identical with regard to the numbering of the jacks as well as the cable form.

The line unit for the exchange lines is in principle similar but is equipped for six lines only. The four empty pairs of holes have, therefore, been covered up.

The position set, Fig. 4, consists of an oak panel covered with black phenolic laminate and contains all common equipment for the wall switchbord with the exception of the dial. The generator and the bell will thus be found in this set together with various relays and keys as well as a connection block for the receiver and the dial. The position set finally contains two jack bars with connection jacks, one for connection of switching sets and one for the cord circuit relays. Wiring to battery, pole changer and extension bell is collected in a cable form terminating in a separate connection block.

The switching sets in the wall switchboard will be described below in connection with other components.

The new wall switchboard has been coded *ADE 1205* and has the following dimensions:

Height 19 1/4″ (490 mm), or 34 1/4″ (870 mm) including cords and pulley weights; width 13 1/4″ (336 mm) excluding receiver and generator handle; depth 16 3/8″ (415 mm). The floor stand, *BAR 1101*, is 19″ (480 mm) high and weighs 17 1/4 lbs (7.4 kg).

Net weight of switchboard fully extended excluding frame and relay sets for the exchange lines is approximately 68 lbs (31 kg).

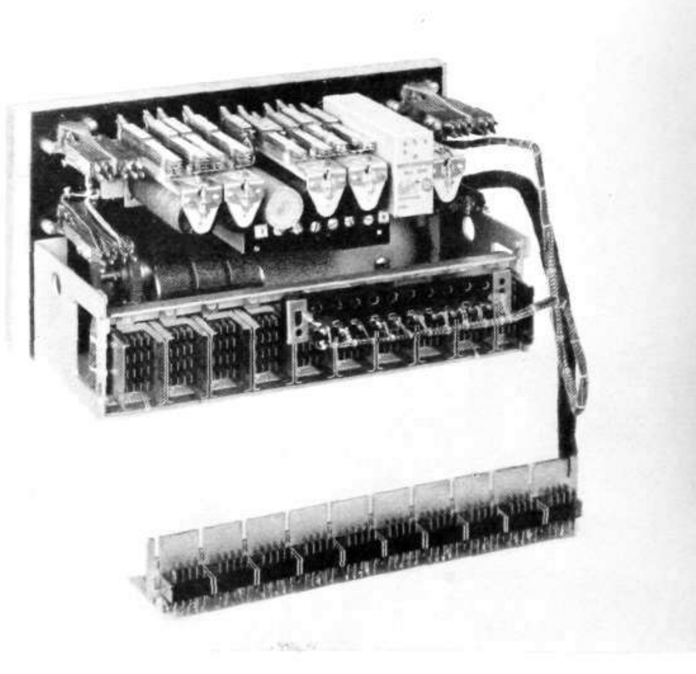
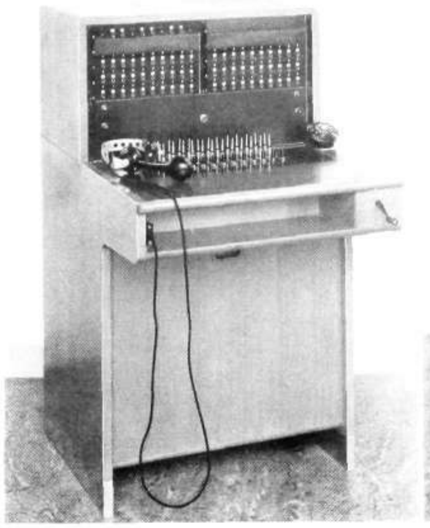


Fig. 4
Position set for ADE 12
rear view

X 6489



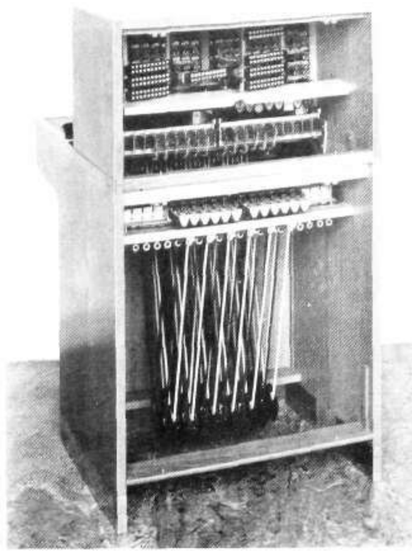


Fig. 5 X 6498

Floor switchboard ADF 1410

for 60 extensions, 6 exchange lines and 12 cord circuits. (right) Rear view with lids removed.

The Floor Switchboards

The floor switchboards are supplied in two sizes, a small, Fig. 5, having a capacity of 80 + 12 lines, and a large, Fig. 6, for a maximum of 180 + 12 lines. Both types may be equipped with a maximum of 20 cord circuits. They are both intended for one operator and are twin panelled. The switchboards differ with regard to the top section, which may be low or high.

The switchboard frames are veneered in light oak on block board combining good mechanical stability with a high quality finish on the large surfaces. Certain stressed elements in the frame are made in solid oak, whereas some concealed parts are in beech wood for manufacturing reasons. The desk surface is covered with green cork lino, which is hard wearing and offers an excellent writing surface. All joints are made by means of resin glue, which is inert against damp and fungii. Certain inside joints have been reinforced by means of wooden laths or angles. A compartment has been arranged under the desk top for the operator's personal effects. The receiver outlet is situated to the extreme left in this compartment and a portion to the right has been partitioned off for the generator. The bottom part of the board has been provided with sheet metal kick guards.

The rear of the switchboard is covered by two lids made in wall board on a frame of soft wood. When the lids are removed all terminal frames, jacks and cord supports are accessible. There is ample space for running cables to the terminal frames in the top part of the board.

The line unit, Fig. 7, differs from that of the wall switchboard only with regard to the cable form. The illustration shows a unit for ten extension lines. The line units are now identical also in the floor switchboard, the separate left or right hand types having been made obsolete.

The line unit for the exchange lines are only made for six lines as in the case of wall switchboards, see Fig. 6. Normally the units are assembled in the board with extension lines built up from the bottom and the exchange lines at the top, but there is nothing to prevent the exchange lines being lowered to a position immediately above the extension lines.

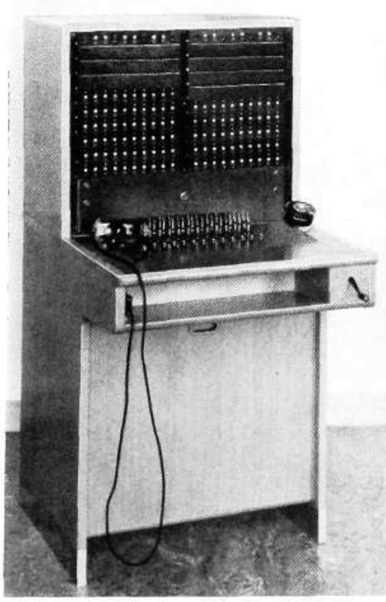


Fig. 6 X 4670

Floor switchboard ADF 1420

equipped for 110 extensions, 12 exchange lines and 12 cord circuits

The position set, Fig. 8, consists of an oak panel covered with phenolic laminate on both sides and carrying all common equipment in the switchboard with

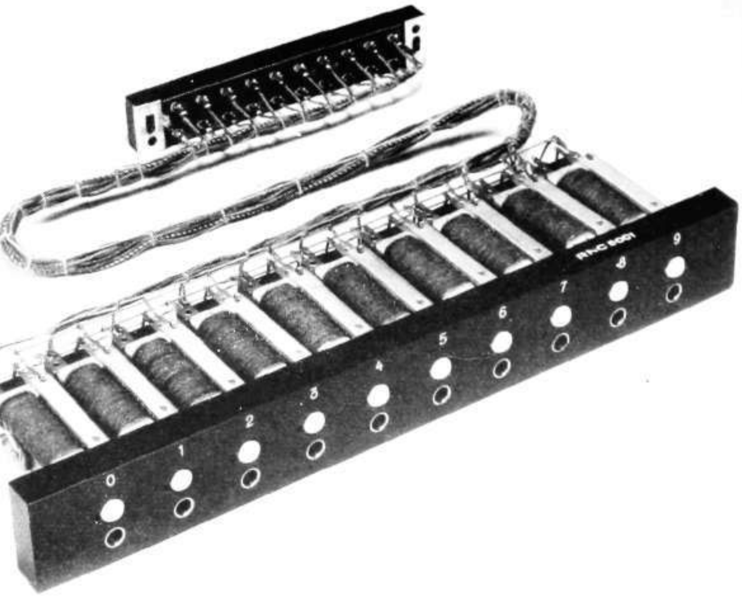


Fig. 7
Line unit for ADF 14

X 6488

exception of the dial and the generator. All wiring for the power supply is collected on a terminal block for easy connection of battery pole changer etc.

The new floor switchboards have been coded *ADF 1410* for the low type and *ADF 1420* for the high type.

The dimensions are:

Height $43^3/_4''$ (1 110 mm) and $50^3/_4''$ (1 290 mm) respectively
Width $25^1/_8''$ (639 mm)
Depth $30^1/_8''$ (765 mm)

Net weight for floor switchboard ADF 1410 with 80 + 8 lines and 12 cord circuits is 156 lbs (71 kg) approx. The corresponding board ADF 1420 is approximately 8 lbs heavier, whereas ADF 1420 with 180 + 12 lines and 18 cord circuits weighs 200 lbs approx. All weights are exclusive of frame and relay sets for the exchange lines.

As all the above switchboards may be extended, empty spaces in a board, not fully extended, is covered by dummies of the same dimensions as the line and cord circuit units. These dummies are also moulded in bakelite.

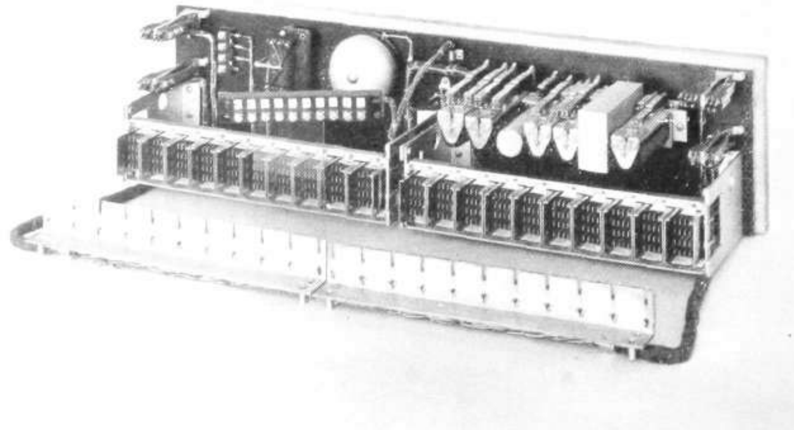


Fig. 8
Position set for ADF 14
rear view

X 6491

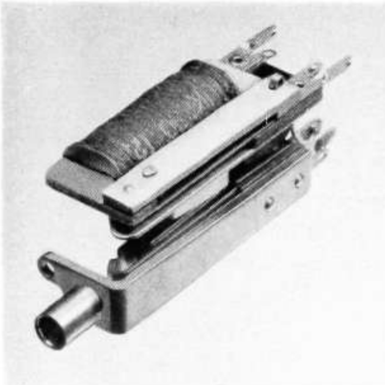


Fig. 9 X 4671
Relay-jack

Components

Only those components which are specially designed for the new CB-switchboards will be described here. The most prominent component is the combined relay-jack, Fig. 9, which serves as calling and connection device in all new CB-boards. It consists of a jack of fairly normal type attached to a lamp fitting and a very simple relay, forming a self-contained unit. The relay is provided with one make-contact only, connecting the lamp on operation of the relay. In spite of the small dimensions the relay will serve as calling relay for comparatively long extension lines. The calling relay and the jack are electrically connected in such a way, that the relay is disconnected from the line, when the plug is inserted in the jack. The relay-jack is mounted on the line unit strip by means of one single screw. All soldering tags, which may be connected in parallel when wiring the line unit, are specially designed for bare wire connection.

The relay in the relay-jack is normally wound with .0032" enam Cu (0.08 mm TE) giving 5 600 turns and 500 ohms, safe operating effect being 0.1 watt approx.

The Switching Set

Fig. 10, contains the essential equipment for a cord circuit. The body is moulded in bakelite and will hold the following components in order from the front.

1 battery feed relay
1 speaking and ringing key
1 supervisory lamp
2 plugs
2 cord connection clamping blocks

The illustration shows a wired unit with the wiring terminating in a connection jack.

The Battery Feed Relay

Fig. 11, has a similar iron circuit as that in the clear signal indicator in the L M Ericsson LB-switchboards. The armature is, however, modified so as to operate a single make-contact, operating the supervisory lamp. When the relay has been fitted in its position in the cord circuit unit, it is enclosed in an iron sheath to prevent cross talk between adjacent units.

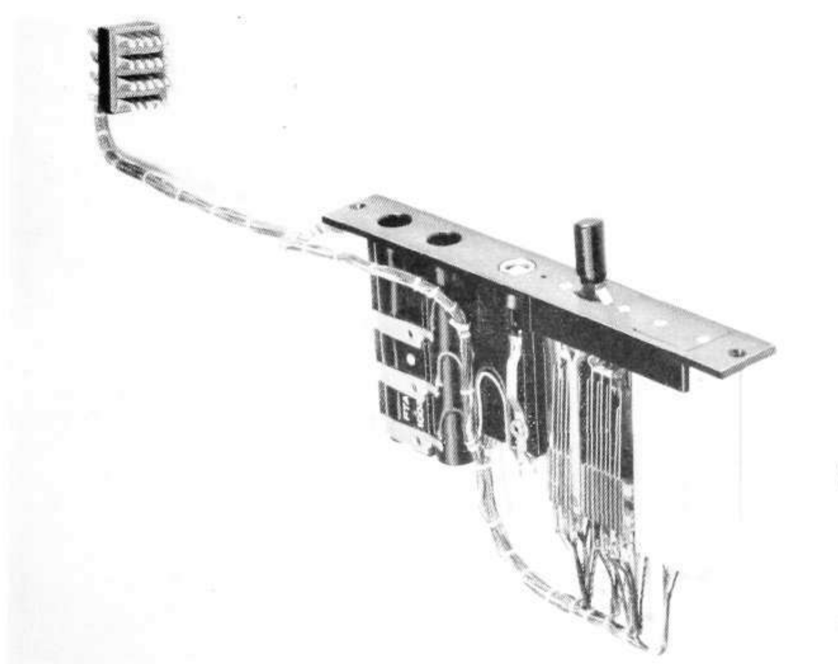


Fig. 10 X 6492
Switching set

The key and the lamp will already be familiar and do not require detailed description.

Fig. 11 X 4672
Battery feed relay

The Cord and the Plug

are comparatively recent components, which have lately been further developed. The cord connections, which earlier consisted of close wound wire cylinders, now consist of metal sheaths which are clamped round the cord, see Fig. 12. The plug has also been improved upon, more hard-wearing materials being used as insulation between plug conductors and as collars on the protection spiral.

The Cord Circuit Relay

Fig. 13. is a complement to the cord circuit unit in the switchboard. Each cord circuit in such a board has to be applied to two different traffic alternatives: internal service and exchange service. For this reason the cord circuit relay has been introduced, which among other things inserts the battery feed relay at internal connections. The cord circuit relay is provided with an attached connection plug and can be connected in its position in the switchboard as easy as the cord circuit unit. The work of replacing a faulty cord circuit or adding new ones is, therefore, only a question of minutes.

Fig. 12 X 4673
Cord and plug

The Relay Frame

As indicated above the new range of switchboards have been provided with separately mounted relays for the exchange lines. In this way many advantages have been gained. The switchboard itself can be made smaller and with a neater appearance. The exchange line relays, being comparatively vital components, will be more accessible for inspection and maintenance. Transport problems are simplified as the relay equipment is rather heavy and requires careful packing.

Fig. 14 shows a relay frame of the type used for the L M Ericsson new switchboards. It is made for wall mounting and contains six relay sets. A wall switchboard ADE 12 requires, consequently, one frame, whereas a fully extended desk switch board ADF 14 requires two frames. The frame is made in mild steel and finished in light aluminium enamel. The individual relay sets are connected over plugs and jacks and are easily removed from the frame. The space at the bottom of the frame is taken up by terminals for incoming and outgoing cables.

The relay frame, which is coded *BED 8006*, has the following dimensions: Height $17^1/_4$″ (440 mm), width $10^1/_8$″ (256 mm) and depth including relay set $6^1/_2$″ (165 mm). Net weight for a frame with fully mounted relay sets *BCB 16* is 44 lbs (20 kg) approx.

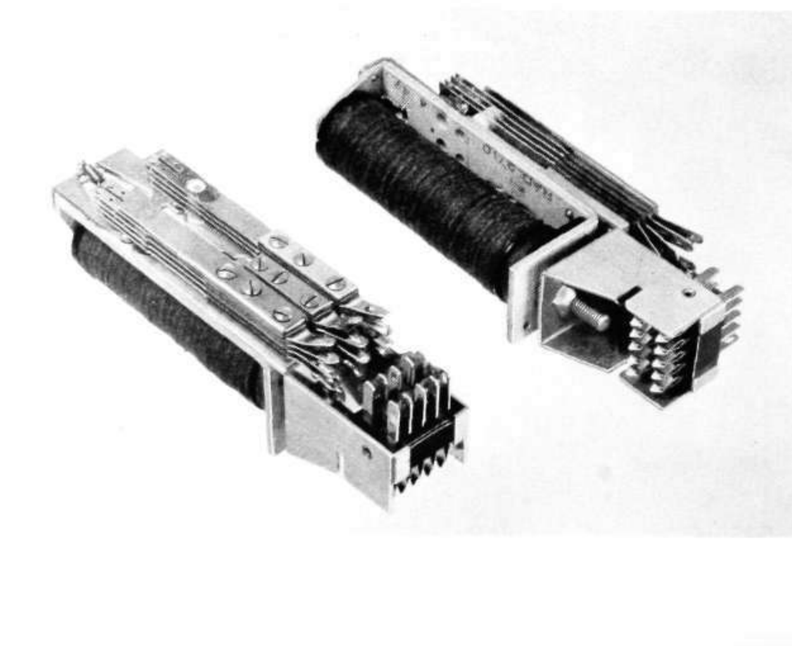


Fig. 13 X 6493
Cord circuit relay with plug

Fig. 14 X 4675

Relay frame BDE 8006

with 6 exchange line relay sets

The Circuit Diagram

Fig. 16 shows the circuit diagram for the new L M Ericsson switchboards. The top part of the diagram is taken up by the line equipment. The centre part shows a cord circuit and the lower part below multiple arrows covers the common position equipment.

The exchange line equipment contains a number of relays XR^1—XR^5, a transformer *Tr*, a few condensers and resistances and a night switching key *NK*, assembled to a relay set, Fig. 15. In the switchboard there are, moreover, relay *XR*, a call lamp *XL* and a jack *XJ*.

The extension line equipment is very simple and contains a relay *ER*, a call lamp *EL* and a jack *EJ*, assembled to a relay-jack, Fig. 9.

The cord circuit equipment includes two cords with plugs *AP* and *RP*, a key *SK*—*SK*—*RK*, a battery feed relay *SR* and a supervisory lamp *SL*, assembled to a switching set, Fig. 10, and finally a cord circuit relay *DR*, Fig. 13.

Apart from keys *NB*—*S*—*RB*—$\sim$, well known in switchboards, the position set contains operator gear *M*—*IC*—*R*, alarm device *NR*—*B*, ringing equipment *HG*—R_4—*RV*, dial *D*, switching relays R_1—R_2—R_5 and battery feed relay R_3.

A detailed description of the circuit procedure, when establishing connection, is outside the scope of this article. In the following we will, therefore, confine ourselves to an enumeration of the different connection facilities in the new L M Ericsson switchboard.

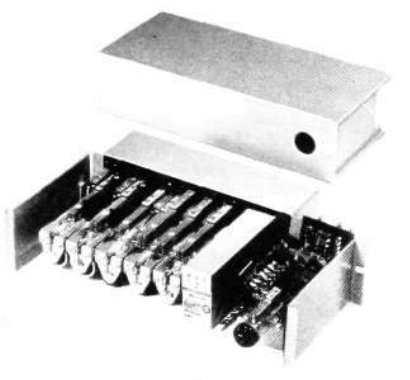


Fig. 15 X 4676

Relay set

cover removed

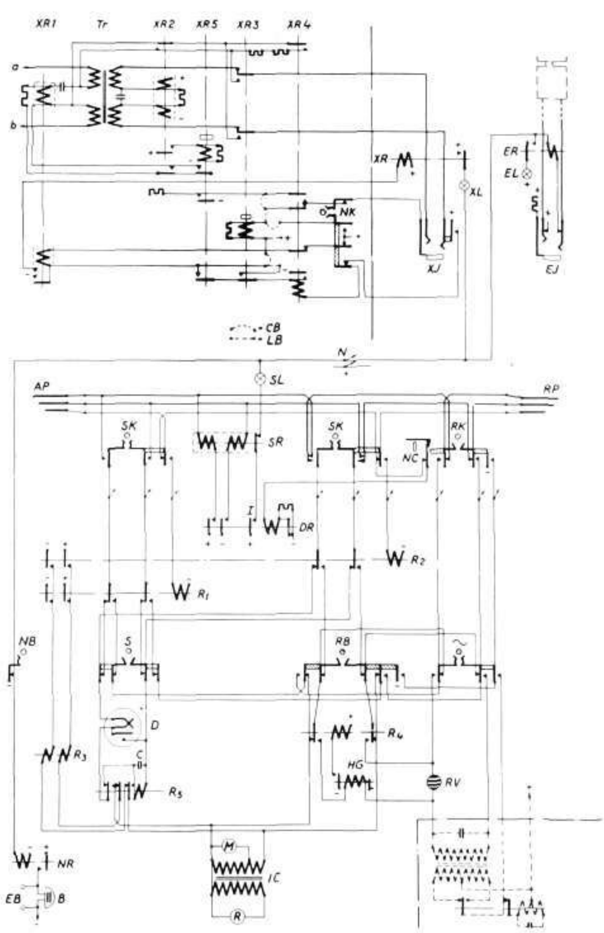


Fig. 16 X 6487

Circuit diagram

for ADE 12 and ADE 14

*

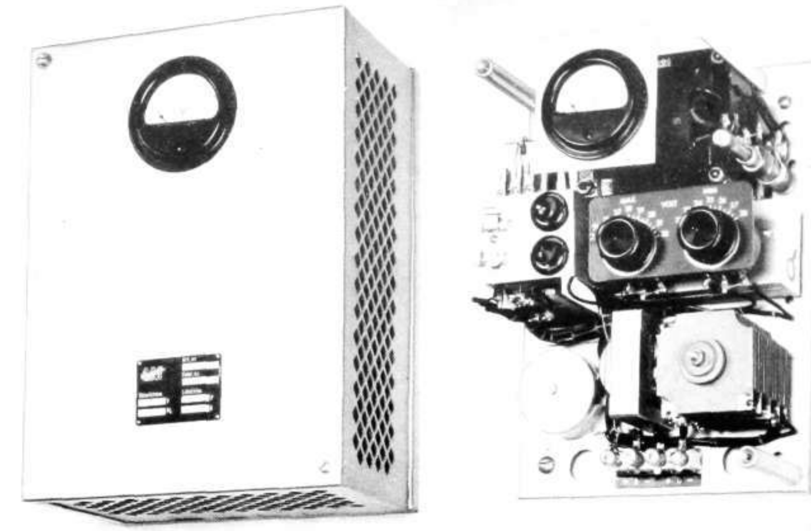


Fig. 17
Automatic battery charger
(right) with cover removed

X 6497

The following connections may be obtained:

extension—operator
extension—extension
extension—exchange
exchange—operator

The same plug in the cord is used when answering an extension and an exchange call.

For calls between two extensions, battery supply is obtained from a common relay *SR* in the cord circuit. For exchange calls, the extension receives battery supply from relay XR_2, in the exchange line relay set. The system is consequently independent of the battery supply from the exchange.

For incoming exchange calls, a holding circuit is formed (by means of relay XR^4) as soon as the operator answers the call, and this circuit remains in operation during the whole call and until disconnection takes place. This enables inquiry and transfer during the call without interfering with the main exchange. In such cases the extension calls the attention of the operator by repeatedly pressing the receiver cradle causing the clear indication lamp *SL* to flash.

For outgoing exchange calls, the exchange line is held directly from the extension instrument this is necessary in order to enable dialling from the extension instrument without the assistance of the operator. The possibilities of inquiry and transfer must, therefore, be dispensed with for such calls.

If an outgoing call is completed but not yet disconnected, a new call may still be received on the exchange line and be indicated in the switchboard. The ringing signal is, however, blocked by transformer *Tr* and does not affect the extension.

Night connection between exchange line and extension may be established by means of the ordinary cord circuits. In doing so, however, certain power consuming circuits must be put out of action by means of key *NK* in the exchange line and *NC* in the cord circuit. Contact *NC* is opened by means of a special key inserted in a round hole in the switching set. At night connection of the exchange line a relay XR^3 is connected, which transfers the ringing signal to the extension for outside calls.

The exchange line relay set as supplied may be connected to manual or automatic CB-exchanges of any type, but if the exchange is an LB one, the relay set wiring has to be modified as indicated by the dotted lines in the diagram. It should, however, be remembered that with LB exchanges night connection can only be arranged for incoming calls but not for outgoing calls.

With regard to the circuit of the new switchboards it should, finally, be added that by modifying the exchange line relay sets, there are considerable possibilities of meeting the various requirements, which may be put on switchboards of this kind.

Power Supply

A manual switchboard as described above is not complete without power supply of various kinds. In the first place 24 V is required as battery supply and as operating voltage for different local circuits. In the second place AC voltage for ringing should preferably be available.

The most reliable supply for 24 V DC is no doubt an accumulator battery with automatic charging equipment. The following capacities for batteries and charging equipment may be recommended depending on kind of available mains.

	ADE 12	ADF 14
Accumulator battery 24 V	15 Ah	30 Ah
Charging equipment for AC	BMM 1715	BMM 1716
Charging equipment for DC	BML 1102	BML 1102 + BML 1101

Providing AC mains are available and the probabilities of mains failure are small, an eliminator may be used, omitting the battery. Suitable eliminators are *BMN 2111* and *BMN 2211* resp.

Generator ringing is always rather cumbersome for the operator and the addition of a pole changer *RGN 6002*, Fig. 18, is recommended. This pole changer is operated on 24 V DC and has an effect sufficient for simultaneous ringing on approximately ten bells. The circuit of the new pole changer will follow from the dotted diagram in Fig. 16.

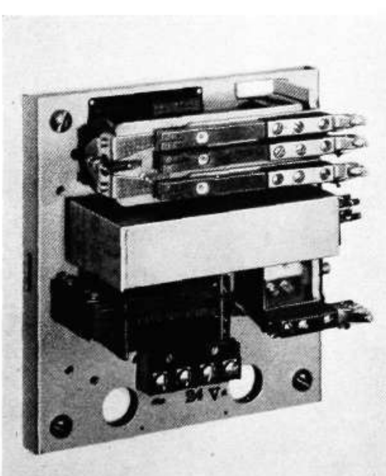


Fig. 18 X 4674

Pole changer RGN 6002

cover removed

Packing

The new private branch switchboards are supplied in parts as in the case of the new LB-boards. The packing principle is in the main similar although a few improvements have been introduced lately. The relay frame and the relay sets for the exchange lines are, however, packed in a separate case.

Through the methodical application of the unit principle for lines, cord circuits, exchange line relays etc., the amount of assembly work is reduced to a minimum and a switch board may be assembled in a few hours without other tools than a screw driver. The new method of packing will no doubt also reduce the risk of transport damage on the more vital components.

Balancing Machine for Motor Car Wheels

E LISELIUS, LM ERICSSONS MÄTINSTRUMENT AB, STOCKHOLM

U.D.C. 621—755:629.113.012.3

Ermi has included a new type of balancing machine in its manufacturing schedule, which is intended for balancing motor car wheels. The Ericsson Review No. 3, 1948 contains a description of the principles followed in the construction of Ermi's balancing machines. The new machine is very similar to these former types, but it has been possible to design it in a simpler form since the demand for accuracy of the measuring results is appreciably less than in the case of the earlier apparatus.

In a rotor which has not been balanced and which is required to rotate at a high speed considerable forces are set up which exercise a disturbing effect and subject the rotor and bearings to appreciable mechanical stresses in the form of vibrations. If, moreover, the rotor has a relatively large diameter in relation to its speed of rotation, these vibrations may have a fatal result on the bearings and shafts. The vibrations are transmitted to the surroundings and, when the rotor is a motor car wheel, the vibrations will not only be transmitted through the steering gear to the steering wheel but the unbalance, both static and dynamic, will set up vibrations throughout the entire car. Modern cars with separate springing are particularly sensitive to these vibrations.

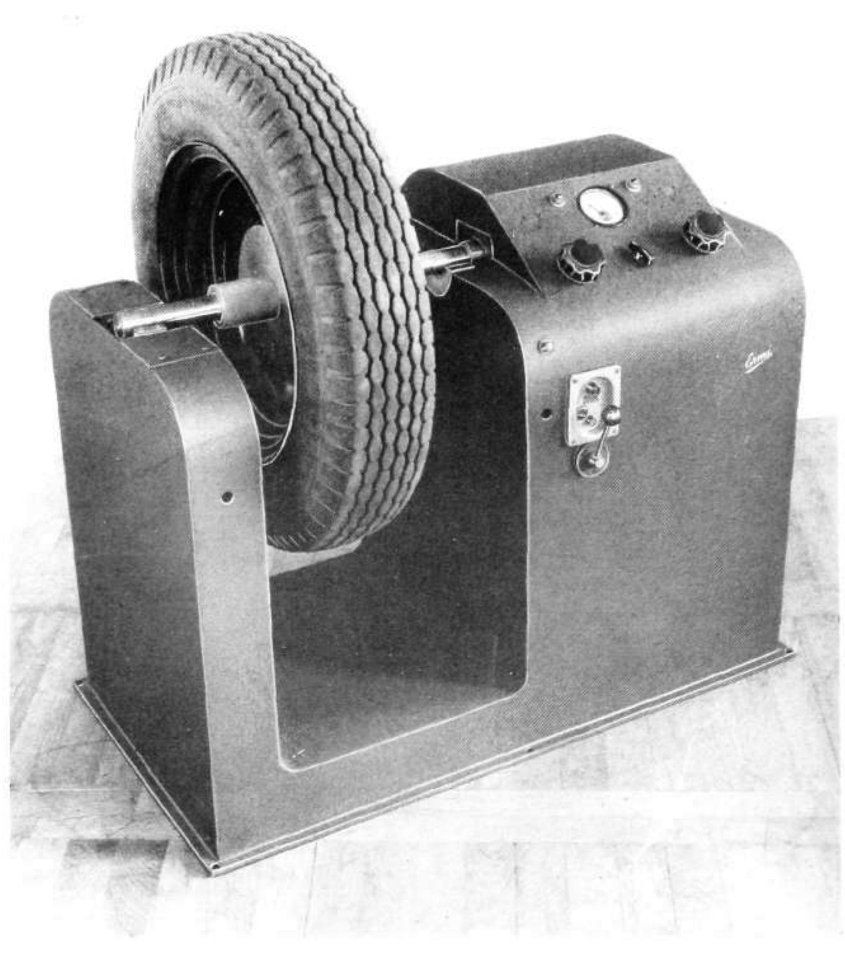


Fig. 1 X 6501
Balancing machine for motor car wheels

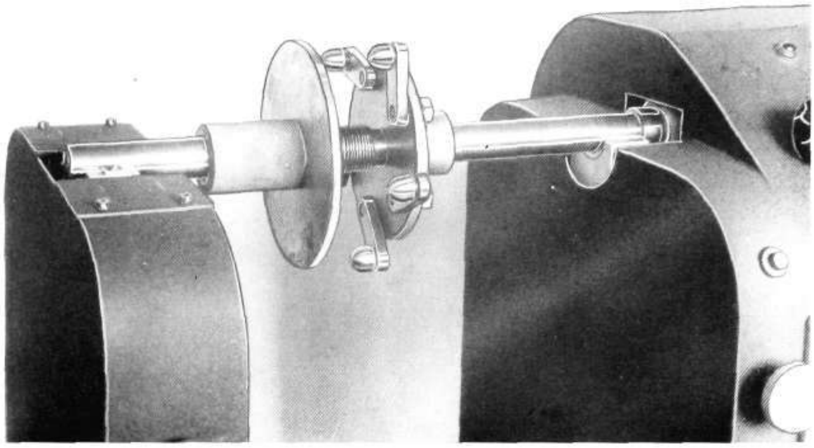


Fig. 2 X 6503
Shafts and hub for fixing the car wheel

If the car is run at a speed as low as 30 km/h (20 miles/h) an unbalance of 100 g (3.5 ozs) will be of no particular significance. When the car is fitted with tyres having the dimensions 6.00 × 16, the forces of vibration will amount to about 1.6 kgs (3.5 lbs). The forces will increase with the square of the speed however, and thus at 60 km/h (37 miles/h) they will be four times as great or 6.4 kgs (14 lbs) and at 90 km/h (55 miles/h) 14.4 kgs (31.5 lbs). A wheel having the above-mentioned dimensions when running at 90 km/h (55 miles/h) rotates at a speed of 670 r. p. m. that is to say, in the course of an hour the wheel will knock against the roadway some 40 000 times with a force corresponding to more than 14 kgs (30 lbs).

An unbalance corresponding to 100 g (3.5 ozs) cannot be regarded as large. Actually, it has been found that the unbalance in car wheels usually varies between 100 (3.5) and 170 g (6 ozs).

Static and Dynamic Unbalance

Static unbalance is produced when the heavy part is distributed symmetrically on both sides of the tyre. This will cause the wheel to jump up and down when rotating. The vibrations thus set up are not perhaps noticeable since the springs and shock absorbers take up the greater part of them. Nevertheless the destructive action which the vibrations exercise on the wheel and its bearings and fastenings still remains.

Dynamic unbalance is produced when the heavy point is located to the side of the wheel's symmetrical plane. Its action is to set up lateral vibration in the car. Thus, dynamic unbalance has a more disturbing effect on the front wheels than on the rear wheels owing to the fact that the lateral vibrations are transmitted directly to the steering gear. This does not imply, however, that unbalance can be permitted in the rear wheels without ill effects. Unbalanced rear wheels give rise to vibrations in the back of the car and these are transmitted through the chassis and set up oscillations and disturbances in the steering gear.

Ermi's balancing machine for motor car wheels, Fig. 1, is built on the same principles as Ermi's other balancing machines, and consequently the experience gained with the latter could be applied to advantage in this new type. It is not necessary to carry out any preliminary static balancing in the wheel balancing machine, since both the static and dynamic unbalance are checked at the same time by a single measurement. The unbalance is referred to and balanced in two planes at right angles to the axis of rotation in such a way that the balance weights are attached between the tyre and the rim on both sides of the latter.

The number of balance weights that should be placed on the wheel may be read off directly from the machine's instrument. The position in which they should be placed is determined automatically inasmuch as a lamp lights up when, after the machine has stopped, the wheel is turned round gently and reaches the position at which the light point is located vertically upwards.

Operating Principles

The wheel is mounted in two open bearings which are resiliently suspended so that they can carry out practically undamped horizontal oscillations of small amplitude. Each bearing is connected to a vibration generator consisting of a coil introduced in the air gap of a permanent magnet. In these two generators alternating voltages of sine wave form are generated which are proportional to the amplitude of the oscillations. These voltages are applied, one at a time, to a coil in an electrodynamic instrument; the other coil is fed from a synchronous generator on the driving shaft, from which it is supplied with a constant voltage. Owing to the cooperation of these two voltages a deflection is produced on the instrument the magnitude of which is dependent upon the amplitude of the vibrations (amount of unbalance) and upon the phase positions of the two voltages in relation to one another.

A synchronous generator is available for each balancing plane, and their stators can be rotated whereby their voltages can be displaced in phase in relation to the voltages from the vibration generators. By comparing the phase positions of the vibration voltages and the phase positions of the reference voltages pro-

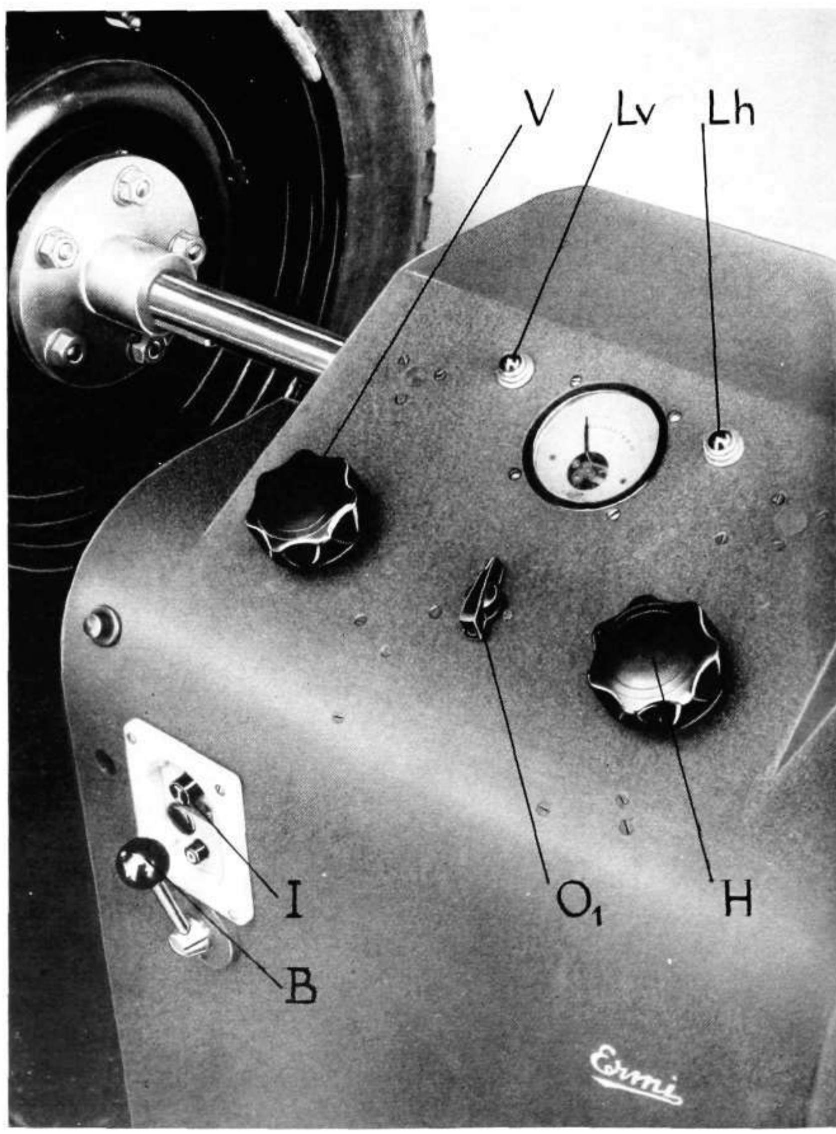


Fig. 3 X 6502

Control- and instrument equipment

The letters refer to the description in the text of the manner in which balancing is carried out.

Fig. 4 X 6496

Balancing weights

with springs for fixing them to the rims

duced by the synchronous generators, that is to say, the angular position of the stators, it is possible to determine the position of the unbalance in the respective correction planes.

Carrying out Balancing

The wheel and its rim are fixed at the hub and the shaft is mounted in the open bearings, Fig. 2.

The motor which is a squirrel-cage asynchronous motor is started by depressing the press-button *I*, Fig. 3. To allow the wheel to be started up gently an automatically acting friction clutch is built into the equipment.

After the wheel has come up to speed the throw-over switch O_1 is moved to the left (measurement in the left-hand correction plane) and the knob *V* is turned until the instrument gives its maximum deflection (the pointer reaches a maximum and then turns towards zero if the turning of the knob *V* is continued). The deflection obtained constitutes a measure for the amount of unbalance and indicates the number of balance weights which should be applied to the left side in order to balance the wheel in this plane.

Fig. 5 X 6495

The balancing weight is applied to the rim

Without stopping the motor, O_1 is moved over to the right (measurement in the right-hand correction plane) and H is turned until the instrument again gives the maximum deflection. The instrument thereby indicates the number of weights which should be applied to the right side.

When these two measurements have been carried out the wheel is stopped by moving the arm B to the right. If O_1 is now moved to the extreme right position and the wheel is turned, the lamp Lh will light up when the wheel reaches such a position that the point at which the balance weights should be applied is located vertically upwards. If O_1 is turned to the extreme left position the position of the unbalance on the left-hand side is determined in the same way, whereupon the lamp Lv will then light up instead. After balance weights corresponding in number and size to the deflection of the instrument have been applied on both sides, the balancing of the wheel is completed. If the amount of unbalance is not too great, a single measurement will suffice to complete balancing.

Shafts with hubs are supplied with Ermi's balancing machine which may be used for the types of rims and wheels commonly encountered.

The balancing weights, Fig. 4, are made of a lead alloy. The weights are available in different numbered sizes varying between $^1/_2$ and 6 ozs. Each weight is provided with a steel spring by means of which the weight is attached to the edge of the rim.

Technical Data

Maximum tyre diameter:	1 200 mm (41 inches)
Maximum wheel weight:	200 kgs (440 lbs)
Minimum wheel weight:	10 kgs (22 lbs)
Sensitivity:	Vibrations having a magnitude of approximately 0.05 mm (0.002 inch) can be measured.
Balancing speed:	480 r. p. m.

AB Alpha — Mechanical and Plastic Products

N KALLERMAN, AB ALPHA, SUNDBYBERG

U.D.C. 061.5 Alpha

In the autumn of 1949 AB Alpha had been a member of the LME group for 20 years of its more than 60 years of existence. A brief account of the firm's origin, development and comprehensive manufacturing programme is given in the following article.

When the Telefon AB L M Ericsson acquired the shares of AB Alpha during the autumn of 1929 a new member was added to the LME family which, however, was far from being a new creation. Some 40 years earlier at the end of the year 1888 the pioneer, Max Sievert, whose name was subsequently associated with Max Sievert's Fabriks AB (Sieverts Cable Works) took the initiative in the founding of a firm which after taking over the Stockholm and Sundbyberg plants of »Hästskosöm Aktiebolaget» was to devote its activities to the manufacture of metals (so-called Alpha metals) and mechanical engineering work. The new company was known as AB Alpha.

As a matter of curiosity, it may be mentioned that the factory premises in question were situated on the site of the present Sieverts Cable Works, approximately at the spot on which the old offices of the latter concern were located. Alpha carried on its activities here, with Sieverts Cable Works as its tenant up to the turn of the century when it moved across »The Esplanade» to its present site. During these early years the firms were respectively referred to as »Iron-Alpha» and »Wire-Alpha», the latter name applying to Sieverts Cable Works.

Manufacturing Programme

During the first years of the company's existence its operations were relatively modest and the economic results achieved were on a similar scale. It was only at the beginning of the new century when Alpha took up the manufacture of machines for testing materials which were primarily based on Brinell's inventions and testing methods that the manufacturing outlook widened.

Fig. 1 X 7579

Factory installation at Sundbyberg

Left: The older part of the factory. Right: The new buildings.

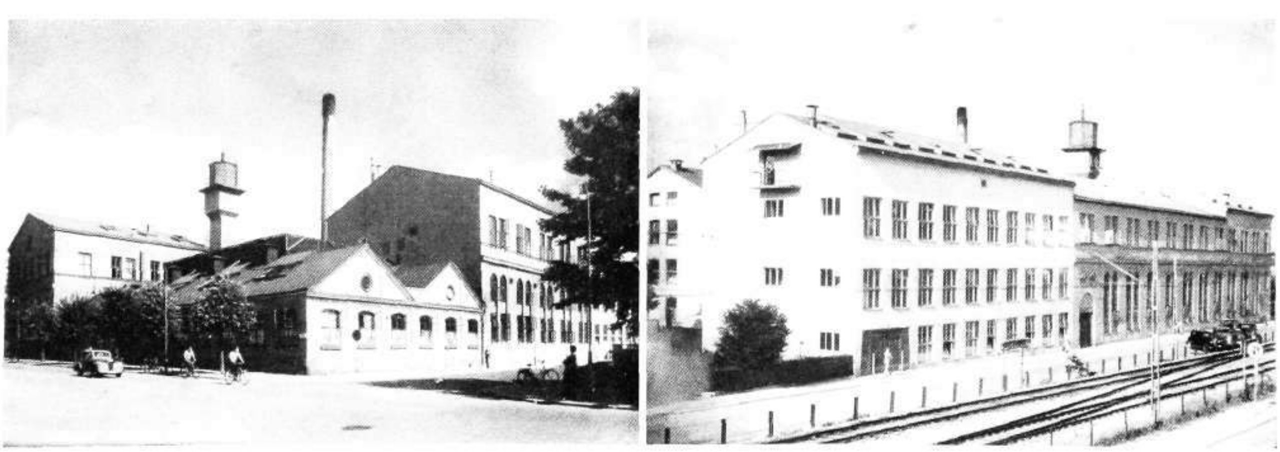


Fig. 2 X 4681

Durometer

for investigating and checking the hardnesss of metallic materials

Fig. 3 X 4682

Carbometer

for determining the carbon contents in a steel bath

Material Testing Machines

The material testing machines, i. e. machines for testing various properties of metals, were for many years — and still remain — one of the company's leading products, and they represent a range for which the firm is practically the sole manufacturer in Sweden. Even at an early stage Alpha's material testing machines made a name for themselves far beyond the country's borders, and thanks to their high quality and consequent precision and reliability, they have built up an excellent reputation for Alpha in this special line. The more important machines included in the production schedule at the present time are Brinell presses, durometers, tensile testing machines, pendulum impact testers, certain testing machines for plastic materials and carbometers.

Plastic Products

After the first world war and at the beginning of the 1920s Alpha became interested in products of an entirely novel character, namely, moulded plastic products. This branch was subsequently to prove of decisive importance to the future fate of the undertaking. Approximately at the same time L M Ericsson had taken up the manufacture of similar products in connection with their production of telephone materials. Since L M Ericsson placed orders covering a by no means inconsiderable part of their requirements with Alpha, however, thus obtaining production from two sources, this proved to be one of the incentives for L M Ericsson's interest in Alpha which culminated in the purchase of this firm by L M Ericsson in 1929. After the concern had been taken over, the bakelite manufacture which had hitherto been carried on at the L M Ericsson factory in Döbelnsgatan was moved to Alpha, and the departments associated with this work have been progressively expanded up to 1949. The moulding department for plastics has a total press capacity of no less than 12 000 tons at its disposal.

Railway and Tramway Signalling Equipment

The collaboration with L M Ericsson has involved Alpha in a new branch of manufacture, namely, certain equipment for railway and tramway signalling installations. On the basis of the designs prepared by L M Ericssons Signal AB Alpha has taken up the production of electrical interlocking machines, point operating gear, point locking devices, track impedances, cable distribution cubicles, cable end-sealing boxes, etc., all in relatively large quantities. This branch of manufacture is constantly growing and Alpha hopes to achieve a further increase in the future.

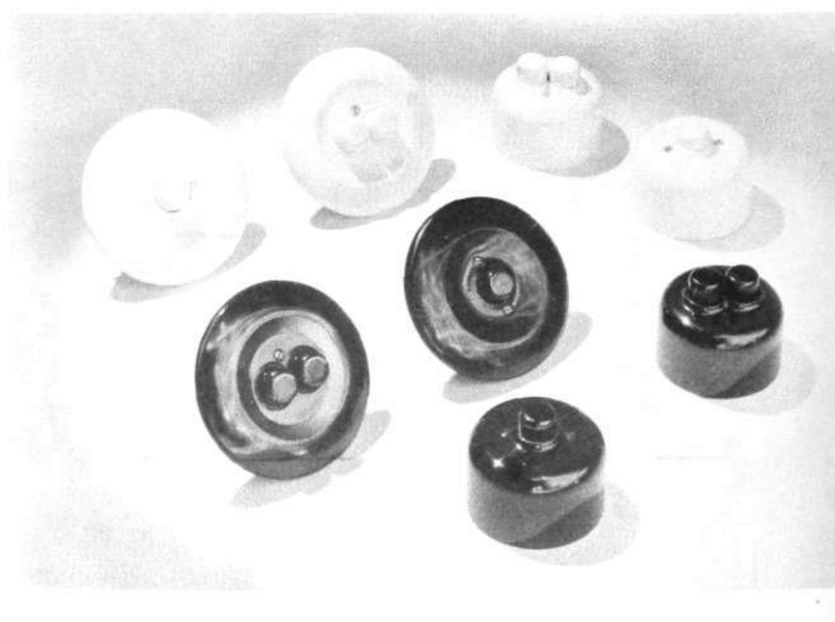


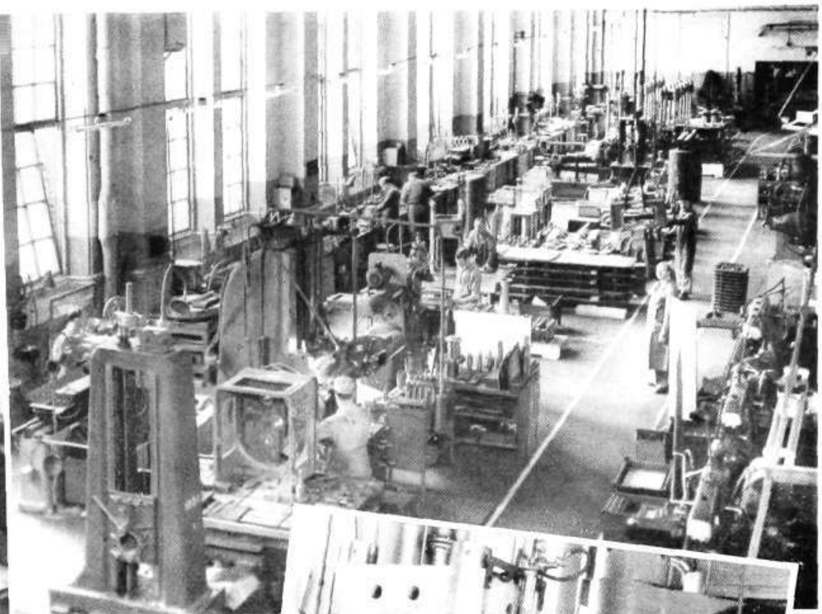
Fig. 4 X 6519

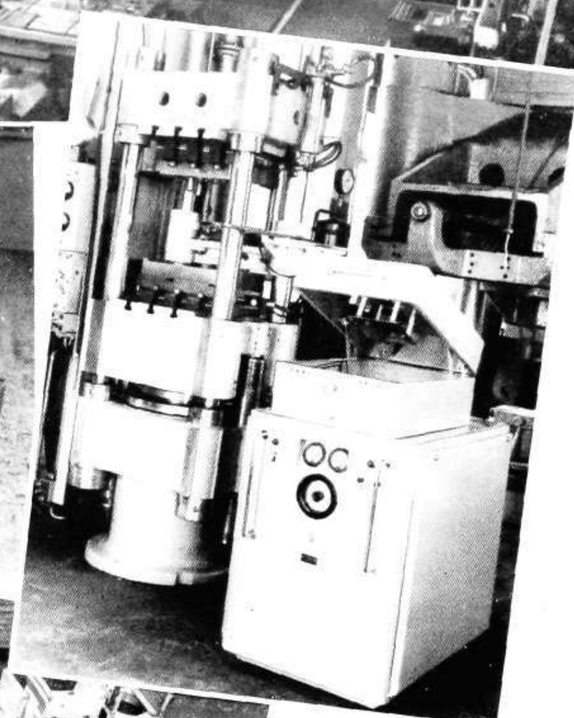
Pello switches

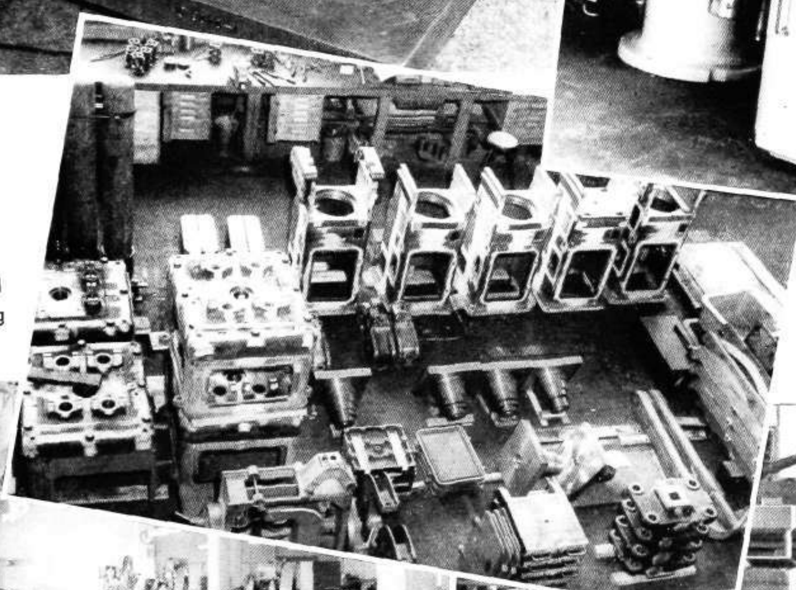
for flush- and surface mounting

Right: Large machine shop. Below: Modern semi-automatic plastic press of Alpha's design. At the front a high frequency set for heating the moulding compound may be seen.

The illustration below shows a filer working on a mould for L M Ericsson's new telephone casing.







Left: A part of the machine shop showing five presses for gramophone records under construction. The illustration below shows the assembly of Pello switches on a belt conveyor.

Below: Metal sheet pressing department

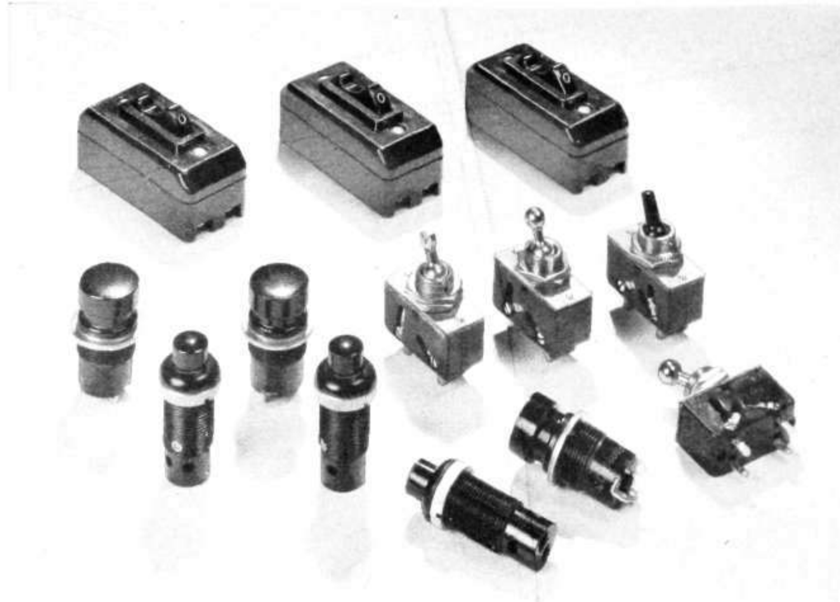


Fig. 5 X 6570
Tumbler switches and press buttons

Electrical Installation Material

Even before its absorption by the L M Ericsson concern, the collaboration with Sieverts Cable Works had provided Alpha with an incentive to take up the manufacture of heavy current installation materials. The best known of these products is unquestionably the Pello switch which has met with a wide sale in Sweden and is probably the most popular amongst the types of switches for lighting purposes at present available in this country.

Apart from the Pello switch, wall sockets represent the leading products, but boxes, lampholders and covers for Gebe fittings, together with the older type of Gebe and the new and smaller ATU type likewise play an important part in the production schedule. Finally, attention may be drawn to the fact that Alpha's tumbler switches, flat-pin contacts and bell circuit material are meeting with ever increasing appreciation and demand.

Hydraulic Moulding Presses

The extensive machine equipment available in combination with Alpha's many years experience of mechanical and hydraulic constructional work rendered

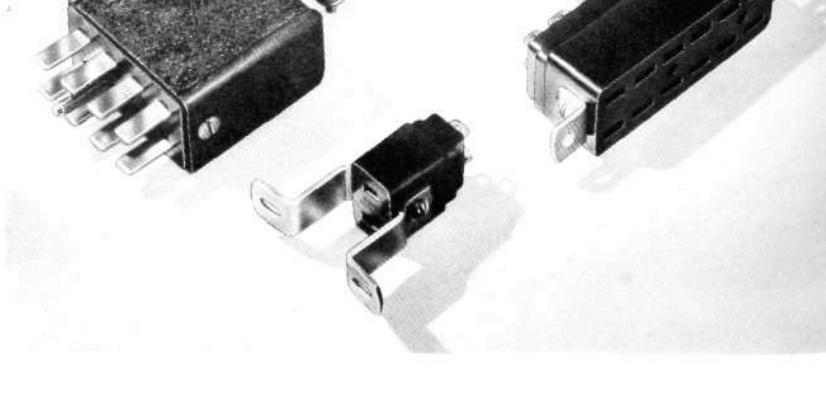


Fig. 6 X 6518
Alpha plugs and sockets

it an obvious step for the firm to take up the construction of the presses required for the production of plastics. The efforts in this direction yielded good results and it not only became possible to provide all the presses needed for Alpha's own moulding department but a number were also supplied in the course of time to the foreign factories associated with the group.

The crowning achievement has been Alpha's delivery of the entire press equipment including moulds to L M's telephone apparatus factory in Karlskrona. This delivery comprised one 50-ton laboratory press, six 100-ton moulding presses for telephone cases, etc., four 165/35-ton presses for transfer moulding of microtelephone handles, one 175-ton press for transfer moulding of bobbins amongst other parts, and two 200/100-ton presses (double acting moulding press) for rings and telephone covers, all provided with instrumentation and control apparatus for semi-automatic operation and adapted for parallel control with high frequency sets, not to mention other refinements.

Appreciable costs have been laid down in the construction of these presses with the object of obtaining a product which would not only meet L M Ericsson's special requirements but could also be sold to outside firms. Up to the present, however, the available production capacity in this branch has been so fully utilized in making deliveries to the companies belonging to the group that it was not possible to deliver to outside firms. Nevertheless, new possibilities have recently been created which have placed AB Alpha in the position to accept a certain number of orders from other customers also. A beginning has already been made inasmuch as the Telegraph Works have ordered three presses and the Åbo Porcelain Factory one press of the Karlskrona type.

Pressing Gramophone Records

Alpha's experience and resources both with respect to mechanical and hydraulic work and the production of plastic materials have also caused the firm to take up the pressing of gramophone records. Ever since the beginning of the 1930s the records of the well-known Swedish brand »Sonora» have been pressed by Alpha. For some time past Alpha likewise counts Decca and Metronome amongst its customers. This work is now carried out in semi-automatic presses of Alpha's own design and construction. Presses of this type were installed some years ago in Denmark and Norway and a marked interest in them is now being displayed by many gramophone recording companies both in Europe and overseas countries.

Manufacture of Moulds

An account of Alpha's manufacturing programme would be incomplete without a special reference to the tool department.

Fig. 7 X 4680
Pressing gramophone records

Alpha's tool department is equipped with an extensive installation of modern machine tools, and thanks to the known skill of its personnel it has been able to produce moulds and dies which, with respect to their quality and precision, are acknowledged to be amongst the best that can be produced in this country. It is, of course, as a supplier of the moulds for all the more or less complicated parts employed in the telephone industry that this department has had to fulfil its chief task, but also for other manufacturing lines in the group such as installation materials, the availability of a highly qualified tool department has been of great value.

It will be realised from what has been said above that Alpha's manufacturing programme has become in the course of time, and still is, comparatively many-sided, although the transference to AB Rifa of the condenser and resistance production formerly carried on may be assumed to have resulted in a certain concentration. These latter forms of manufacture which were taken up by Alpha at the beginning of the 1930s covered small condensers for low tension, including both paper-insulated condensers and electrolytic condensers, surface resistances, powdered carbon cores and the like, mainly to meet the requirements of L M Ericsson's telephone materials production. This production was transferred in 1949 to AB Rifa, a detailed description of which firm is contained in the Ericsson Review No. 1, 1950.

An Enterprise in Progress

Since the manufacturing programme has attained the extensive proportions described above, it will be clear that Alpha has grown considerably in the course of time, both as regards its premises and staff.

New buildings have been erected on the site at Sundbyberg on several occasions during the past 20 years, and in addition, it became possible to acquire the plant and works of the Svenska Bakelite AB, Uddevalla, in 1938.

Immediately before the transference of the condenser production to Rifa the total staff employed by Alpha amounted to slightly more than 1 000. The number is approximately 800 at the present time, but an increase in this figure may be anticipated, given normal working conditions and after the premises formerly devoted to condenser manufacture have been adapted to new production tasks.

New Telephone Instrument for the L M Ericsson Loudspeaking Telephone

G. THAMES, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

U.D.C. 621.395.721:621.395.623.8

The L M Ericsson loudspeaking telephone has up to the present consisted of the telephone instrument, desk microphone, loudspeaker and amplifier. Of these the telephone instrument and the microphone are generally placed on the desk and it has, therefore, been found expedient to combine these two into one single instrument. It has often proved awkward to place both the telephone instrument and the microphone in convenient positions generally to the disadvantage of the microphone. With the combined instrument the microphone will obtain a more favourable position added to which the requisite desk space is reduced.

Design

The new telephone instrument is a combination telephone set and microphone used as part of the L M Ericsson loudspeaking telephone system. As will be seen from Fig. 1 the dial is placed to the left and the microphone to the right on the front of the instrument. Between these two is a pilot lamp which indicates when the microphone is connected. The three push buttons required to operate the instrument are mounted on top of the case. The function of these buttons is the same as in earlier instruments; the left-hand button calls the exchange and the right-hand one increases the volume of incoming speach when required. The centre button is used to disconnect the call when completed.

The handset is supported in a cradle on the back of the instrument. The shape of the cradle is such that the prongs are well visible above the rear edge of the instrument when the handset is removed, thus facilitating the replacement of the handset.

If the handset is lifted during a conversation while using the microphone and loudspeaker, the buttons are released and the call is automatically connected to the handset.

Fig. 1 X 7567

Telephone instrument type DBF 11

with built- in microphone. On the top of the instrument: push buttons, on the front: dial, pilot lamp and microphone; (right) rear view

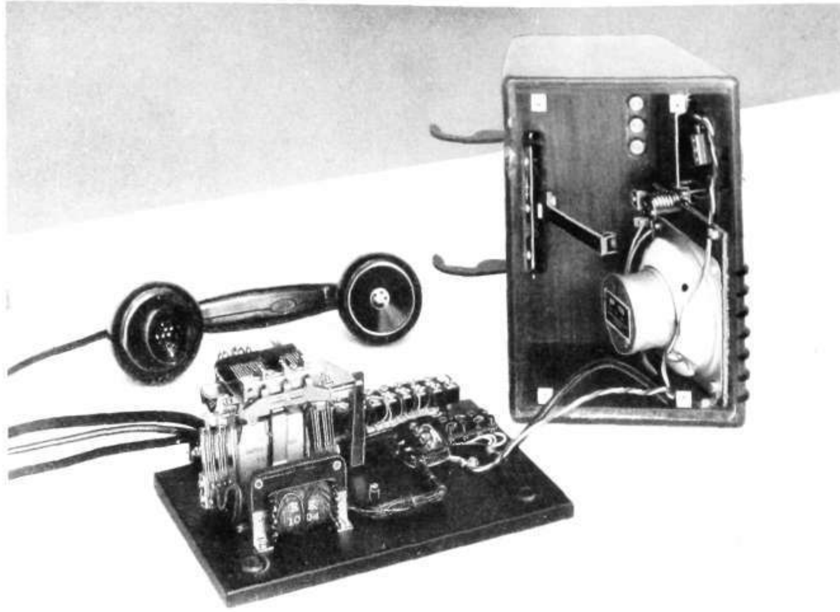


Fig. 2 X 6504

Telephone instrument DBF 1102

cover removed

Apart from handset and cord with terminal box, the instrument consists of a base-plate with a case mounted on it. The case of the instrument as well as that of the loudspeaker is made of polished wood.

Mounted on the base-plate, see Fig. 2, are the cradle switch, push button, contact springs, transformer, condenser, buzzer and various terminal blocks whereas the dial, microphone with pilot lamp and the cradle itself are mounted in the case.

The dial and microphone are wired to the terminals on the base-plate by means of two flexible cords.

Fig. 3 X 6516

Conference telephone

(left) Manager's table and loudspeaker, (right) On the desk the new telephone instrument with built- in microphone

Application

The new telephone instrument may be used in place of the usual loudspeaking telephone or with conference telephone type *AEC 200* as follows:

Telephone instrument	Connected to CB exchange[1]	Corresponding to		Application
		Instrument	Microphone	
DBF 1001 *DBF 1101*	manual automatic	*DBH 2411* *DBH 2511*	*RLC 1001*	Loudspeaking telephone
DBF 1002 *DBF 1102*	manual automatic	*DBH 2402* *DBH 2502*	*RLC 1001*	Conference telephone type *AEC 200*

[1] The instruments are intended for use with 24 V exchanges with 400+400 ohms feeding coils or systems with other working voltages and feeding coils which give the same maximum feed current to the telephone instrument's transmitter. Instruments for connection to exchanges having battery supply conditions deviating from those mentioned here can be supplied on request.

Connection

The new instruments intended for conference telephone type *AEC 200* have circuits identical with those of earlier instruments and the connections are made in exactly the same way.

Even the new instruments used as loudspeaking telephones are connected in the same way as before except for the fact that the terminal box is different. The circuit is, however, now altered to provide for the connection of an extension instrument. The new instrument then serves as a main station and the extension station may be an instrument of ordinary type, for instance *DBH 1501*. Calls on the main station which always has right of way, cannot be overheard on the other instrument. Another new feature is the provision on the main instrument for direct connection of the »ENGAGED ON TELEPHONE» indication. This is an indicator lamp or panel mounted outside the door which lights up when the telephone is being used.

As with the original equipment a signal transfer switch may be connected to the instrument, which transfers the ringing signal to another instrument after a certain number of signals have been received. (See Ericsson Review No. 3, 1945.) Finally the instrument may be provided with an extension bell.

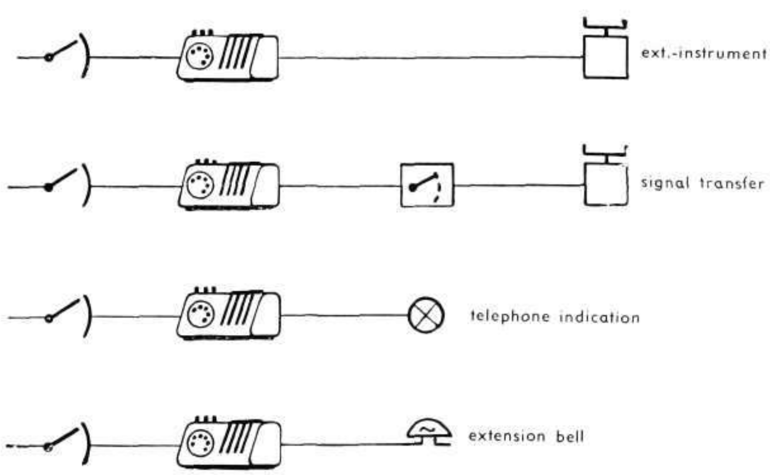


Fig. 4 X 6508

Diagram illustrating various extension equipments which may be connected to the new telephone instrument

New Type of Staff Locator

A TRÄGÅRDH, TELEFONAKTIEBOLAGET L M ERICSSON, TELESIGNALFABRIKEN, STOCKHOLM

U.D.C. 654.938

Staff locator systems are being increasingly used in modern offices as a means towards good service and rational office routine. Such systems enable rapid contact with staff, which owing to the nature of their work often have to be away from their place in the office and which time and again are required by customers or colleagues.

L M Ericsson have designed and marketed a new type of staff locator which in certain respects differs from earlier types.

A staff locator is generally composed of visual indicators e. g. lamp panels, placed in office rooms and corridors and containing up to five differently coloured lamp sections, together with operating relays and control equipment placed at the telephone switchboard. By means of push buttons or keys the operator connects different colour combinations for continuous or flashing light indicating the person required.

When the lamp panels have to be fitted in positions exposed to strong day light it is for certain colour combinations difficult to decide whether the lamps are operated or not. L M Ericsson have, therefore, designed a new lamp panel utilizing specially shaped red coloured lamp lenses emphasizing the effect of the lamps and making them well visible even in sunlight. Due to the design of the lenses lamps for lower effect may be used, which will reduce the power consumption and the cost of the wiring.

A new control set for the operator has also been designed, which may be operated without reference to the actual lamp combinations and which eliminates all confusion between different combinations.

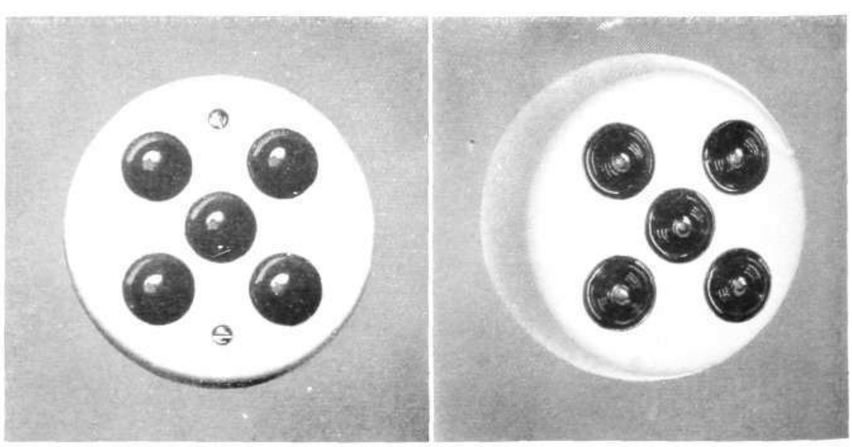


Fig. 1 X 6500

Lamp panels

(left) KNH 9501 for flush, (right) KNH 9511 for external mounting

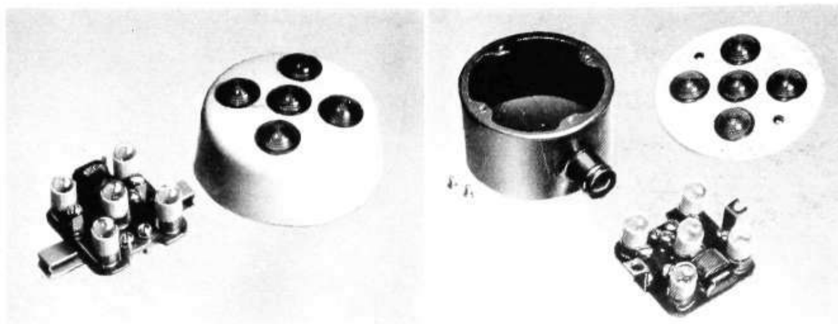


Fig. 2 X 7566
Lamp panels dismantled
(left) external type, (right) flush type

Design

The lamp panels, Fig. 1, are supplied for flush or external mounting and contain 5 red coloured lenses placed to form a square as illustrated, whereas earlier panels have differently coloured lamp sections placed in a vertical row as shown in Fig. 3. In the new lamp panels it is the position of the operated lamp that is of significance, whereas in the earlier panels the colour is a means of reading the combination. A staff locator system must, therefore, contain either old lamp panels or new lamp panels but not both types.

The power consumption of the lamps is only 1.2 W per lamp as compared with 3 and 5 W respectively for the earlier types. The lenses are specially manufactured and moulded in polystyrol with a ribbed inside surface diffracting the light from the lamp in such a way that a lighted lens is well visible, even if the panel is exposed to sunlight.

With 5 lamps in the panel 31 different combinations may be obtained but as a rule only 30 of these are utilized in order to reduce wiring cost. With continuous and flashing light 60 persons may be signalled. Both the flush and the external type may be fitted with buzzer to call attention when signals are in progress.

The casing for the external type and the cover plate for the flush type are made in plastic. Fig. 2 illustrates the build-up of the two lamp panels. It will be noted that the main component, the lamp insert with buzzer, is common to both types. The panels are designed so as to facilitate fitting and replacement of lamps as far as possible.

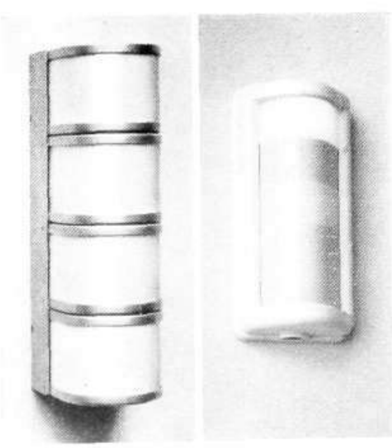


Fig. 3 X 4180
Lamp panels with lamp sections in a vertical row
(left) mild steel frame, (right) plastic frame

The control set, Fig. 4, is made in the manner of a plug switchboard and may be placed with the panel horizontally on a desk or vertically on the top of a switchboard. The set contains 3 jack strips, each containing 10 jacks, and one cordless plug. Each of the 30 jacks may be used for 2 persons, one with continuous light and one with flashing light, and the control set may, consequently, signal 60 persons in all.

The jacks are built up and wired in such a way that the combination of the required person is operated when the plug is inserted in the appropriate jack. There is, therefore, no need for the operator to know each person's lamp combination. The plug is merely inserted in a jack with the guidance of the name designation strip over each jack list. The designation strip may carry two names for each jack, as two persons may have the lamp combination for continuous or flashing light alternatively. Flashing light is obtained by operating a common key in the control set. The set also contains a push button for operation of the buzzers to call attention either at the commencement of the signal or if the required person does not respond within reasonable time.

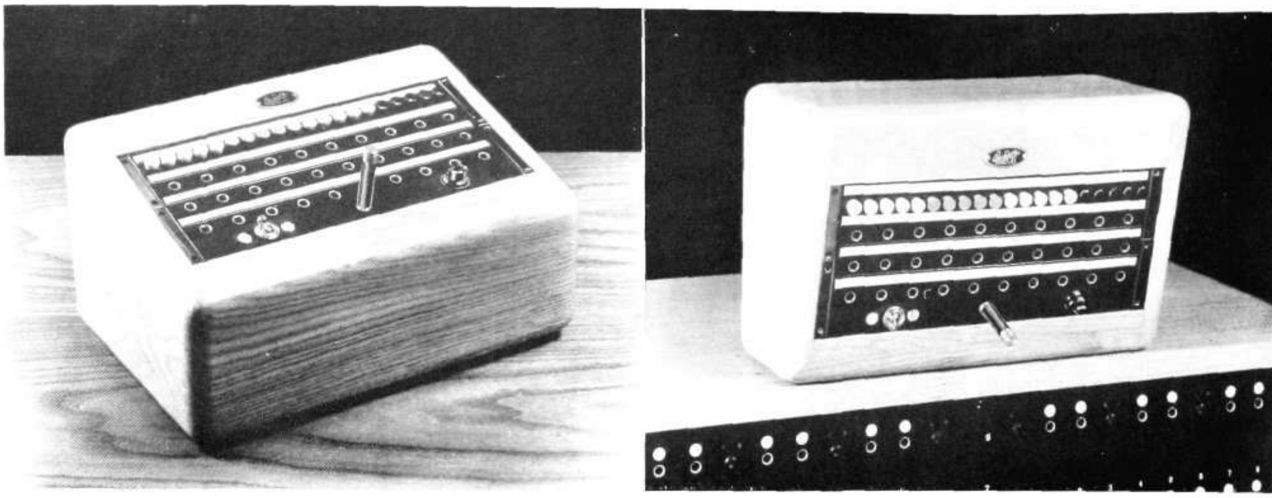


Fig. 4
Control set KEM 3111
(right) placed on top of switchboard

X 7566

Above the jack lists is a separate row of holes containing four groups of differently coloured loose dummy plugs. The operator may utilize these to indicate if a person is unavailable. A dummy plug does not issue a signal when inserted in a jack. If a person is away on a journey, the operator may, for instance, insert a red plug in his jack as an indication of this. If he is ill, a yellow plug may be used, on holiday a green plug, and if he has left for the day, a white plug.

The new lamp panels may also be used in connection with earlier types of control sets for manual transmission of lamp combinations or with automatic control sets. The new control set may similarly be connected to the old vertical types of lamp panels with colour combinations.

Ericsson Radio Receivers

C FREDIN, SVENSKA RADIOAKTIEBOLAGET, STOCKHOLM

U.D.C. 621.396.62

Svenska Radioaktiebolaget presents for the 1950—1951 season in first hand two table sets and one radio-gramophone. The smaller of the table sets goes by the name of the Ericsson Kuplett. Ericsson Operett is the larger one, a 6-valve receiver with band spread (localised) short-wave. The new radio-gramophone is called the Ericsson Spinett.

Ericsson Spinett

Ericsson *Spinett*, Fig. 1, is a very handy and neat radiogramophone, which can be placed anywhere. The radio- and gramophone equipment is concealed under a lid and the volume control in a small ornamental grid in the front alone disclose the nature of this piece of furniture. The legs can be unscrewed for transport purposes, so that the entire apparatus, when packed, is no larger than an ordinary table set. The apparatus is supplied in mahogany, walnut and light elm finish.

The Ericsson Spinett incorporates many features which as a rule are only to be found in more expensive radio-gramophones. The power amplifier in particular has numerous interesting coupling details. The output stage consists of two push-pull coupled output valves operated by a mixer valve which is here used as a double triode. One half of the valve functions as an audio frequency amplifier and the other half as a phase inverter. The intermediate frequency valve is a diode-pentode. The diode is operating as detector and supplies the

Fig. 1 X 7568
Ericsson Spinett
with lid raised, on the right

Fig. 2 X 6507

Dial, tone control and tuning knob combined with bandswitch

Record player on the left

DC voltage to the A.G.C. system. In the radio position the pentode is an intermediate frequency valve but in the gramophone position it operates as a correction valve. The purpose of this extra valve in the audio frequency amplifier is to improve the tone frequency characteristic of the pick-up. Furthermore, the coupling restores the bass register. When playing gramophone records the bass is actually reduced by 6 dB per octave below 256 c/s.

Ericsson Spinett has two loudspeakers. The bass is reproduced by a 9-inches P.M. speaker *HP 1021* with a flux density of 10 000 gauss. This bass speaker is directed downwards. The treble is reproduced by an *HK 1010* located behind the small decorative grid at the front of the radiogramophone. A choke in parallel prevents the bass to reach the treble-loudspeaker.

As already mentioned, only one of the controls is placed on the front of the apparatus. This device consists of an off-on switch and volume control. The knob or handel is flush-mounted in a cup of plastic, illuminated while the apparatus is on.

Ericsson Spinett is also fitted with a convenient radio-gramophone switch.

Fig. 3 X 7564

Circuit diagram for Ericsson Spinett

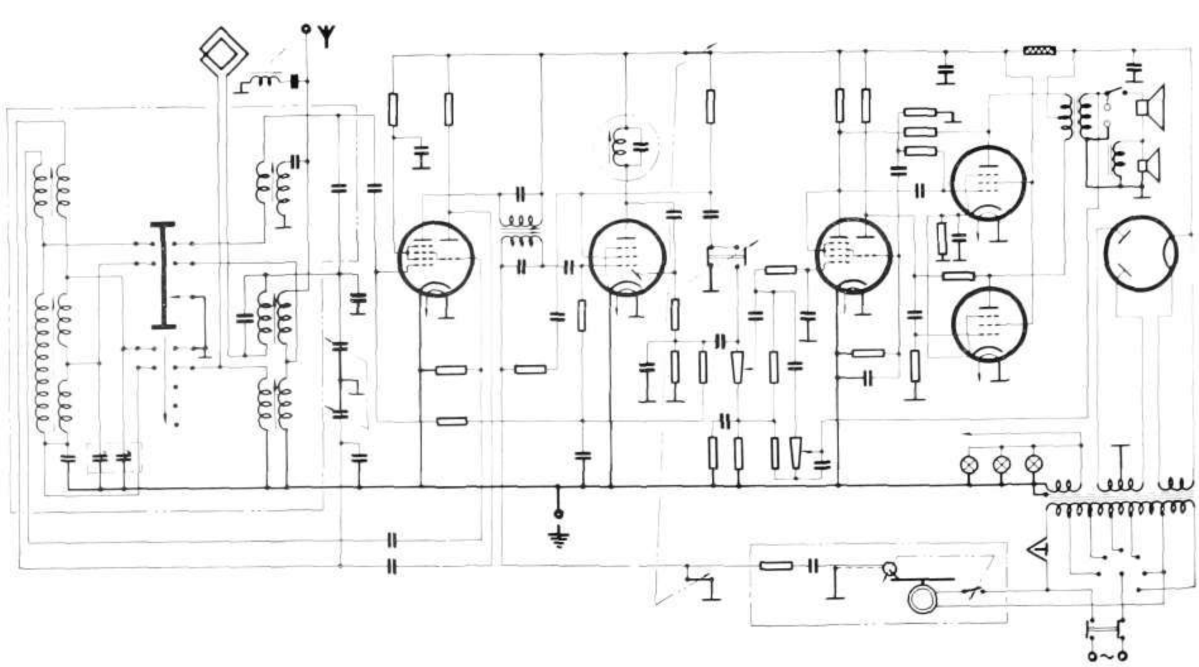


Fig. 4 X 6506

Ericsson Operett

Amongst other refinements, the built-in loop antenna may be noted which gives excellent results without the use of an external antenna. The terminals for an additional loudspeaker will also prove useful, as the amplifier has sufficiently output to feed a number of loudspeakers.

The record player is started by first raising the pick-up-arm and then moving it slightly to the right, and it stops automatically when the record has been played. The apparatus is adaptable to all ordinary AC voltages.

Ericsson Operett

Ericsson *Operett*, Fig. 4, is an entirely new ingeniously designed 6-valve set with 7 bands, tone control and tuning indicator. The construction differs in several respects from earlier models. The new chassis and dial arrangement permit the use of an appreciably smaller cabinet whilst retaining a large speaker. Speaking of size, Ericsson Operett cannot be included amongst the large table sets, but it is nevertheless provided with a 7-inch P.M. speaker *HK 1018*. The dial is printed in decorative colours which show up to the best advantage owing to the effective illumination.

Ericsson Operett has four controls, two knobs at the front and two at the sides, one on each side of the receiver. These controls have the following functions: left-hand knob is the volume control and right-hand tuning knob. At the sides the left-hand knob is a combination of an off-on switch and tone control; the right-hand knob controls the wave bands. The position of the wave band switch is shown by an indicator on the right-hand side of the dial.

On the back of the receiver are the antenna and earthing connections, terminals for extra loudspeaker, pick-up etc.

Fig. 5 X 4467

Intermediate frequency coil for Ericsson Operett

An entirely new design for the intermediate frequency filters has been adopted for Ericsson Operett. The coils, see Fig. 5, are divided into two small coils which are movable directly on the iron core. The distance between the coils determines the inductance. In consequence of the arrangement and coupling of the coils the self-capacity with its associated losses is reduced. The inductance is adjusted by varying the coupling between the coils and not, as is common, by displacing the core so that the latter partially projects outside the coils.

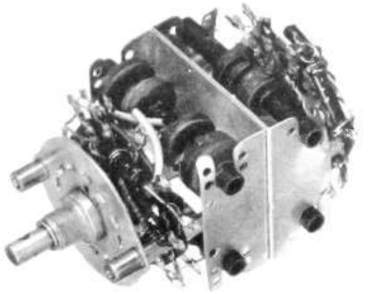


Fig. 6 X 4678
Coil assembly for Ericsson Operett

and consequently an excellent Q (quality factor) is obtained over the entire regulating range. The inductance may be varied $\pm 15\,\%$ and Q will be better than 260.

By means of a filter and a tuned anode circuit a band width of 20 kc/s is obtained with an attenuation of 40 dB. This figure is fully comparable with the results usually obtained with 4 tuned circuits.

Amongst other newly designed features may be noted a tuner of reduced size for medium wave, long wave and »localised short wave» covering the 16, 19, 25, 31, 41 and 49 m bands, see Fig. 6. The various antenna and oscillator coils are threaded into four pertinax tubes containing the necessary iron dust cores. The inductances are set at the correct value by moving the coils laterally. In a certain position they will contain the proper quantity of iron. The tuning coils are connected in series so that a certain sequence must be observed in trimming.

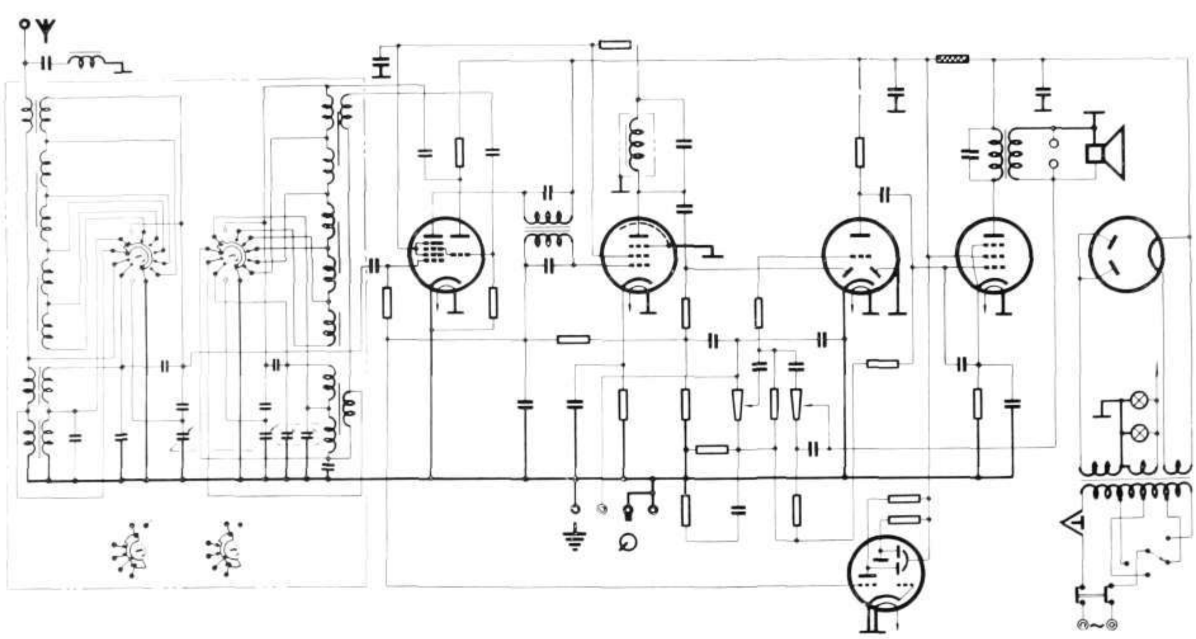
Trimming is rendered extremely simple owing to the fact that the majority of the capacitances concerned are fixed. Capacitative trimming is only required for medium- and long wave.

With a »localised short wave» the tuning is excellent within the broadcast bands which include the majority of the stations. In the intermediate ranges the dial is compressed and tuning is slightly less convenient. The coupling elements employed have been so selected that frequency drift caused by heating has been practically eliminated. A fourth advantage resulting from »localised shortwave» is that the risk of microphone effect between the tuning condenser and speaker is reduced to a minimum.

Notwithstanding the very small dimensions — the entire system is no larger than 50 × 70 mm — relatively good values are obtained for voltage gain and second channel frequency ratio. The oscillating voltage is even over the different ranges, see the following table.

Wavelength	m	19	25	31	41	49	250	500	800	1800
Oscillating voltage	V	4	6	6	5	3	8	6	11	8
Gain in antenna circuit	dB	12	15	15	14	11	15	19	3	17
Second channel suppression	dB	9	11	12	18	21	33	35	29	35

Fig. 7 X 7563
Circuit diagram for Ericsson Operett



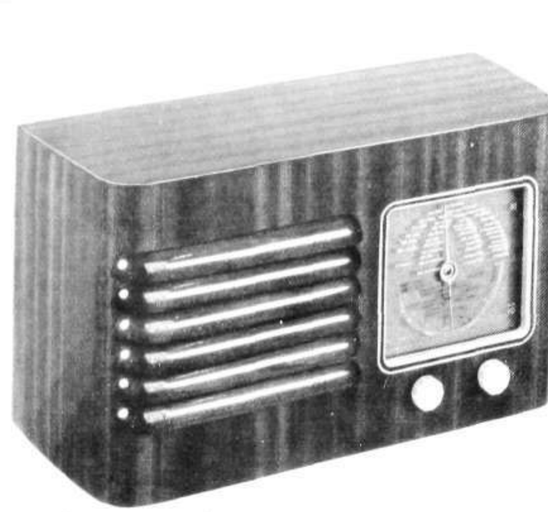


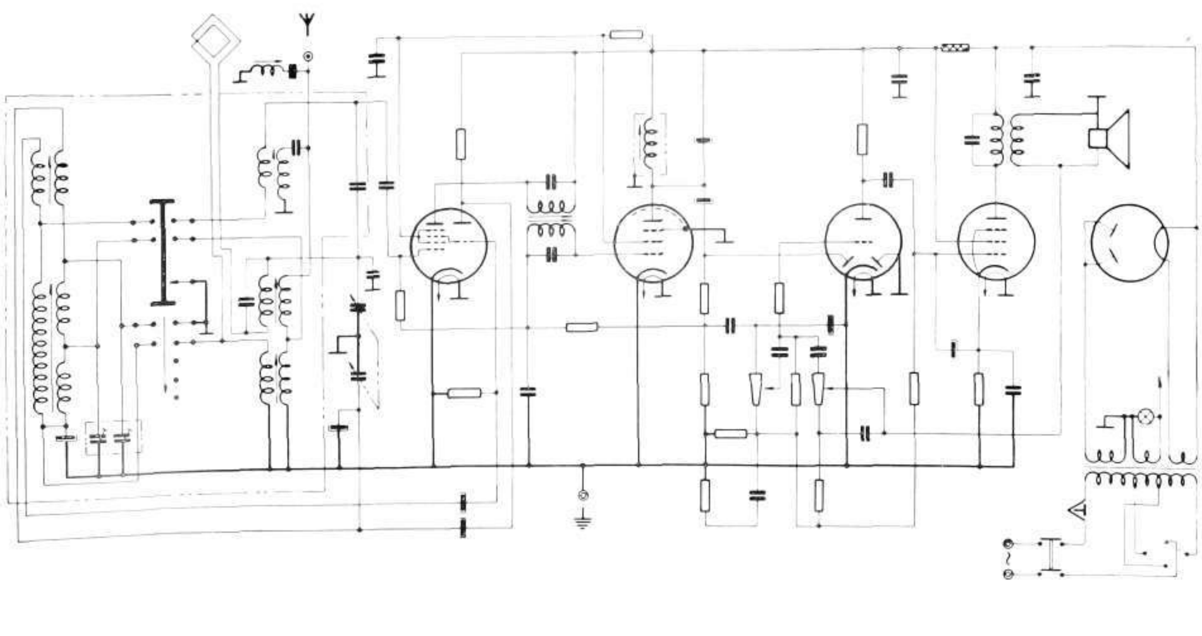
Fig. 8 X 6505
Ericsson Kuplett

Ericsson Kuplett

Ericsson *Kuplett* which is a 5-valve receiver, reminds slightly in appearance and electrical design, of Ericsson 1502 V previously described in the Ericsson Review No. 4, 1949. Ericsson Kuplett is, however, a larger type, and is superior to 1502 V in several respects. It is supplied in highly polished mahogany, walnut or light elm.

As may be seen from Fig. 8, the speaker opening is covered by a number of wooden bars in place of fabric. The station names are printed on thick glass which is richly illuminated. The two knobs below the dial functions as volume control and combined tuning — band switch respectively. The tone control is placed at the back of the receiver and the tone may be varied from a position giving treble, suitable for speech, to a normal response. On further rotation of the knob the top will be damped down, and the bass increased. The 6-inch P.M. speaker *HK 816* has a flux density of 8 000 gauss.

Fig. 9 X 7562
Circuit diagram for Ericsson Kuplett



		Spinett (507)	Operett (1505)	Kuplett (1503)
List of valves				
Converter		MECH 42	MECH 42	MECH 42
I.F. valve			6BA6	6BA6
I.F.-det. 2-corr.valve		MEAF 42		
AF-det. 2-valve			6AT6	6AT6
AF-inverter-valve		MECH 42		
Output valve 1		MEL 41	MEL 41	MEL 41
Output valve 2		MEL 41		
Rectifier valve		MAZ 41	MAZ 41	MAZ 41
Tuning indicator valve			MEM 34	
Number of valves		6	6	5
Number of valve functions		10	8	7
Number of dial lamps BA9S 6,5 V 0,2 A		3	2	1
Main features				
Sensitivity	μV/50 mW	20	10	20
Selectivity (band-width at 40 dB)	kc/s	24	20	24
Output	W	5	3	2.5
Intermediate frequency	kc/s	460	460	460
Receiver's power consumption	W	40	30	28
Record player's power consumption	W	15		
Switchable for voltages	W	110, 127, 140 155, 220, 245	110, 127 220, 245	110, 127, 220
Wave band ranges	m	690—2000 190—580 18—50	690—2000 190—580 40—51 32—42 26—32 20—26 16—20	690—2000 190—580 18—50
Speaker		HP 1021	HK 1018	HK 816
Flux density	gauss	10000	10000	8000
Effective cone area	cm²	300	200	135
External speaker terminals		4 Ω	4 Ω	
Treble speaker		HK 1010		
Flux density	gauss	10000		
Effective cone area	cm²	50		
Tuning indicator		—	x	—
Tone control		x	x	x
External speaker terminals		x	x	—
Pick-up		—	x	—
»Lokalised short wave«		—	x	—
Internal loop antenna		x	—	x
Dimensions and weight				
Height	mm	600	270	197
Width	mm	500	410	354
Depth	mm	335	185	139
Weight	kg	14	6.5	4.3

U.D.C. 621.395.23

ENGQVIST, E I: *Manual Private Branch Switchboards with Cords.* Ericsson Rev. 27 (1950) No 2 pp. 36—45.

The development of the L M Ericsson CB-switchboards has with regard to subscriber's boards resulted in a range of new cord type switchboards meeting very exacting requirements. The article gives a summary of the new types, new elements are described, connection possibilities are listed and finally the new method of packing is explained.

U.D.C. 621—755:629.113.012.3

LISELIUS, E: *Balancing Machine for Motor Car Wheels.* Ericsson Rev. 27 (1950) No 2 pp. 46—50.

In the introduction the article gives examples of the significant effect of unbalance in motor car wheels, followed by a short account of static and dynamic unbalance. The operating principles of the new Ermi balancing machine for motor car wheels and the method of carrying out balancing are then described.

U.D.C. 061.5 Alpha

KALLERMAN, N: *AB Alpha — Mechanical and Plastic Products.* Ericsson Rev. 27 (1950) No 2 pp. 51—56.

A brief description of the company's origin and activities.

U.D.C. 621.395.721:621.395.623.8

THAMES, G: *New Telephone Instrument for the L M Ericsson Loudspeaking Telephone.* Ericsson Rev. 27 (1950) No 2 pp. 57—59.

The L M Ericsson loudspeaking telephone has up to the present consisted of the telephone instrument, desk microphone, loudspeaker and amplifier. The telephone instrument and microphone has been combined into one single instrument, which is described with regard to design, advantages, applications and connections.

U.D.C. 621.396.62

FREDIN, C: *New Ericsson Radio Receivers.* Ericsson Rev. 27 (1950) No 2 pp. 63—68.

A description of Ericsson Spinett — the new radio-gramophone — and also the Ericsson Operett and Ericsson Kuplett — the new table sets in the Ericsson series, together with circuit diagrams and technical data.

U.D.C. 654.938

TRÄGÅRDH, A: *New Type of Staff Locator.* Ericsson Rev. 27 (1950) No 2 pp. 60—62.

In the new L M Ericsson lamp panel for staff locators the position of the operated lamp in the panel, signifies the combination, whereas in the previous models the colour was an additional means of reading the signal. The control equipment has also been redesigned for the new staff locator system, which is described with regard to design and application.

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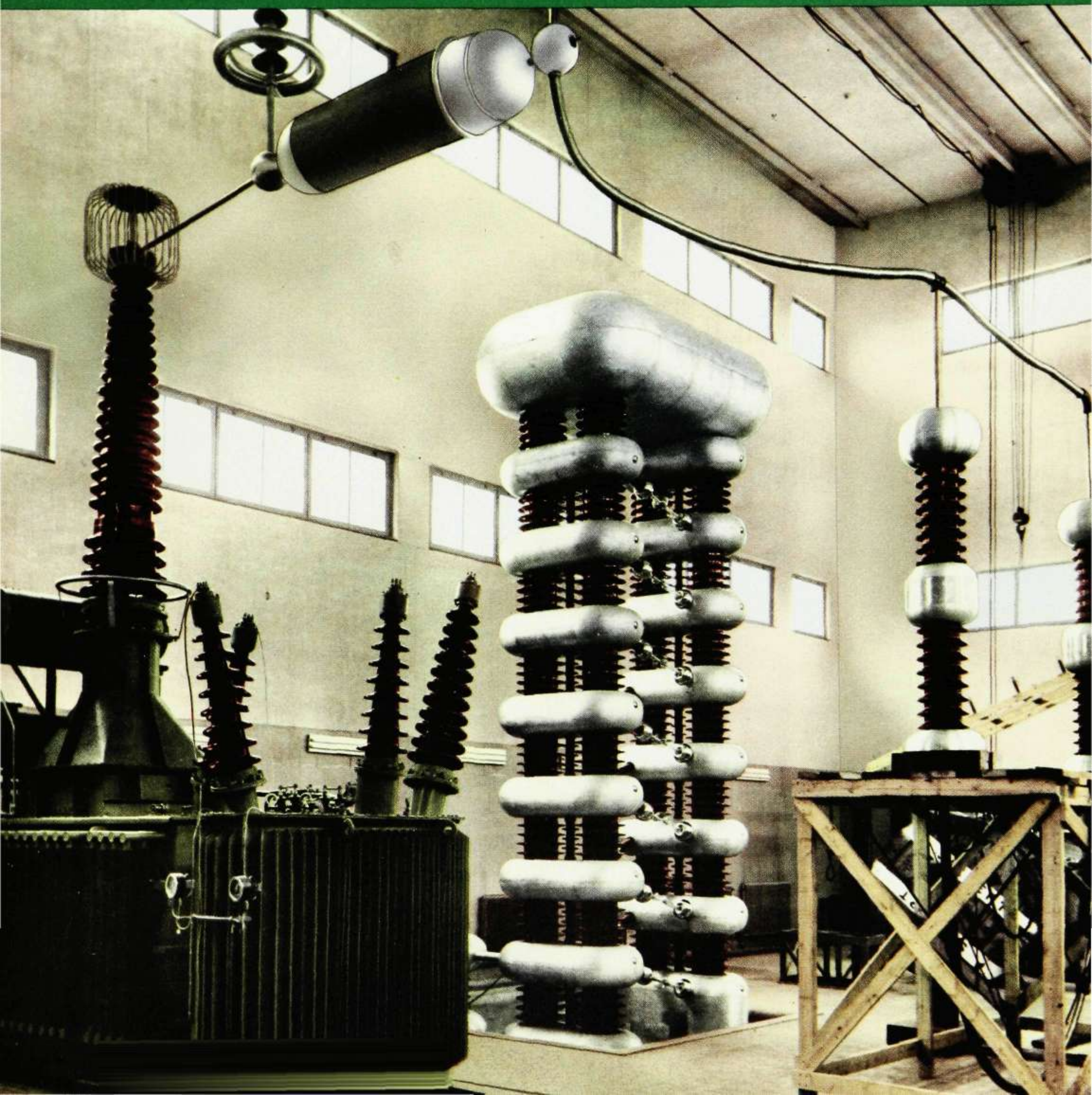
Ericsson Review

No 3
1950



ERICSSON REVIEW

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CONTENTS

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Sieverts Kabelverk's Laboratories

R NORDELL, SIEVERTS KABELVERK, SUNDBYBERG

U.D.C. 542.1
621.317.2

Since a few years, a far-reaching modernization activity has been in progress at Sieverts Kabelverk, involving factories, offices and equipment. As a first step a new building for offices and laboratories was erected in the year 1946. In 1949 the new factory for rubber- and plastic-insulated wire was completed. Connected with this factory, another building was erected at the same time, housing among others the main entrance of the factory, the doctor's reception rooms, the welfare office, and in addition to this a teletechnical laboratory. A new steam generating plant was put in service in 1950. A new factory for paper-insulated power cables is to be erected in the near future.

Concerning the organization, the laboratories are either directly subordinated the central management or belonging to a special department. The central laboratories include the material testing laboratory and the research laboratories for power engineering and for teletechnics. The new laboratories will give Sieverts Kabelverk widely increased facilities to meet the increasing demands for research work within the scope of the company's activity.

The Material Testing Laboratory

The purpose of the material testing laboratory is partly to test materials before and during the manufacturing processes, partly to carry on research work concerning the materials used or contemplated. The whole top floor in the new office and laboratory building is at this laboratory's disposal. The said building is separated from the factory block by a street, but a tunnel under the same from the new factory for rubber-insulated wire serves as a passage for trucks and other kinds of traffic. The tunnel joins to goods lifts, and in this way the materials can be transported in a convenient way from all parts of the factory to the laboratory.

A characteristic feature of the manufacture of cables and insulated wire is that the material costs of the finished product are high in comparison with the labour costs. Under such circumstances it is, of course, particularly important that the materials used are kept under continuous control and that never-ceasing efforts

Fig. 1 X 6526

Sieverts Kabelverk's new office and laboratory building

The material testing laboratory occupies the whole top floor, the research laboratory for power engineering is housed in the right wing.

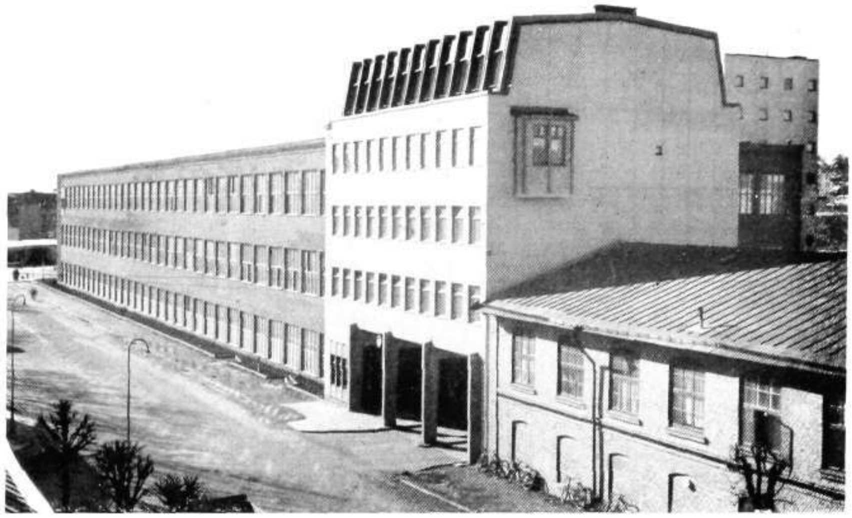


Fig. 2 X 6535

The new factory for rubber-insulated wire with the entrance building

The two upper floors of the latter building are occupied by the teletechnical research laboratory.

are made to improve them and to make them cheaper. The most important materials used in Sieverts Kabelverk's production are

lead for cable sheaths
copper for conductors
steel wire and steel tape for cable armourings
aluminium foils in capacitors
paper for insulation in cables and capacitors
oil for impregnation of cables and capacitors
rubber and plastics for insulation and jackets
textile materials for braiding and for other kinds of covering
enamel for enamelled wires.

The laboratory disposes of different rooms with special equipment for

mechanical tests
tests at constant air humidity
microscopy, such as the examination of the crystal structure in lead sheaths
viscosity tests of oils and compounds
spectral analysis of metal alloys
colorimetric measurements
general chemical analysis
micro-analysis.

On the roof of the high tension hall, which roof is flat and on the same level as the material testing laboratory, a platform enables insulated wires and constructional details to be exposed to the air, so that the corrosion effect of the same can be studied over long periods.

With the completion of the new factory for rubber-insulated wire, the material research work in connection with rubber and plastics was transferred to a special laboratory, direct belonging to this factory department.

The Research Laboratory for Power Engineering

This laboratory is intended for development work in the field of power cables and capacitors.

Certain standardized type tests in connection with the production are, however, also made here, since it is not practically or economically justified to provide the ordinary test rooms with the special equipment, necessary for such tests. With this arrangement, the test rooms can be reserved mainly for the routine tests.

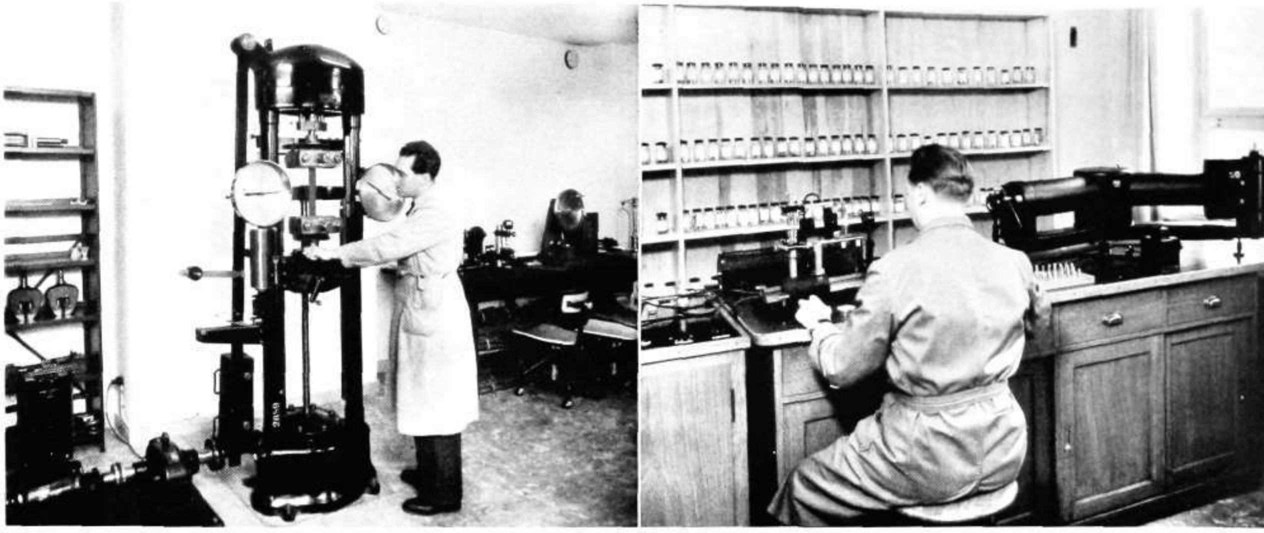


Fig. 3 X 7573

Interiors from the material testing laboratory

Left: Mechanical tests of various kinds constitute an important part of the laboratory's work.

Right: Qualitative and quantitative analysis of lead alloys is performed with a spectrograph and a photometer.

A great part of the investigations in this laboratory are made at low tension or at comparatively moderate voltages. Since cables as well as capacitors are manufactured also for extremely high voltages, the laboratory consequently must have resources for making tests in combination herewith. New Swedish standards prescribe, for example, a test voltage more than one million volts (surge voltage) for cables and capacitors for 220 kV. Besides the tests with high voltage, tests with heavy currents are frequently made in combination with investigations concerning heat dissipation in cables.

The laboratory is housed in the same building as the material testing laboratory and has at its disposal all the four floors in the eastern wing. The largest room is a high tension hall with a floor space of 13×33 m and a height of 14 m, which means that the hall passes through all the four floors. A high and wide door gives access to the space outside the building, so that very large cable drums can be taken in from the factory.

In the high tension hall, equipment is installed for the generation of different kinds of high voltage. Thus, transformers can deliver up to 512 kV, 50 cycles AC, a cascade-connected rectifier 1 400 kV DC as a maximum and a surge generator up to 2 000 kV nominally. In the hall there are also specially equipped testing places for tests with a maximum voltage of 80 kV AC. The height of the ceiling is here 6 m only, so that it has been possible to use the space above for other laboratory rooms. The voltage is transmitted to these testing places by means of cables from a total of 11 transformers and reactors, installed in adjoining rooms.

Fig. X 6528

A part of the general chemical laboratory

The rectifier, mentioned above, was designed and built by Sieverts Kabelverk. The company has, however, passed over the design and supplied capacitors and other parts to three other laboratories, which have installed similar cascade generators. These laboratories are

The Nobel Institute of Physics at Frescati (Prof. Siegbahn)
The Radiophysical Institute at the Karolinska Sjukhuset (Prof. Sievert)
The Institute of High Tension Research in Upsala (Prof. Norinder).

In the high tension hall there are three separate heating and refrigerating chambers. In these rooms large cable drums and even 220 kV capacitors (height approximately 3.6 m) can be tested at max. 80 kV, 50 cycles, and under simultaneous heating or cooling. A tank, 2 m in depth, is available in the floor of the high tension hall. This tank can be filled with water, so that cables and other objects may be submerged in it in combination with certain tests.

The equipment in the high tension hall and in the adjoining rooms is operated from a control gallery, passing along the hall. Above this gallery there is an observation gallery, which forms a continuation of the corridor in the main building on the corresponding floor.

Close to the large high tension hall, there is a smaller high tension room with a floor space of 7×10 m and a height of 6 m, where tests with moderate high voltages can be carried out. Along one side of the large high tension hall, there are several rooms for induction regulators, circuit-breakers, transformers, reactors and other kinds of equipment. Large storage rooms have been furnished, also in connection with the high tension hall.

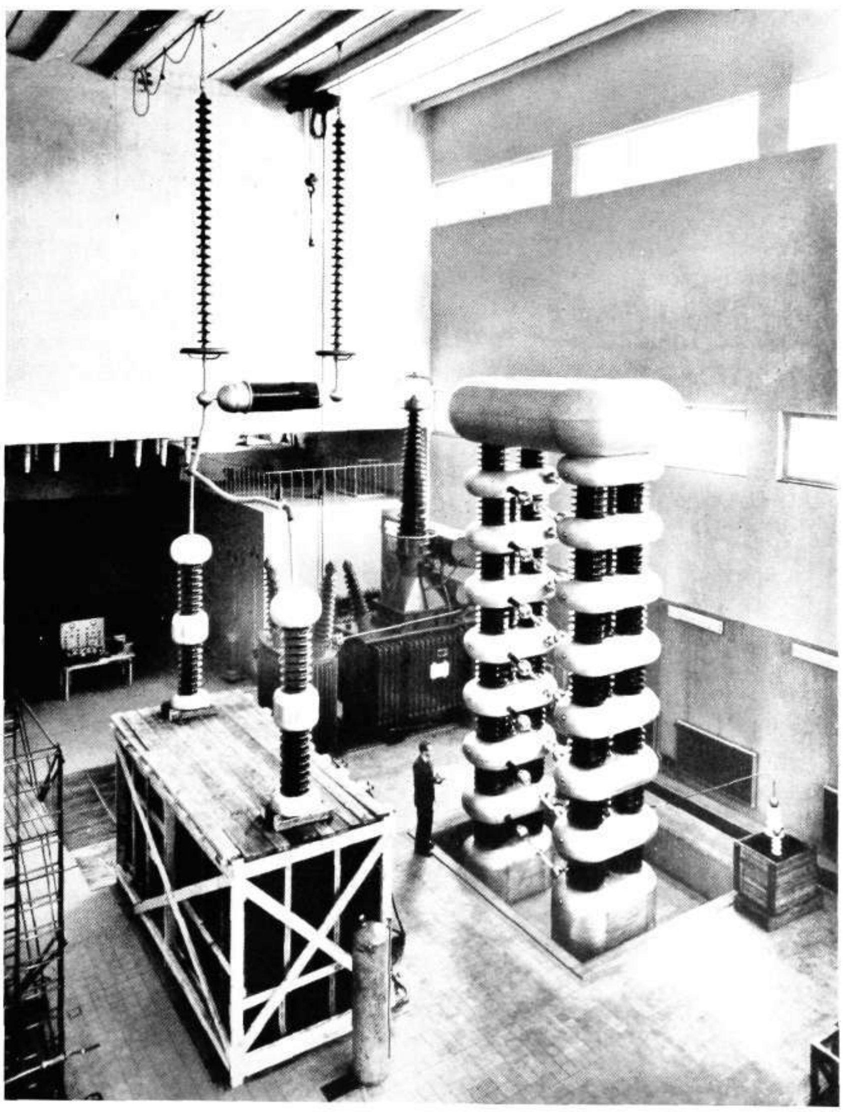


Fig. 5 X 6527

A corner of the high tension hall

The illustration shows the 512 kV transformers, the 1400 kV DC generator and refrigerating and heating chambers in the background on the right. A sample of 220 kV cable is prepared for testing.

Fig. 6 X 4692

The equipment in the high tension hall is operated from a control gallery running along one side of the hall

Because most of the test pieces, such as cables and capacitors, represent a capacitive load, a part of this load and in many cases the greatest part can be compensated by means of inductive reactors. In this way it has been possible to reduce the rating of the transformer and regulating equipment considerably. Thus, most of the smaller transformers have a rated output of 200 kVA, and the reactors, that may be connected in parallel, 300 or 600 kVA. It is therefore possible to obtain a total capacitive output of 500, or at certain voltages, 800 kVA, that is available for the tests. In the case of single-phase testing, induction regulators are frequently used up to 100 kVA for the voltage regulation. If greater loads or three-phase tests are required, the transformers and other testing equipment are fed from a motor-generator, installed in a separate machine room. The motor-generator has a rated output of 400 kVA and is designed to give a particularly pure voltage curve. The same machine room also contains a number of smaller motor-generators, by means of which a frequency range of 20—10 000 cycles can be covered. A special motor-generator set gives a constant voltage with varying load. From the smaller motor-generators and also from the rectifiers and accumulator batteries, fixed connections pass to several laboratory rooms. Other fixed connections transmit the voltages from the central control board in each room to terminal panels at the tables.

Adjoining the control gallery a central measuring room has been equipped for the measurement of losses and insulation resistance. From different points in the high tension hall special connections pass through ducts to this measuring room. The laboratory possesses a number of Schering bridges, and also standard capacitors for very high voltages.

The surge voltages from the surge generator are recorded and measured by means of a rapid-recording cathode ray oscillograph of the hot cathode type. This oscillograph is mounted in a special room adjoining a photographic dark room.

Other rooms are specially equipped for

long-life tests (ageing tests),
low tension measurements (e.g. fluorescent tubes),
heavy current measurements,
physical measurements,
special investigations,
testing insulation materials.

Fig. 7 X 6534

Control of the capacitance and of the loss angle of oil-impregnated paper

Samples of insulated paper are dried and impregnated in the laboratory for insulation materials, after which they are measured by means of a Schering bridge.

In the laboratories for insulation materials, insulating paper is dried and impregnated on a small scale and thereafter investigated with regard to its electrical properties. As was the case in the general material testing laboratory, certain routine tests are, however, also carried out here in connection with the production.

The Teletechnical Research Laboratory

This laboratory is housed in the two upper floors of the new entrance building, adjoining the factory for rubber-insulated wire. Its object is to carry out research work in the telephone cable field, particularly with regard to technical problems concerning transmission. Special interest is devoted here to coaxial cables for long-distance telephony and television.

The laboratory investigates how the transmission qualities depend upon the design of the cables as well upon the manufacturing process. In the upper floor of the laboratory there is a measuring room with equipment for such measurements. In combination herewith, it is possible to place big cable drums outside the measuring room on the roof of the factory for rubber-insulated wire. A special platform for such drums has been provided.

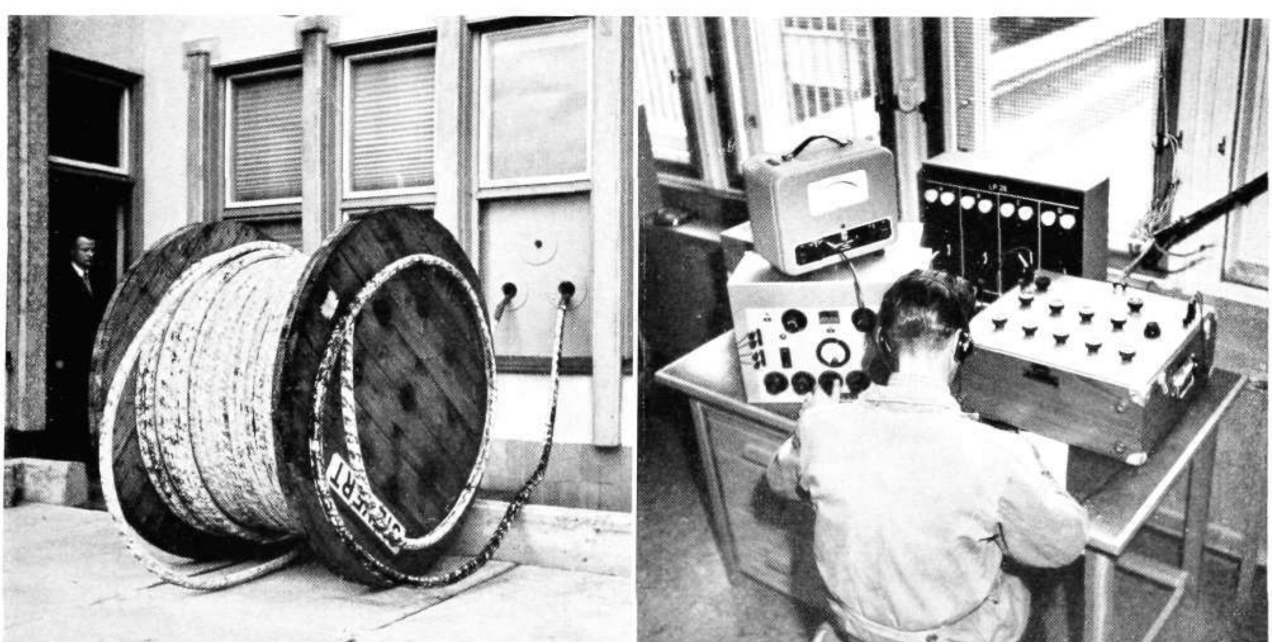
The laboratory has to its disposal a workshop of its own, where equipment for experiments can be made and repaired. The laboratory also controls all instruments that are used in the manufacturing process.

All laboratory rooms are shielded by means of a double system of metal network. The inner shields, surrounding each room separately and not connected to any potential, as well as the outer, earthed shield, which surrounds all the rooms together, are laid in a concealed position in the walls. The shields not only cover the walls, floor and ceiling but also the doors and windows. The transformer which supplies the laboratory with 50-cycle current, as well as the cables from the transformer, are shielded in accordance with the same system as that adopted for the rooms. Batteries of accumulators are available inside the shielded system for the supply of direct current.

Fig. 8 X 7572

Measuring telephone cables in the teletechnical research laboratory

Large cable drums on the roof outside the measuring room and, to the right, part of the measuring equipment.



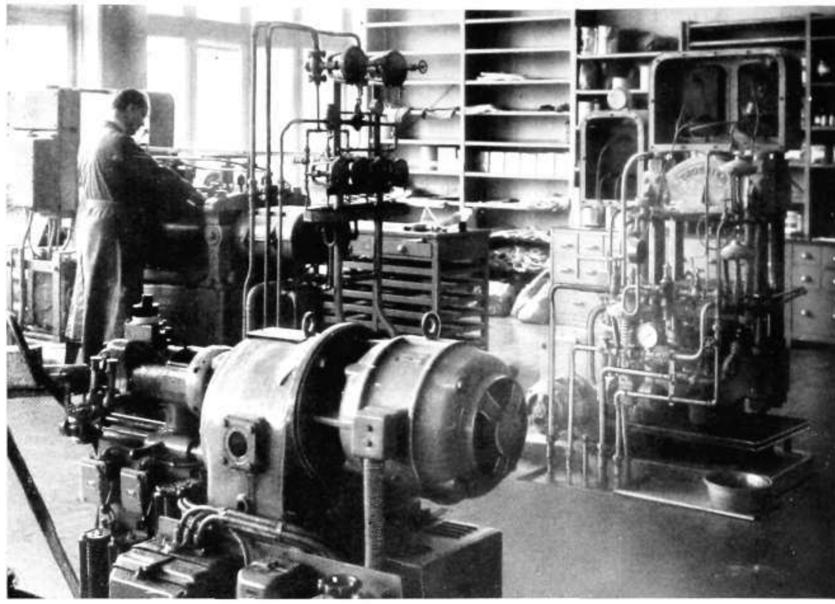


Fig. 9 X 6532

A picture of the pilot plant belonging to the factory for rubber-insulated wire

Other Laboratories

As already mentioned, there are also a number of laboratories which belong directly to certain factory departments. Thus, the new *factory for rubber-insulated wire* has a well-equipped laboratory of its own for control and research work in the field of rubber and plastics. An important part of the equipment of this laboratory consists of a pilot plant, i. e. a number of machines, by means of which most of the processes in the factory can be reproduced in half-scale and thoroughly studied.

The *installation and service department* undertakes the laying and installation of cables and is responsible for the service activity in general, as for instance fault locations and repairs. This department also has its own laboratories and workshops, closely associated with the research laboratory for power engineering. Here the service men are trained in making special joints and sealing ends. In addition to this, certain tests more particularly of a mechanical nature, such as pressure tests, tightness tests, etc., are performed. The premises are also used for courses of instruction, arranged by Sieverts Kabelverk at regular intervals for fitters in the service of electrical utilities and other enterprises.

The *cable and capacitor factories* have special test rooms for the routine tests. Insofar as time and resources permit, certain research work is also carried out here, this work being directly associated with the activities of the respective factory departments.

Workshops

It is extremely important that the laboratories have special workshops at their disposal, in which certain mechanical work can be performed rapidly and without too many formalities. Workshops of this kind are available in the central laboratory building. They consist of a mechanical workshop for smaller pieces containing the usual machine equipment and of a workshop in the basement for heavier work, such as forging, welding, shearing, etc. At the same time these workshops meet another important requirement, inasmuch as they produce such special parts on behalf of the factories, which cannot rationally be fitted into the manufacturing scheme of a factory department.

The Ericsson Type BMN Battery Eliminators

H BERGSTRÖM, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

U.D.C. 621.314.6:621.391
621.314.6:621.395.72

The constantly increasing reliability of a.c. power distribution systems has been accompanied by a growing tendency to connect small telephone and telesignalling installations directly to the supply system without employing storage batteries as an emergency source of power. It is first necessary, however, to convert the supply voltage to a d.c. voltage suitable for the installation in question, by means of a so-called battery eliminator.

In order to meet the growing demand, Telefonaktiebolaget L M Ericsson has designed a series of battery eliminators known as type BMN specially for supplying current to telephone and telesignalling installations. The new series is described in the following article.

Telefonaktiebolaget L M Ericsson has been engaged on the manufacture of dry type rectifiers for various purposes ever since the year 1928. Many of the rectifiers produced round about 1930 are still in service. Thus, when designing the new series of battery eliminators it was possible to profit by the experience gained over many years. These battery eliminators are constructed in an extremely simple and reliable form and require no attention under normal working conditions, a point of the utmost importance in places where a skilled staff is not available. The running costs for these sets are lower than those for a current supply equipment employing battery and charging device, since a storage battery always requires special attention and inspection in order to operate with reliability. A battery eliminator is therefore an ideal source of power for an installation that is not required to function in the event of a breakdown in the supply system.

Even in the case of very small telephone installations such as a house telephone- or hallway telephone installation for which dry batteries are normally employed it may be found worth while to adopt an eliminator set, notwithstanding the higher initial cost as compared with a dry battery. It sometimes happens, for example, that the dry battery becomes discharged owing to the omission to replace the microtelephone on its hook. In such cases the services of an expert are frequently employed to exchange the batteries which naturally entails certain service costs.

Constructional Principles

The new battery eliminators may be divided into two groups with respect to their electrical properties.

The first group which includes the types BMN 201—221 consists in principle, see Fig. 1, of a transformer Tr with separate primary and secondary windings,

Fig. 1 X 6521

Schematic diagram for battery eliminators type BMN 2111, 2112, 2211 and 2212

C electrolytic condenser
Dr choke
L rectifier
r resistance
SS_1 fuse
SS_2 fuse
Tr transformer

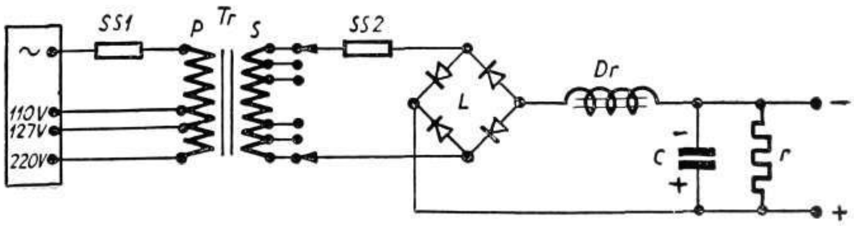
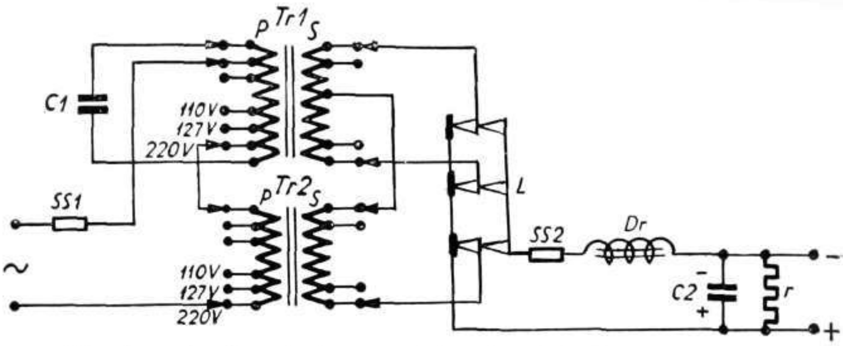


Fig. 2 X 6520

Schematic diagram for the battery eliminators type BMN 3201, 3202 and 3301

C_1 oil-filled condenser
C_2 electrolytic condenser
L rectifier
r resistance
SS_1 fuse
SS_2 fuse
Tr_1 saturated transformer
Tr_2 transformer with airgap



a rectifier L and a filter device comprising the choke Dr, the electrolytic condenser C and the resistance r. An eliminator set designed on this principle has a low no-load consumption and a high efficiency. The initial- and operating costs are low. The employment of the set is limited by the fact that the d.c. voltage obtained is not constant but varies with the load. The d.c. voltage fluctuates proportionally with the variations in the supply voltage but, on the other hand, it is independant of variations in the supply frequency within the range 40—70 c/s. This group of battery eliminators is suitable for installations for which a constant d.c. voltage is not necessary.

The other group of battery eliminators which includes the types BMN 320—330 is constructed in accordance with the patented Westat-principle of the Westinghouse Brake & Signal Co. Ltd., London, see Fig. 2. The d.c. voltage obtained is very constant, even with normal load- and supply voltage fluctuations. The d.c. voltage varies with changes in the supply frequency however. These sets have a high no-load consumption and higher initial cost than the corresponding sizes of the previously mentioned types BMN 201—221. Consequently, the running costs are also higher. For installations in which a very constant d.c. voltage is required, however, it is necessary to use such sets.

The choke and electrolytic condenser in the battery eliminators reduce the ripple on the output voltage of the rectifier, so that the residual ripple of the set does not exercise a disturbing effect. This superposed a.c. ripple voltage is ususally referred to as the hum voltage and is measured in mV R.M.S. value. The ripple frequency of the hum voltage for sets constructed according to Fig. 1 is equal to double the supply frequency, that is to say, 100 c/s with a 50 c/s supply. For sets constructed in accordance with Fig. 2 the ripple frequency varies between 100—300 c/s.

The chief purpose of the resistance r in the eliminator sets is to prevent the electrolytic condenser from raising the no-load voltage, which for a 24 V set would otherwise be about 45 V, for example.

If the battery eliminator is to be employed for a telephone installation, it is only necessary to consider that part of the hum voltage which is perceptible to the ear through a telephone receiver. This voltage, which is known as the psophometric or output hum voltage is measured in mV, and read with the help of a so-called telephone noise meter (psophometer) containing a filter with a specified frequency curve.

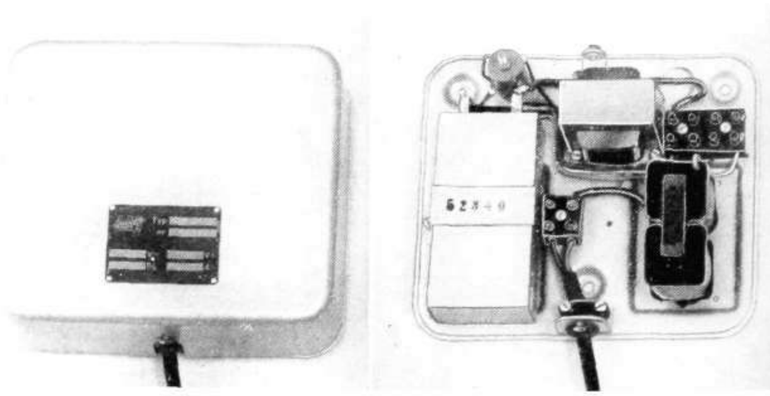


Fig. 3 X 6523

Battery eliminator type BMN 2011
right: with cover removed

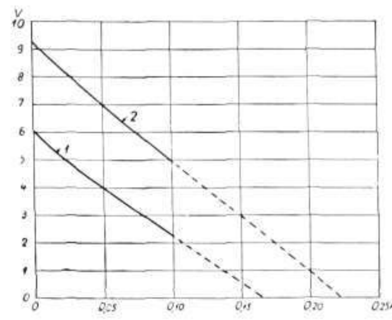


Fig. 4 X 4683

Load curve for battery eliminator type BMN 2011—2014

Curve 1 applies to the 4 V tapping and curve 2 to the 7 V tapping

Electrical Data

Battery Eliminators Type BMN 2011—2014

shown in Fig. 3 are intended for the current supply of local telephone installations with house telephone-, line selector- or LB-apparatus, and they give a d.c. voltage of 4 or 7 volts with a loading of 0.05 A. The d.c. voltage can be changed over by means of two tappings on the secondary winding of the transformer. Normally, the 4 V tapping is used, but with long lines between the telephone sets the 7 V tapping must be connected up to obtain a ringing signal of sufficient strength. The load curve for the sets is shown in Fig. 4.

In designing these eliminators special attention has been given to rendering them suitable for use in a household, and to the fact that the telephone equipment is frequently installed by relatively unskilled persons. On this account the sets are constructed for one voltage only, so that they cannot be connected up incorrectly. Connection to the supply system takes place by means of a short rubber-insulated cord and ordinary plug contact. The transformer is of the core type, the primary and secondary windings each being mounted on a separate limb. This renders the transformer short-circuitproof whilst at the same time adequate insulation is obtained without any risk of current leakage from the supply mains to the telephone installation. The sets can be connected to an alternating current supply system with a frequency of 40—60 c/s, and are available for the following voltages

Type No	*Supply Voltage*
BMN 2011	110 V
BMN 2012	127 V
BMN 2013	150 V
BMN 2014	220 V

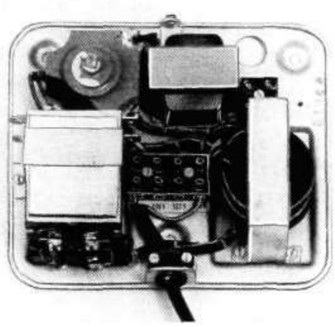


Fig. 5 X 4687

Battery eliminator type BMN 2021

The current consumption of these sets is very low. On no-load they consume 0.75 W (2.8 VA) and at 7 V with a load of 0.05 A the consumption is 1.3 W (3.2 VA). The choke and condenser are so dimensioned that telephone communication is not disturbed by any mains hum. The hum voltage is about 25 mV at 4 V and 0.05 A loading, and approximately 40 mV at 7 V and 0.05 A.

The psophometric hum voltage is 0.4 and 0.6 mV respectively.

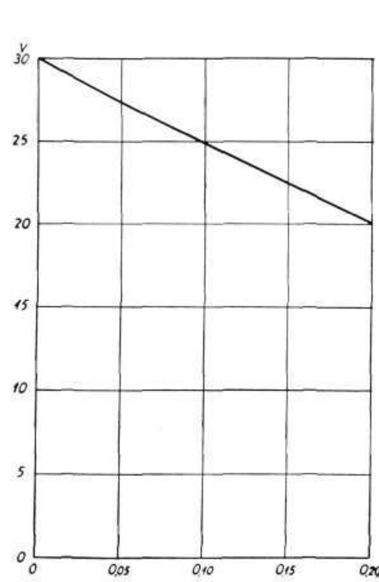


Fig. 6 X 4684

Load curve for battery eliminator type BMN 2021

Battery Eliminator Type BMN 2021

illustrated in Fig. 5 is intended for conference telephone installations, small telephone exchanges, relays, etc., for 24 V.

The set gives a d.c. voltage of 30 V on no-load, 24 V with a load of 0.1 A and 20 V at 0.2 A according to the load curve in Fig. 6.

The hum voltage is 220 mV on no-load, 350 mV at 0.1 A and 600 mV at 0.2 A and the psophometric hum voltage is 3.3, 5.3 and 9 mV respectively.

The set can be reconnected for 110, 127 and 220 V alternating current, 40—60 c/s.

The current consumption on no-load is 3 W (7.3 VA), 6.3 W (9.3 VA) with a load of 0.1 A and 9.8 W (11.4 VA) with a load of 0.2 A. A 0.5 A fuse is provided to protect the set against overloads.

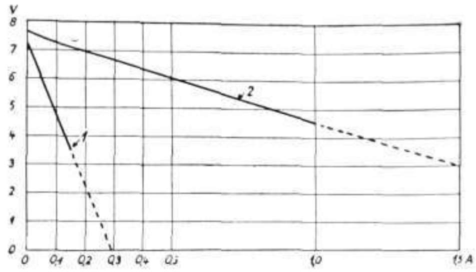


Fig. 7 X 6522

Load curve for battery eliminator type BMN 2025

Curve 1 applies to the 4 V tapping (microphone feed) and curve 2 to the 6 V tapping (current for door lock).

Battery Eliminator Type BMN 2025

shown in Fig. 8 is intended for supplying current to hallway telephone installations of L M Ericsson's type. It can be reconnected for 110, 127 and 220 V, 40—60 c/s. The set has two d.c. voltage circuits with rated voltages of 4 V and 6 V respectively. The 4 volt circuit is provided with a filter so that direct current free from hum is obtained for feeding microphone and loudspeaker. The voltage is 4 V at a load of 0.12 A which corresponds to the current consumption for one calling connection. The hum voltage is then approximately 10 mV and the psophometric hum voltage 0.1 mV. For the current supply to buzzers, bells and electromagnets for electrical door-locks the 6-volt circuit is employed. The latter has a low internal resistance so that the relatively high current required for door-locks can be obtained, see load curve, Fig. 7.

A 2 A fuse is provided to protect the set against overloads.

The current consumption on no-load is 1.2 W (6 VA), for supplying one microphone only (calling connection) 2.3 W (6.3 VA) and for opening door-locks at 1 A, 11.9 W (12.6 VA).

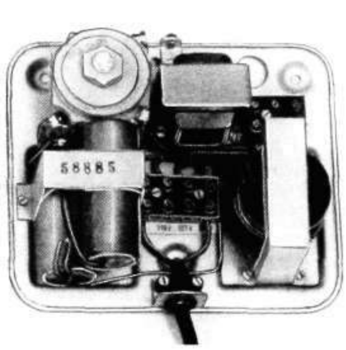


Fig. 8 X 4688

Battery eliminator type BMN 2025

Battery Eliminators Type BMN 211 and 221

shown in Figs 9 and 10 are intended for supplying current to manual telephone exchanges and telesignalling or similar installations which do not require a constant d.c. voltage. When the supply voltage is very steady the sets may also be employed in some cases for automatic telephone exchanges.

These sets are characterized by their low no-load consumption and high efficiency.

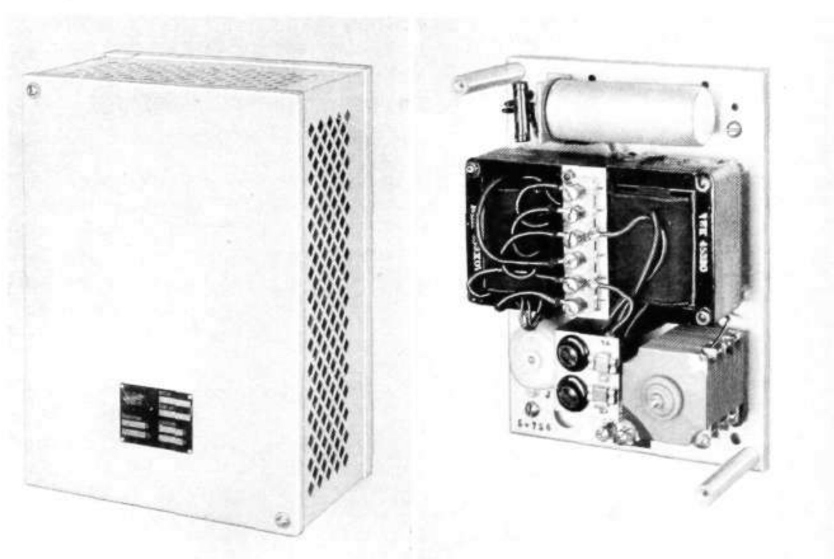


Fig. 9 X 6524

Battery eliminator type BMN 211

right: with cover removed

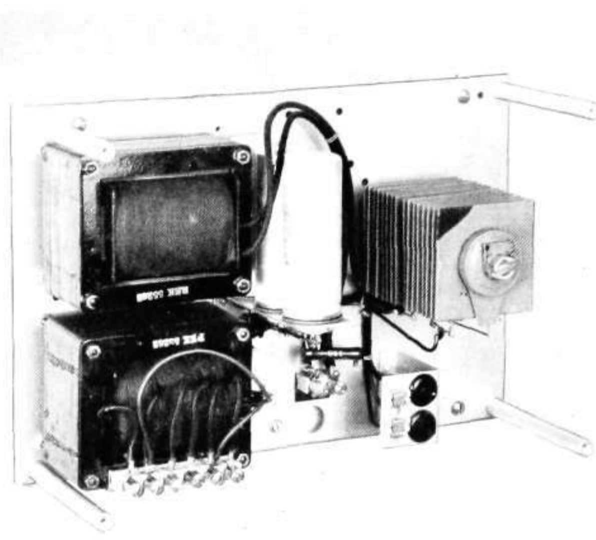


Fig. 10 X 6525

Battery eliminator type BMN 221
with cover removed

The following types are manufactured for 24 V:

Type No.	Rated Current A	No-load consumption		Efficiency at full load %
		W	VA	
BMN 2111	0.5	3	11	62
BMN 2112	1	5	16	63
BMN 2211	2	10	20	65
BMN 2212	4	14	36	70

All types can be reconnected for 110, 127 and 220 V, 40—60 c/s. The d.c. voltage obtained is about 30 V on no-load and 24 V at full load. The schematic diagram may be seen in Fig. 1. By means of the 6 transformer tappings on the secondary side the d.c. output voltage can be adjusted in 9 steps, see load curve, Fig. 11, so that a working voltage suitable for the apparatus in question can be selected. The hum voltage and psophometric hum voltage do not exceed 240 mV and 2.8 mV respectively at the full current.

The power factor at full load is approximately 0.85.

Battery Eliminators Type BMN 3201, 3202 and 3301

shown in Fig. 12 are employed for all forms of telephone exchanges or installations that require a constant d.c. voltage. They should therefore be used with L M Ericsson's exchanges types OL, ALD and AHD.

The following types are manufactured for 24 V

Type No.	Rated Current A	No-load consumption		Efficiency at full load %
		W	VA	
BMN 3201	3	29	34	59
BMN 3202	6	38	51	60
BMN 3301	12	70	93	63

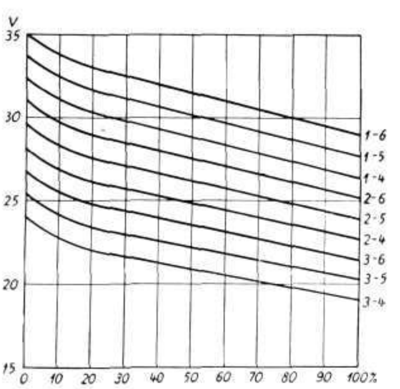
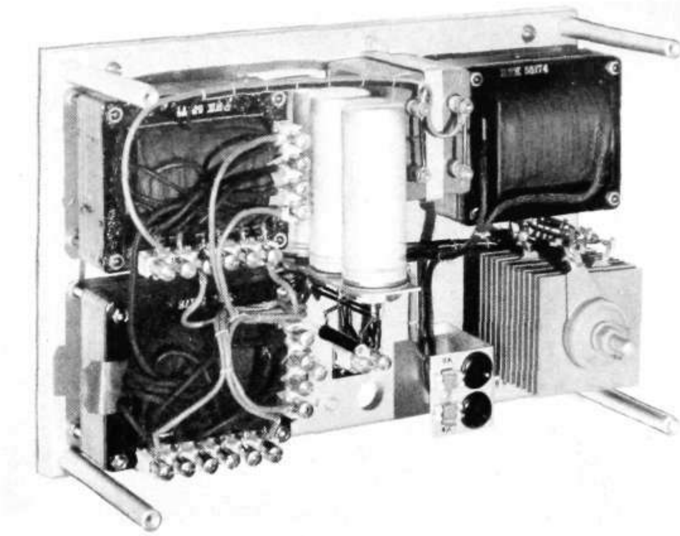


Fig. 11 X 4685

Load curve for battery eliminators type BMN 211—221

The curves 1—6, etc. refer to the different tappings on the transformer.

The sets can be reconnected for 110, 127 and 220 V, 50 c/s. They give a d.c. output voltage that only varies ± 0.5 V with a load fluctuating between zero and the rated current and with a variation in the supply voltage of ± 10 %. Even when the supply voltage drops far below this value, the set can still keep a steady voltage with a reduced load current. In the case of voltages of long duration in excess of 10 % there is a risk of the set becoming overheated.



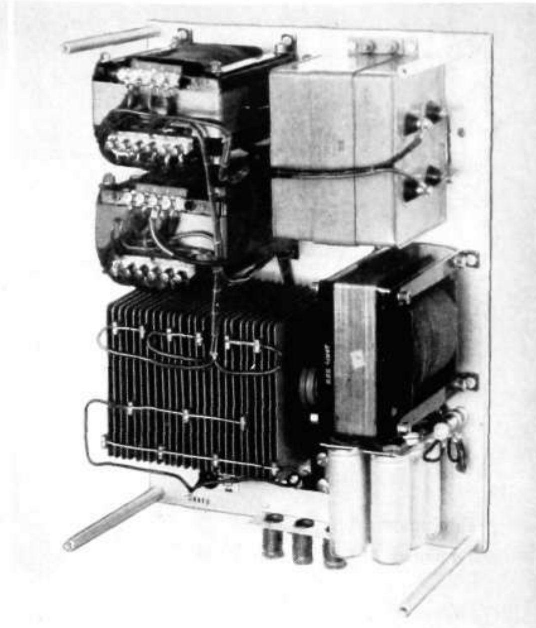


Fig. 12 X 7571

Battery eliminators type BMN 3201 left, and type BMN 3301, right

with covers removed

The d.c. voltage obtained is sensitive to variations in the supply frequency. If the frequency fluctuates by ± 1 c/s, the d.c. voltage will vary approximately ± 0.7 V. The set is unsuitable, therefore, for connection to mains with a widely varying frequency, if a constant d.c. voltage is required. It will not be adversely affected in any way, however, if the frequency varies between 45—55 c/s. A typical load curve for this set is shown in Fig. 13. The characteristic can be adjusted by changing the connections at the transformer's tapping terminals. The set can also be adjusted in such a way that the d.c. voltage rises with an increasing load and compensation can thus be obtained for a voltage drop in the conductors leading to the consumption apparatus. These sets are adjusted for approximately 25 V on delivery. The sets consist of two transformers Tr 1 and Tr 2, the primary windings of which are in series and are connected to the supply system, see Fig. 2. The condenser C 1 is connected in parallel with the transformer Tr 1, the iron core of which is *magnetically saturated*. The voltage in the transformer Tr 1 is therefore displaced in phase in relation to the voltage in transformer Tr 2 which has an air gap in the iron circuit so that its flux is low. The secondary winding on Tr 2 is connected to the centre tapping of the secondary winding on Tr 1 (Scott's connection). In this way three voltage vectors are formed which at a given load, are similar to a 3-phase system which is rectified by the recitifier L. With a fluctuating supply voltage and varying loads the three voltage vectors will be rotated in such a way that the resulting d.c. voltage will be practically constant. The filter device consists of the choke Dr, the condenser C 2 and the resistance r.

The hum voltage is approximately 50 mV on no-load and does not exceed 200 mV at full load. The ripple frequency at light load is 100 c/s and at full load 300 c/s with a mixture of the two ripple frequencies at intermediate loads.

The psophometric hum voltages are 0.9 and 2.2 mV respectively. The power factor at full load is about 0.95.

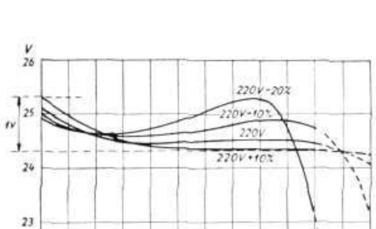


Fig. 13 X 4686

Load curve

with different supply voltages for the battery eliminators type BMN 320—330

Mechanical Construction

All battery eliminator sets are constructed for wall mounting. The different parts are mounted on a base-plate. The protecting cover has an aluminium-lacquer finish and is perforated at the sides to allow for circulation of the air. As regards eliminator set BMN 201, this set has such a low power consumption that the cover can be made tight so that it can also be placed in a horizontal position without making allowance for ventilation. The sets equipped with fuse gear are supplied with a double set of spare fuses on delivery. The smaller sets BMN 201 and 202 are connected to the supply system by connecting cords and plug contacts. The remaining sets should preferably be connected by fixed conductors which are led up to the terminal box of the set either through an opening in the cover or from the back through a hole in the base-plate.

Erection

As is well-known, all dry type rectifiers possess the property that their internal resistance slowly increases in the course of time. This increase in resistance, known as ageing, occurs chiefly owing to the heating up of the rectifier element and it makes itself apparent in the form of a progressive reduction of the d.c. output voltage under load. The rectifier element must be exchanged, therefore, when the voltage becomes too low or when the characteristic of the set becomes unsuitable in other respects, as for example, when the transformer tappings can no longer provide compensation for ageing. In order to ensure as long a life as possible for the rectifier element it is extremely important that the temperature should be kept low by placing the set in a cool position so that a satisfactory air circulation is obtained. Overloading for long periods should be avoided. Under correct operating conditions a life of at least 10—20 years can be obtained in temperate climates; it will be somewhat shorter in the tropics. Small battery eliminators are as a rule quite noiseless in operation. In the case of the larger sets, however, especially those with saturated transformers, it is difficult to obtain absolutely silent operation on account of the strong saturation of the iron cores. The sets should therefore be placed in positions where these mechanical vibrations will not be disturbing.

New forms of small telephone exchanges and telesignalling devices are now very frequently provided with built-in eliminators specially adapted to the form in question. It is then possible in a telephone exchange, for instance, to obtain the necessary d.c. voltage and the buzzer- and ringing voltage directly from the eliminator set. By way of example it may be mentioned that L M Ericsson's telephone exchanges types OL-15, AMD 10201 and AMD 10501 are fitted with built-in battery eliminators.

Ericsson Technics

Ericsson Technics No 49, 1950

Yngve Rapp: The Economic Optimum in Urban Telephone Network Problems

In the heavy capital investment represented by the exchanges and subscribers' network for a telephone plant the incomparably greatest part of the costs falls on the network. Consequently, it is of vital importance to the economy of the telephone plant that adequate care should be devoted to the planning and construction of the network.

Hitherto most of the work in telephony has been directed towards the exchanges and their expedient planning, whereas comparatively little attention appears to have been devoted to the rational economic lay-out of the network. It is the purpose of the paper referred to above to remedy this omission.

The author places economic considerations in the foreground and points out the methods to be followed in order to keep the costs for telephone plants as low as possible. The methods described have already been applied in practice and excellent results obtained with them.

The article reproduced on the following pages of this publication: »On the Planning of Networks for Telephone Plants» presents a convenient summary of the viewpoints advanced in the more comprehensive paper.

On the Planning of Networks for Telephone Plants

Y RAPP, TELEFONAKTIEBOLAGET LM ERICSSON, STOCKHOLM

U.D.C. 621.395.74

The cost of the network for a telephone plant amounts to approximately 60—70 % of the total outlay for the installation. Careful planning of the network lay-out is, therefore, of importance with a view to obtaining the lowest possible total costs. Thus, it is necessary, amongst other steps, to divide up the network group areas into a suitable number of exchange areas and select an appropriate network system permitting the maximum possible economic adaptation of line drawing with respect to the town plan. In this connection it is not only necessary to take into account the immediate demand but also the probable future subscriber growth.

The viewpoints advanced in the following article are discussed in greater detail in a more comprehensive paper by the author, published in Ericsson Technics No. 49 under the title »The Economic Optimum in Urban Telephone Network Problems».

When planning exchange areas, junction circuits and subscribers' networks within a network group, the designer is confronted by a whole series of problems the solution of which calls for considerations of an economic nature.

Such considerations concern the selection, amongst a number of technically equivalent solutions, of the most economical one, and thus they have for their purpose the adoption and exploitation of different lay-out elements in combination with one another in such a way that the total costs will be brought down as low as possible.

Stated more precisely, it is a question of dividing the network group areas into a suitable number of exchange areas appropriately connected to each other by a junction cable network and selecting suitable conductor dimensions for the junction cables and subscribers' network.

With respect to the subscribers' network within the various exchange areas, apart from the selection of a suitable system for the lay-out of the network, the laying of the different lines must be adapted to the town plan in the most economical manner and appropriate sizes must be chosen for the spreading points and distribution cabinets.

Since the demand for telephone connections usually increases in the course of time, it is not sufficient when planning and constructing a telephone network merely to consider the immediate demand, but the probable future subscriber growth must also be allowed for in the calculations. The increase not only determines the magnitude of the stages for the extension of the plants, but may also influence the selection of the constructional method adopted inasmuch as one particular method or system may be found more advantageous than others, according to whether the required development is large or small, or whether the increase in the number of subscribers can be predicted with a high or low degree of probability.

The viewpoints advanced here, which are based on a previously published paper »The Economic Optimum in Urban Telephone Network Problems» (Ericsson Technics No. 49, 1950) refer throughout to entirely new installations, but this does not detract from their interest with regard to existing network groups which in consequence of their development, and for other reasons, deviate from the most advantageous lay-out. The growing demand for telephones, the removals of subscribers and the alteration in the character of the traffic in the course of time render constant extensions and changes imperative. When planning to this end, an idealized fundamental plan for the network group drawn up for the long view and corrected from time to time will be found of very great value.

1. General Principles for the Economic Optimum Construction of Networks

A modern automatic national telephone network is divided, according to European practice at least, into network groups or network group areas in which each group is characterized by the fact that its subscribers' numbers all fall under the same number series and that one or more of the exchanges in the group maintain the traffic with subscribers outside the group. Thus, exchanges of the latter type may be referred to as trunk exchanges. The cables between the exchanges in the same network group are known as junction lines, those between trunk exchanges being referred to as trunk lines.

The network groups are, of course, formed around densely built-up centres, but notwithstanding this fact the arrangement of the division of rational network groups is accompanied by considerable practical difficulties. The geographical extension of a network group with heavy line density and traffic should be less than that for a group with insignificant density and traffic. An economic limit exists for the extension of the network groups, however, as long, at least, as the trunk lines can be interconnected without amplification.

According to the recommendations of the CCIF, the reference equivalents for the transmitting and receiving national systems should not exceed the maximum values 2.1 and 1.5 nepers respectively. On this account the conductor dimensions for the junction cables which connect a telephone exchange in the network group with a trunk exchange at the centre of the group, must have increasing diameters as the distance from the centre increases. This entails an appreciable rise in the cost of the junction cables as the distance increases, which sets an economic limit for the extension of the network group. If it is nevertheless desired to avoid very small network groups, as may be desirable for example, in densely populated districts, it is possible to resort to the use of telephone amplifiers without departing too widely from the economic optimum.

In planning exchange areas and junctions within the different network group areas, an attempt must be made to determine the following more or less associated factors:

the number of exchanges,
the location of each exchange,
the extent of each exchange area,
the conductor dimensions in the subscribers' network and junction cables,
the arrangement of suitable junction routes.

These factors are more or less dependent upon one another and must therefore be determined simultaneously for an optimum planning system, in principle at least. In consequence of the large number of variables the matter becomes somewhat complicated. It is possible, however, to formulate approximate methods which possess the simplicity necessary for their practical application and are at the same time sufficiently accurate.

1. Number of Exchanges

It is possible in many cases to obtain a conception of the appropriate number of exchanges within a network group or certain parts of the latter by surprisingly simple methods. This is particularly the case where the district exhibits a number of clearly demarcated concentration areas. If the number of subscribers is not very small there is reason to assume that the number of exchanges will not differ greatly from the number of these concentration areas.

In the case of large connected areas the task is not quite so simple, and a certain amount of laborious work is unquestionably involved in the progressive series

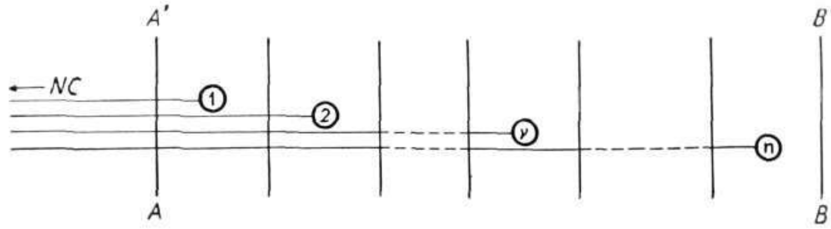


Fig. 1 X 6514

Example of an exchange area division in a part of a network group

of trial calculations which must be carried out to determine the most suitable number of exchanges. In most cases, however, this work may be facilitated in a high degree by means of calculations that can be made under considerably modified assumptions, thus rendering them extremely simple.

Let us for example consider an area bounded by the lines $A—A^1$ and $B—B^1$, according to Fig. 1, in which the number of subscribers is relatively small in comparison to the number of subscribers in the whole network group and in which the telephone exchanges *1, 2. . . . . . . n* lie along one and the same route with a fairly constant subscriber density. The exchanges are assumed to be star connected to the network group centre NC by junction cables having the same conductor dimensions, and to lie at the centre of each exchange area. Finally, it is assumed that the incoming and outgoing traffic for each subscriber is constant and ε_0 erlangs. A trunk cable which connects an exchange ν within the area under consideration to the network group centre NC must then clearly be dimensioned for a traffic of

$$E_\nu = 2\,\varepsilon_0\, N_\nu \left(1 - \frac{N_\nu}{N}\right) \text{ erlangs} \;\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

where N_ν is the number of subscribers within the area ν and N is the total number of subscribers within the network group. The number of junction cables Q_ν from the centre of the network group to the exchange ν may then be written approximately as:

$$Q_\nu = c_1\, E_\nu + c_2 \;\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

where c_1 and c_2 are two constants which depend upon the nature of the traffic and the prescribed blocking.

According to the assumptions, the number of subscribers within the area investigated is small in relation to the total number of subscribers within the network group, and the subscriber density along the route is substantially constant. It follows from this and from equations *(1)* and *(2)* that the number of junction cables to an area ν is practically a linear function of the extent of the exchange area and that the total number of junction cables to the network group centre for a given number of exchanges is practically independent of the size of the separate areas. Finally, it follows from this that the total quantity of junction cable calculated in pair-metres is substantially independent of the size of the exchange areas and that the exchange areas should be of the same size. The total costs for the subscribers' network which is likewise assumed to be laid out with conductors of the same dimensions will actually be lowest with exchange areas of the same size.

On the basis of the foregoing assumptions it is easy to estimate the number of lines N_C which should be available for the subscribers' network of each exchange area. Thus it is found that

$$N_C = \sqrt{\frac{4\;(C + c_2\, b_t\, l_{tm})}{b_a}\cdot\beta} \;\ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

where C = »fixed» costs per exchange, *i. e.* that part of the costs which does not change with the capacity of the exchange,

b_a = the pair-metre cost for the subscribers' network,

b_t = the pair-metre cost for the junction cable network,

l_{tm} = mean length of line in the junction cable network to the area in question,

c_2 = the constant according to *(2)*,

β = the line density, *i. e.* the number of pairs in the subscribers' network per unit of length of the route investigated.

One of the basic assumptions in the above, namely, that all exchanges within the area investigated lie along one and the same route, is not always fulfilled, particularly in large, closely adjoining built-up areas. It may then be preferable to assume instead that the exchanges are located at the centre of a square exchange area. If the influence of the junction cable costs is neglected, the following equation is obtained for the capacity of the exchanges:

$$N_C = \sqrt[3]{\left(\frac{4\,C}{b_a}\right)^2 \alpha} \quad \ldots \ldots \ldots \ldots \quad (4)$$

where α is the line density in a number of pairs per unit of surface in the area investigated.

The equation (4) gives a lower limit for the economic size of the exchange.

2. *Extent of the Exchange Areas*

From Fig. 1 we now select two adjacent exchange areas which, as we have seen, should be of the same size under the given assumptions.

Let it now be assumed instead, however, that these exchange areas are located at such a distance from the network group centre that the conductor diameters in the outer area are larger than those in the inner area for technical reasons relating to transmission.

The boundary line previously drawn between the two exchange areas will then no longer represent an optimum planning.

A slight displacement of this boundary line outwards will actually reduce the costs for the junction cable network inasmuch as the number of conductors with the larger dimensions will be reduced to the same extent as the number of conductors with the smaller dimensions increases, whilst at the same time the total costs for the subscribers' network, which is still assumed to be constructed with conductors of the same dimensions, remain unchanged. Thus, the boundary line between the exchanges should be displaced outwards, and in this case the outer exchange area will be smaller than the inner one with economic optimum planning.

Under the given assumptions, it will be clear from this result that in a network group where the distances between the main exchange and the sub-exchanges are so great that the costs for the junction cables, calculated per pair-km in an optimum planning, must increase with the distance from the main exchange, the capacity of the exchange will decrease as the distance from the trunk exchange increases.

In exchange areas where all conductor costs, calculated per pair-km, are independent of the distance from the main exchange, all exchanges will have the same capacity, however, with the exception of the main exchange which will be the largest.

3. *Location of Exchanges and Exchange Boundaries*

In the foregoing it has been assumed for the sake of simplicity that the exchanges were located at the centre of the exchange areas. In reality, the exchanges will be displaced in the direction towards the incoming junction cables.

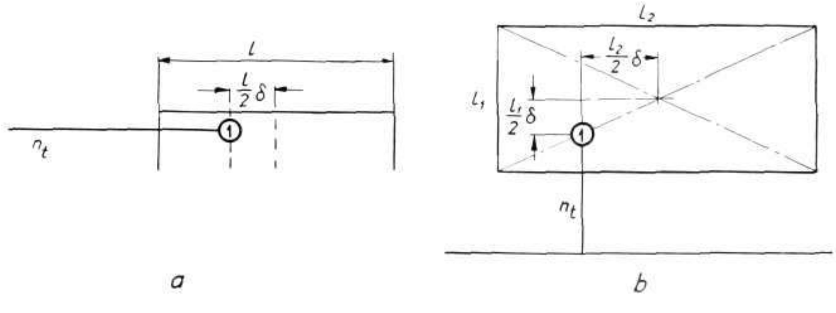


Fig. 2 X 6533

Displacement of a telephone exchange 1 within an exchange area with respect to the influence of the junction cable costs

A station (1) according to Fig. 2 a having n_t incoming junction cable pairs with pair-metre costs b_t and n_m outgoing primary pairs with pair-metre costs b_m and which supplies an area having the length l should be displaced over the distance $\frac{l}{2}\delta$ from the centre point where δ is determined by the expression

$$\delta = \frac{n_t b_t}{n_m b_m} \quad \ldots\ldots\ldots\ldots \quad (5)$$

If the point within the exchange area which gives the shortest length of average line in the subscribers' network does *not* lie in the direction of the incoming cable route as shown in Fig. 2 a, but is located at the side of it instead, as in Fig. 2 b, an exchange that supplies a rectangular area having the sides l_1 and l_2 in a square town plan should be displaced in both street directions by the distances $\frac{l_1}{2}\delta$ and $\frac{l_2}{2}\delta$ respectively in accordance with Fig. 2 b.

This displacement of the exchanges influences the exchange boundaries, which in turn reacts upon the location of the exchanges.

With fixed positions for the exchanges the boundary line between the exchange areas may be simply determined by the condition that the conductor costs to any point whatsoever in areas shall be the same, whether a subscriber is connected to one exchange or another.

The exchange locations and exchange boundaries should obviously be determined simultaneously. If the exchanges are located along the same route with a fairly constant subscriber density, this determination can conveniently be carried out analytically. In other cases the determination is effected by a series of approximations directly on the plan where the result of the town-quarter calculations is inserted in a manner which will be described subsequently in detail.

4. Economic Conductor Dimensions

In determining the conductor dimensions of the cables in a network group the practice appears to have been widely adopted hitherto of starting from a certain given value for the permissible reference equivalent in a subscribers' network and another given value of the reference equivalent for a junction circuit between two exchanges. With a starting point of this kind the determination of the conductor dimensions is a purely technical problem which can be solved at once from the conditions laid down for transmission. Nevertheless, there are strong economic reasons why that part of the total permissible reference equivalent which can be allotted to the subscribers' network and junction network together, should be divided instead over the network and junction cables respectively in such a way that conductor dimensions corresponding to the division will result in the lowest possible total cost for the network and junction cables. The manner in which this can be effected will now be described in detail.

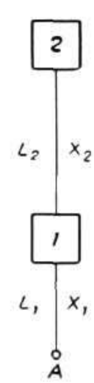


Fig. 3 X 1950

Diagram of a simple network group

1 local exchange

2 trunk exchange

Let it be assumed in accordance with Fig. 3 that a subscriber's set A is connected through the subscriber network L_1 to a local exchange *1* which in turn is connected to the trunk exchange *2* through the junction circuit L_2. The maximum values recommended by the CCIF for the reference equivalents may be divided up for this circuit under the following headings:

	Transmitting Nepers	Receiving Nepers
1. Reference equivalent of the subscriber's set at zero ohm local line		
2. Tolerance allowed for in the above value	0.2	0.2
3. Microphone efficiency loss due to feed attenuation		
4. Attenuation in subscriber's line		
5. Attenuation in local exchange		
6. Attenuation in the junction circuit		
7. Attenuation in the trunk exchange		
Total	2.10	1.50

It is assumed here that the reference equivalents for the subscriber's set, the local and trunk exchanges are determined from the outset. Thus, a value is also obtained in the first instance which is the sum of the maximum permissible reference equivalents for the subscribers' network, and the junction cable network, *i. e.* the sum under the headings 3, 4 and 6 when transmitting and the sum of 4 and 6 when receiving. The conductor dimensions x_1 and x_2 in the network and junction cables should obviously be so selected that neither of the above-mentioned sums is exceeded.

In this selection, sometimes the reference equivalent for transmitting and sometimes that for receiving will be decisive. From the above consideration it will be seen that the reference equivalent for transmitting is decisive as soon as a value comprising

the sum of items 1 and 4 for transmitting
reduced by item 1 for receiving

is greater than 0.6, and that the reference equivalent for receiving is decisive as soon as the value obtained in the manner described is less than 0.6.

For the sake of simplicity it is hereafter assumed that the reference equivalent for receiving is the determining factor for dimensioning. This assumption in no way restricts the general validity of the results obtained in principle.

As is well-known the reference equivalent for a non-pupinized cable of a given type may be written:

$$\beta = \frac{b}{x} \text{ nepers/km} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (6)$$

where b is the attenuation per km for a 1 mm conductor and x is the conductor diameter in mm. Thus, for the conductor dimensions of the network and junction cable, any pair of values x_1, x_2 may be taken which satisfy the expression

$$\frac{b}{x_1} L_1 + \frac{b}{x_2} L_2 \leq B \ldots\ldots\ldots\ldots\ldots\ldots \quad (7)$$

where

$L_1 =$ the longest subscriber line in the network (1)
$L_2 =$ the distance between the exchanges (1) and (2)
$x_1, x_2 =$ the conductor diameter in the network and junction cables respectively
$B =$ the combined maximum permissible reference equivalent for the subscribers' network and junction cable.

Apart from the conductor dimensions x_1 and x_2, the total consumption of copper is also dependent upon the number of pair-metres M_1 and M_2 in the network and the junction cable respectively, and is proportional to the equation:

$$K = M_1 x_1{}^2 + M_2 x_2{}^2 \ldots\ldots\ldots\ldots\ldots\ldots \quad (8)$$

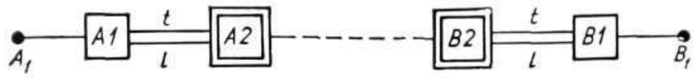
In order to construct the network and junction cables in such a way that the total costs will be as low as possible without exceeding the prescribed maximum values for the reference equivalents, one should obviously select from amongst the pair-values satisfying eq. (7) that pair of values x_1, x_2 which when introduced into eq. (8) will give the lowest figure for the quantity K. This pair of values is said to constitute the economic conductor dimensions for the case in question, see Fig. 3. This case may occur, in a town network, for example. If the junction cables are pupinized, an analogous method may be employed.

Fig. 3 represents an example of a network group of the simplest kind. The same method which was employed in this case to determine the economic conductor dimensions may, however, be adopted in principle for any network group whatever, although the problem naturally becomes more involved for more complicated network group configurations in consequence of the fact that the number of variable conductor dimensions and the number of conditional equations of the same type as eq. (7) are both increased.

Fig. 4 X 6512

Example of two network groups, A and B, connected by a junction cable

The traffic within and between the respective network groups passes over different junction cable bunches l and t with different conductor dimensions.



5. Division of the Junction Cable Traffic into Two Bunches

Let us consider two network groups A and B according to Fig. 4 with network group centres $A2$ and $B2$, connected to a junction line with a positive reference equivalent of 1 neper at the most.

The conductor diameters in the two network groups are assumed to be so selected that the reference equivalent from a subscriber A_1 (B_1) to the trunk exchange $A2$ ($B2$) is less than the maximum value recommended by the CCIF.

The total reference equivalent for a telephone call between the subscribers A_1 and B_1 is thereby less than

$$2.1 + 1 + 1.5 = 4.6 \text{ nepers}$$

which according to the CCIF recommendations is the maximum permissible value for a telephone connection between two subscribers within the same continent.

On the other hand, the reference equivalent for a telephone connection within some of the network groups amounts to a value which is less than $2.1 + 1.5 = 3.6$ nepers, that is to say, for a telephone connection between the network groups it is less by the same amount that the reference equivalent between the network groups $A2$ and $B2$ is greater than zero.

There are scarcely any real reasons why the transmission level for a local call should have a higher value than for a trunk call provided that the latter value gives satisfactory transmission.

The opinion is now generally held that a reference equivalent amounting to the recommended CCIF maximum value of 4.6 nepers is unsatisfactory and there is a general tendency to adhere to a lower value. Hereafter it is assumed that the reference equivalent for a telephone connection between two subscribers in the two network groups A and B lie so far below the recommended maximum value that the transmission level for a trunk call is agreed to be entirely satisfactory. In such circumstances no reason whatever exists for demanding that the reference equivalent for a local call should be better than that for a trunk call.

To obtain the same reference equivalent for calls within the network group as for calls between the groups it is possible, in all register controlled telephone automatic systems at least, to divide the junction cables between the local exchange $A1$ ($B1$) and the network group centre $A2$ ($B2$) into two bunches, one of which l, which may be of smaller dimensions, serves the traffic between subscribers within the same network group, the other t, being employed for traffic between subscribers in different network groups.

Since the amount of traffic between different network groups is usually only a fraction of the traffic within the network group, it is clear that this division of the junction cables into two bunches with different conductor dimensions may lead to a very considerable saving in the installation costs.

The method of dividing the traffic into two bunches may also be adopted with advantage for traffic between different exchanges within one and the same network group so that for traffic with a certain group of exchanges, junction cables of one type l are employed whilst for traffic between different groups of exchanges within the network group conductors of the other type t are employed. The extent to which a division of this kind can be carried must be determined in each particular case.

6. Differentiation of the Conductor Dimensions within the same Exchange Area

In the foregoing it has been tacitly assumed that all cable conductors in one and the same exchange area have the same dimension and that this dimension is based on the length of the longest subscriber line.

In most cases, however, this is uneconomical, particularly for large exchange areas with many subscribers, since subscribers located close to one another can without disadvantage be served by conductors of smaller dimensions.

Let us assume that in order to effect savings, it is desired to employ two different conductor diameters in an exchange area. These can be utilized in the most economical manner if the larger one is allowed to serve the outer parts of the exchange area, the other and smaller one serving the remaining area around the telephone exchange, that is to say, by allowing the two bunches to work in parallel and independently of one another. If on the other hand, the cables with different dimensions are series-connected, the saving that can be effected will be appreciably less, and consequently a method of this kind is not to be recommended.

In so far as the permissible transmission losses in the network are fixed, the conductor dimensions for the outer area are obtained directly by the first-mentioned method. The conductor diameter for the inner area is determined with the help of a distribution curve for the number of pair-metres in the network in such a way that the sum of the costs for the inner and outer areas will be as low as possible.

When making practical calculations it is found that dimensions lying close to one another in the manufacturing series should as a rule be avoided. In the differentiation of the conductor dimensions within an exchange area, therefore, it is usually advisable not to select 0.7 and 0.6 mm but 0.7 and 0.5 or 0.7 and 0.4 mm.

In large networks of considerable extent it may sometimes be found advantageous to divide the network into three bunches with different conductor diameters such as 0.9 and 0.6 and 0.4 mm for example. It should be noted, however, that on practical grounds the number of different conductor dimensions employed in a network should not be too great. The advantages accompanying the economic adjustment of the conductor dimensions in the network and junction cables should always be weighed against the disadvantages entailed by too great a number of cable types as regards the maintenance of an increased stock for example. This applies in particular to small network groups. It may, therefore sometimes be found desirable to change the calculated optimum conductor dimensions somewhat. Such changes, which must, of course, be carried out without neglecting the principles involved in economic dimensioning, usually result in costs which are only slightly in excess of the optimum costs.

7. Junction Cable Network

After the positions and boundaries of the exchanges have been determined and the conductor dimensions for the conductor dimensions of the network and junction cables have been fixed, it will be time to turn one's attention to determining the extent to which mesh form and star form junction cable circuits should be laid. This may prove somewhat troublesome owing to the difficulty in estimating the magnitude of the traffic between separate exchanges in the network group. In new network groups or multi-exchange areas it is advisable for this reason amongst others to construct the junction cable network at the outset with a suitable emphasis on the star form. Only after the area has been extended and traffic calculations can be made it is possible to plan the mesh form circuits in greater detail. This does not, of course, prevent the junction cable circuits in star form from being used from the beginning to connect up a number of exchanges in mesh form. As is well-known, it is economical with a growing subscriber demand to dimension the cables so that they will meet the requirements for a certain time ahead. Thus, a number of cable pairs will already be available from the outset which may be used gratis, so to speak, for the connections in question.

8. Practical Methods

From what has been said above, it will have been realized that the exchange location, boundaries for exchange areas, conductor dimensions in the network

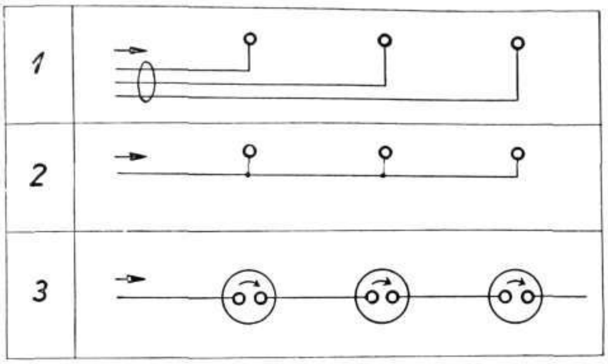


Fig. 5 X 6511

Diagrammatic sketch showing the basic connections in a network system

and junction cables and suitable cable routes are dependent on one another and must therefore be determined simultaneously. It might thus appear that the determination of all these associated factors would be accompanied by certain practical difficulties when it is necessary to lay out a scheme in a concrete instance. These difficulties may be evaded, however, if the previously described methods and results are taken as a guide, the definite calculations being carried out subsequently as a series of progressive approximations, in the following manner.

In the first place the positions of the exchanges and the exchange boundaries are estimated roughly with the help of a map showing the subscriber distribution.

The conductor dimensions in the network and junction cables are then determined provisionally in accordance with the economic principles previously described.

New exchange boundaries corresponding to the assumed exchange positions and the selected conductor dimensions can be fixed subsequently.

New exchange positions corresponding to these new exchange boundaries can then be determined. The method is repeated until the desired degree of accuracy is reached. Finally, a check should be made to ensure that the provisionally selected conductor dimensions are actually the most economical and that the conditions for transmission are satisfied.

II. Types of Installations for Subscribers' Networks

1. Basic Connections

The subscribers' network presents installation problems of a technical nature, especially when it is constructed as a cable network. A cable network of this kind may be constructed in accordance with a number of different methods or systems, which however dissimilar they may appear at first sight, may all be built up with three simple basic connections, namely:

1. star connection
2. teed connection
3. series connection

In the star connection illustrated, at *1* in Fig. 5, each spreading point is connected to its own individual pair in the cable.

In the teed connection, illustrated at *2* in Fig. 5, a cable bunch with an unchanged number of pairs is branched off in such a way that a given pair in the cable can be connected to a subscriber at any one of a given number of spreading points.

In the series connection, finally illustrated at *3* in Fig. 5, a cable route is divided into a number of separate sections with different numbers of pairs, between which cross-connections can be made.

2. The Rigid Network System

In the simplest form of network system, known as the rigid system, star connection is employed exclusively, and therefore, in this system each spreading point in the network is directly connected with a cross-connection in the exchange by its own individual conductors.

This simple system may be employed in districts where it is anticipated that the demand will rapidly reach the saturation point and where the number and positions of subscribers may also be predicted with a high degree of probability. Under these conditions a satisfactory service for the subscribers can be ensured with quite inappreciable reserves and the costs for the network will remain reasonable even when high demands are made on the network's preparedness, that is to say, the possibilities for rapid connection of subscribers.

The greater the uncertainty existing regarding the number and positions of subscribers and the longer the period over which the future growth is likely to extend, the greater will be the reserves it is necessary to lay down in the network to enable the subscribers to be connected up in the same satisfactory manner as before. The cost of the rigid system will then be high and it will be worth while to introduce cable saving devices of one kind or another.

3. Other Types of Installations

Devices of this kind are expensive and a certain distance from the exchange is therefore necessary to render them remunerative. In the vicinity of the exchange only systems provided with equalisation arrangements between the spreading points can compete with the rigid system.

For the objective comparison of the different systems with one another it is necessary to provide a measure by which the possibilities of connecting up subscribers can be assessed. On the assumption that both the subscribers and the subscription periods are distributed purely at random, it is an obvious step for this purpose to start from Erlang's well-known formula for the proportion of lost calls in a fully available group so arranged that any call not finding an idle circuit is lost.

The necessary capacity Q for a spreading point with a mean loading of A subscribers can then be calculated with sufficient accuracy in the same way as the number of junction cable circuits according to eq. (2), that is to say, in accordance with the formula

$$Q = c_1 A + c_2 \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (9)$$

where the constants c_1 and c_2 are dependant upon the prescribed blocking.

If the subscribers are assumed to be distributed in accordance with some other scheme of probability such as Bernouilli's or Poisson's distributions, it is still possible to use a formula of the same type (9) to calculate the capacity of the spreading points with a given blocking or a given disadvantage regarding the connection of the subscribers, defined in some other suitable form. But the constants c_1 and c_2 will then, of course, have other values. If the probability that a subscriber's line will be required at a given position approaches the value, one, that is to say, complete certainty, the constant c_1 will approach the value, one, whilst the constant c_2 will approach the value, zero.

With reference to the foregoing, let us now compare two network systems I and II, see Fig. 6. Both systems are assumed to consist of n spreading points

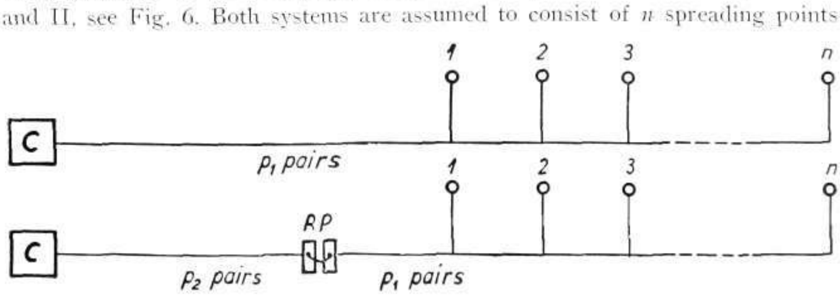


Fig. 6 X 6513

Diagrammatic comparison of two network systems

C telephone exchange
RP reduction point
1, 2 . . . n spreading points

of equal size with individual conductors and with a total capacity of p_1 pairs. In system I all these p_1 pairs are connected to the exchange C, whilst in system II a smaller number of p_2 pairs are connected to the exchange through the reducing point RP at which cross-connections can be made as required. From eq. (9) it will then be seen that the junction cable in system II can be dimensioned for a number of pairs which is less by

$$p_1 - p_2 = (n-1)\,c_2 \text{ pairs} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (10)$$

than the number of pairs in the junction cable for system I, without the disadvantages regarding the connection of subscribers being greater for system II than for system I. Thus, notwithstanding the inevitable costs for the reduction point RP, system II is nevertheless cheaper than system I provided that the junction cable is of sufficient length, that the number of spreading points connected up is large enough and that the knowledge of the individual subscribers' positions is sufficiently incomplete.

Furthermore, in system II, contrary to system I, the cable network can be constructed on both sides of the reduction point quite independently of one another and in close association with the economic period of requirement which is of the order of 20 years, for the outer parts of the network and 5 years for the inner parts, for example. Finally, an unforeseen new demand in the vicinity of the reduction point can be met more cheaply in system II as long, at least, as vacant pairs are available in the junction cable, since it is only necessary to draw out a cable from this point whereas in system I it is necessary to draw out a new cable from the exchange C. A new demand of this kind may, however, also be met by a modification of system I, namely, by tapping the junction cable and connecting the spreading points for the new demand in parallel with a number of those installed at the outset. The same method adopting teed connection may also be employed in system I in the first instance in order to allow the junction cable to be constructed in economic stages.

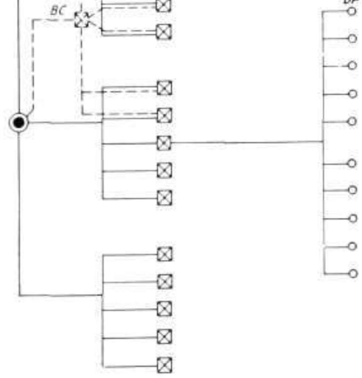
The costs for this modified system I may then be less than for system II on account of the necessary connections and the fact that any cross-connecting devices are less expensive and that they only need to be made when the demand actually exists, that tapping can take place at any point along the junction cable and finally, that the junction cable's capacity is greater from the beginning than in system II. A system I modified in this manner is, however, not quite as simple as system II.

In Figs 7—12 a number of typical network systems are illustrated in principle. Of these, as may be seen, the systems in Fig. 9 and Fig. 12 have special arrangements for obtaining connections between spreading points within a group, either by multiplying the pairs at the different spreading points in accordance

Fig. 7—9

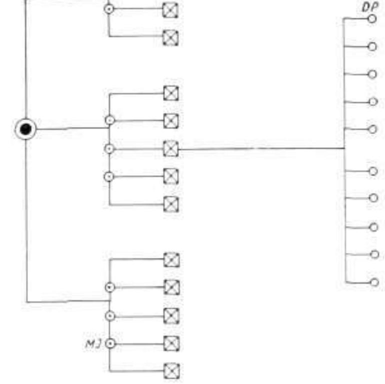
Typical network systems

X 2028
X 2029
X 2030



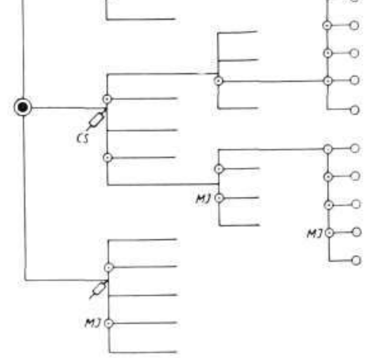
Ericsson's Cabinet System

BC buffer cabinet
DC distribution cabinet
DP distribution point



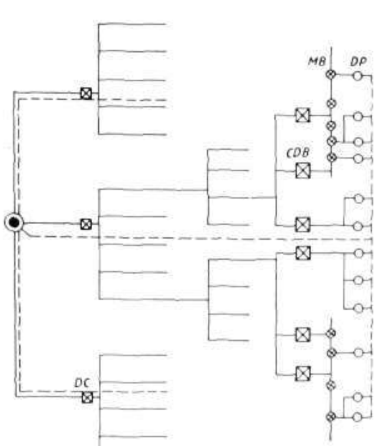
Australian Pillar system

DP distribution point
MJ multiple joint
P pillar



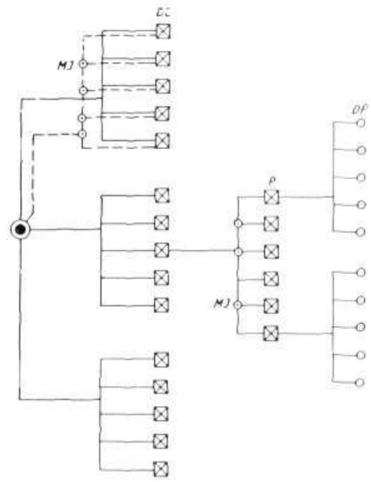
American network system

CS cable stub
DP distribution point
MJ multiple joint



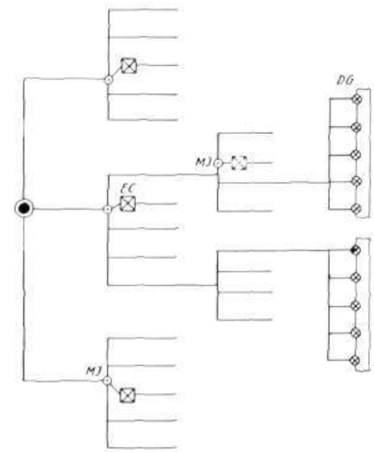
German network system

CDB *distribution points*
DC distribution cabinet
DP spreading point
MB multiple box



English network system

DC distribution cabinet
DP spreading point
MJ multiple joint



Ericsson's HT system

DG distribution group
EC equalization cabinet
MJ *multiple joint*

Fig. 10—12 X 2031 X 2032 X 2033

Typical network systems

with a certain overlapping system or by arranging a number of cable pairs in a loop and through these, providing means for cross-connection between the spreading points.

4. *Planning the Cable Lay-out*

The planning of the cable lay-out within an exchange area is a problem which *in principle* at least is relatively independent of the system on which the network is constructed. The simplest planning is that for the rigid system and a few words will now be devoted to this form.

As a starting point we will take a rigid system which is to be adapted to a square town plan and in which the subscriber lines from the exchange to the telephone apparatus pass through conductor types of three different kinds 1, 2 and 3, such as underground cables, overhead cables and bare wires with the following unit costs:

Conductor system	Unit costs Crs/cable metre	Unit costs Crs/pair-metre
1. Underground cables ..	a_1	b_1
2. Overhead cables	a_2	b_2
3. Bare wires		b_3

$$a_1 > a_2 \qquad b_1 < b_2 < b_3$$

These conductor systems must be laid in the town plan so that they form right-angles with one another, as is shown in Fig. 13.

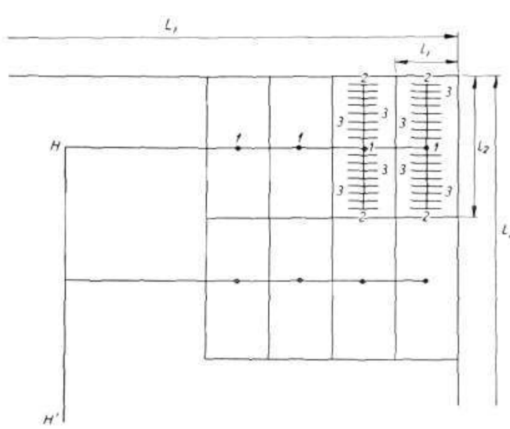


Fig. 13 X 2935

Theoretical lay-out for the rigid network system

The distribution points *1* between the conductor types *1* and *2* should not lie at the centre of the rectangular areas with the sides l_1 and l_2, see Fig. 13, but should be displaced in the direction of the exchange by a distance which can be calculated in the same way as the displacement of a telephone exchange due to the influence of the junction cables, see eq. (5) and Fig. 2. For the same reason the distribution points between systems *2* and *3* must be displaced. The effect of this displacement may be included in the pair-metre costs for systems *2* and *3* and it is thus possible to calculate *as though* the distribution points were located at the centres of the respective areas served.

Let α be the subscriber density, that is to say, the number of subscribers per unit of surface and assume further for the sake of simplicity that all conductor systems are constructed for a capacity that exactly corresponds to the number of subscribers in the area which, both as regards location and number, remain unchanged in the course of time.

The approximate costs per surface unit, and insofar as they are dependent upon l_1 and l_2, will then be

$$\frac{a_1}{l_2} + \frac{a_2}{l_1} + \frac{1}{4} b_2 l_2 \alpha + \frac{1}{4} b_3 l_1 \alpha \quad \ldots\ldots\ldots\ldots\ldots \quad (11)$$

from which expression it is found that the minimum costs are obtained when

$$\alpha l_1^2 = \frac{4 a_2}{b_3}, \quad \alpha l_2^2 = \frac{4 a_1}{b_2} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (12)$$

As will be seen, each of these expressions gives the number of subscribers within a square area having sides corresponding to one or the other of the distances l_1 and l_2 sought. As soon as the constants in the right-hand term of the expression (12) are known it is possible, therefore, to sketch out the cable lay-out directly on the building plan, merely by drawing squares which contain $\frac{4 a_2}{a_3}$ or $\frac{4 a_1}{b_2}$ subscribers.

From the expression (12) it also follows that

$$\frac{l_2}{l_1} = \sqrt{\frac{a_1}{a_2} \cdot \frac{b_3}{b_2}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (13)$$

Since $a_1 > a_2$ and $b_3 > b_2$, it is clear that $\frac{l_2}{l_1} > 1$.

Thus, the district l_1, l_2 should be long and narrow, and so located that the longest side l_2 is at right-angles to the underground cable.

The number of subscribers n_2 within the area l_1, l_2 is found to be

$$n_2 = \alpha l_1 l_2 = 4 \sqrt{\frac{a_1 a_2}{b_2 b_3}} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (14)$$

i. e. it is independent of the subscriber density.

Analogous expressions can be derived by starting instead from the assumption that the subscriber lines pass through a number of different conductor types, such as lead-covered cables, armoured cables, overhead cables and bare wires. The rectangular areas into which the exchange area may be divided in the same way as above, should, in accordance with the same principle, always be located at right-angles to one another and should each include a number of subscribers which can be calculated from the unit costs for the different types of conductors.

If it is desired to carry out calculations of this kind for more complicated systems and more realistic conditions as regards the possibilities of utilizing the network, it is necessary amongst other things to take into consideration the costs for the spreading points and distribution cabinets and other saving connections, and the fact that a cable bunch can be utilized to better advantage, the greater the number of pairs it contains, and that with a growing demand, the installations will be constructed in suitable economic stages.

The Alpha Three-way Wall Socket

E JENSEN, SIEVERTS KABELVERK, SUNDBYBERG

U.D.C. 621.316.541.11

Wall sockets employed hitherto have generally speaking, been of the one-way type, although a two-way type has also been used more recently to some extent. Thus, when it was desired to connect a number of apparatus to the same wall socket, it was necessary to employ a branch connector which both from the point of view of appearance and safety must be characterized as undesirable. As cases frequently arise, especially in private households, in which a three-way socket is called for, Alpha has produced a socket of this type and placed it on the market recently.

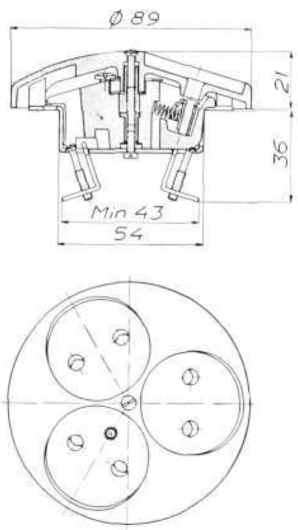


Fig. 1 X 4694

Cross-section and dimension sketch of a hree-way wall socket

The new three-way wall socket is manufactured for flush mounting on walls, both forms being supplied with a brown or white finish. The wall socket for box mounting fits the various types of boxes on the market. Thus, it may be fixed by means of claws in the pasteboard insulation of boxes for the Bergmann system or by two screws in boxes adapted for this method of fixing. The wall socket for surface mounting is substantially the same as that for box mounting but it is provided with a plate with two holes for fixing it.

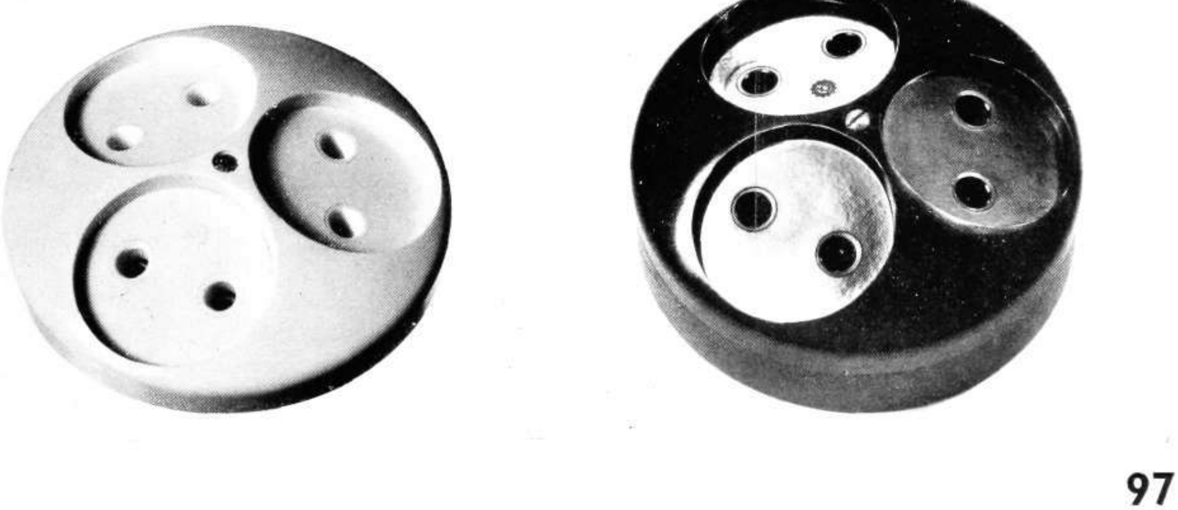
Since it is important, as regards the current transmission and prevention of radio interference, that there should be no play at the contacts, special attention has been devoted to the form of the contact sleeves. These should be capable of receiving a 4 mm split contact pin as well as a 5 mm solid pin, and must therefore be resilient. The sleeves consequently consist of a fixed and a moving part, the latter being under the action of a strong spiral spring. This spring is of special steel which retains its resilient properties throughout the life of the wall socket.

The practical advantages of the new socket will be obvious. Furthermore, as the difference in price between a three-way and two-way or even a one-way socket can be regarded as insignificant, the three-way wall socket is likely to replace single- and two-way types on a large scale in new buildings. Similarly, where a single- or two-way socket is found inadequate to meet the requirements, it is preferable to replace it by a three-way socket, rather than to continue using devices of a more or less temporary and hazardous nature.

Fig. 2 X 7574

Three-way wall socket

Left: for flush mounting, right: for surface mounting



Vehicle-actuated Road Traffic Signals

S EKWALL, L M ERICSSONS SIGNAL AB, STOCKHOLM

U.D.C. 656.054

Vehicle-actuated traffic signal installations have hitherto been equipped with mechanical or pneumatic vehicle detectors in which contact is established by the weight of the vehicle *in its passage over the detector.* L M Ericssons *Signalaktiebolag has now* designed an entirely new form of vehicle detector without any moving parts and with which contact between the vehicle and detector is established electromagnetically when the vehicle passes over the detector.

The first installation equipped with these new detectors was carried out for trial purposes at the street intersection Götgatan—Högbergsgatan in Stockholm, and was placed in service in April 1949. At the present time orders for seven similar installations are in hand for Stockholm City, four for Västerås and one for Helsingfors. A general description of an installation for a street intersection, and the apparatus of which it is comprised is given below.

Construction of the Installation

A vehicle-actuated road traffic signalling installation consists of the following units:

light signals,

vehicle detectors for registering arriving vehicles,

control apparatus for regulating the light signals in accordance with the vehicles registering impulses,

cables for the connection of the light signals and detectors to the control apparatus.

Fig. 1 shows a plan of a street intersection, from which the location of the light signals, vehicle detectors and control apparatus may be seen. Three light signals are usually installed for each direction of the traffic, such as *1 A*, *2 A* and *3 A*. Signal *1 A* is placed immediately beside the stop line, and is the signal which controls the traffic at the street intersection. Signal *2 A* is a repeat-signal for *1 A*, located on the opposite side. This signal is provided primarily for the vehicles that have stopped directly on a level with the stop line at *1 A* and possibly in the righthand row of vehicles from which position it may be difficult to observe the signal *1 A*. On a level with the signal *2 A*, but to the right of the street intersection, a further repeat-signal *3 A* is placed which serves as a guide for pedestrians.

The vehicle detectors *DA 1* and *DA 2* serve for the registration of vehicles in the A-street whilst *DB 1* and *DB 2* register the vehicles in the B-street. For the purpose of registering tramcars in the A-street, two circular detectors are located on a level with *DA 1* and *DA 2*, and are connected to *DA 1* and *DA 2* respectively. All detectors are placed approximately 30 metres in front of the respective stop lines. The distance is calculated in such a way that in the case of a vehicle passing a detector at a maximum speed of 25 kms/hr (15.5 miles/hr), the corresponding light signal for which shows a red light, the signal will have time to change to green before the vehicle reaches the stop line. It is here assumed that the traffic flow in the crossing street does not prevent the changing of the signal.

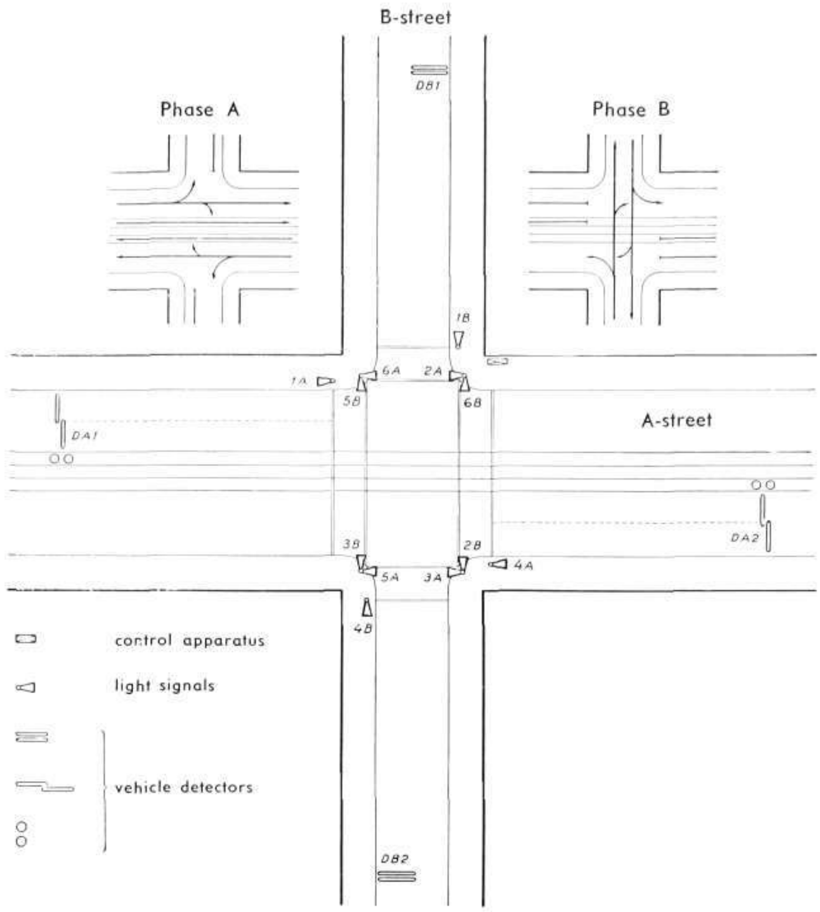


Fig. 1
Plan of a simple street crossing

X 6485

The control apparatus is either mounted so that it stands free or against a house wall, and preferably so that clear vision is obtained from its position, over the street intersection.

The cables for the light signals and detectors consist of armoured lead-covered cable laid in the street or the footway, depending upon which cable route is found the more suitable in each particular instance.

Light Signals

The light signals for the vehicle traffic consist of one or more signal lanterns mounted on tubular masts by means of brackets. The lantern casing itself is constructed of aluminium in one unit with three light apertures, namely, red, amber and green. Where a signal applies to one direction of travel only, it is provided with a green light aperture with an arrow indicating the permissible direction of travel. Each light is fitted with a glass reflector and a 40 or 60 watt lamp.

The signal lanterns can be individually adjusted in relation to the street level, thus enabling the light beam to be adjusted both in a vertical and a horizontal direction. Fig. 2 shows a light signal with two signal lanterns.

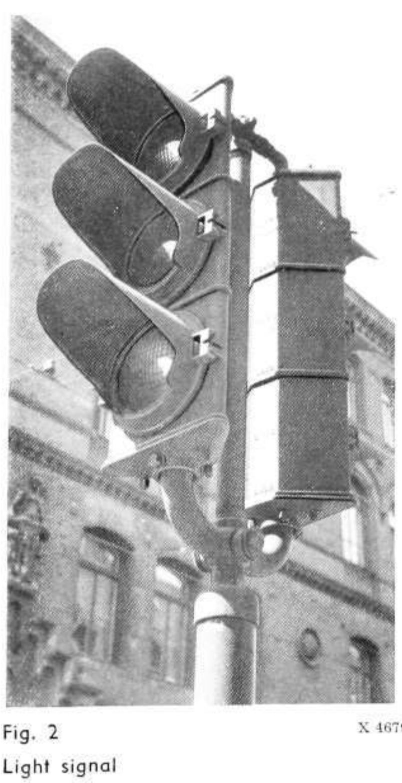


Fig. 2
Light signal

X 4679

The light signals for pedestrians consist of one or more signal lanterns mounted on the tubular mast. In these signals also, the lantern casing consists of aluminium and they are constructed as a single unit, usually with two light apertures. One of these is provided with green text, for example »Go Now» which lights up when pedestrians have the right to use the crossing which it is the purpose of the signal to protect. The other light aperture is white and is located directly below the previously mentioned one. The white light is shown immediately before the text »Go Now» is extinguished. This white light is intended in the first case as an indication of an approaching change of signal, and in the latter case after the text »Go Now» has been extinguished, as an indication to pedestrians that the signal is in operation. (In a number of instances the pedestrian signals are only connected up during certain times of the day.) The lamps in the light apertures are either 40 or 60 W types.

In addition to the two forms of signals mentioned above, special signals are also employed for tramways, etc.

Vehicle Detectors

A vehicle detector consists of two wire-wound impulse coils which are placed below the street surface and electrically balanced against one another. When a vehicle passes over the detector a certain differential current is set up which after passing through an amplifier, actuates relays in the control apparatus.

Where the available street space does not allow the division of the traffic into rows so that vehicles coming from the direction of the street intersection also pass over the detectors, the latter are constructed in a single-acting form only. This implies that the impulse for changing the signals is only generated by vehicles passing over the detectors in the direction towards the corresponding light signal.

The detectors *DA 1* and *DA 2* in Fig. 1 are double-acting, whereas *DB 1* and *DB 2* are single-acting.

The detectors for tramcars consist of circular impulse coils which are laid between the rails, see Fig. 3. No additional equipment is required on the tramcars themselves to enable them to actuate the detectors.

The coils are placed on a concrete foundation and are then cast in asphalt. Fig. 4 shows the concrete foundation for a coil on the left, whilst in the centre the coil is seen placed in position ready for casting the asphalt. Finally, the righthand illustration shows the coil cast in position, after which it is only necessary to complete the laying of the road surface above the coil.

Fig. 3
Detectors for tramcars
laid between the rails

X 6509

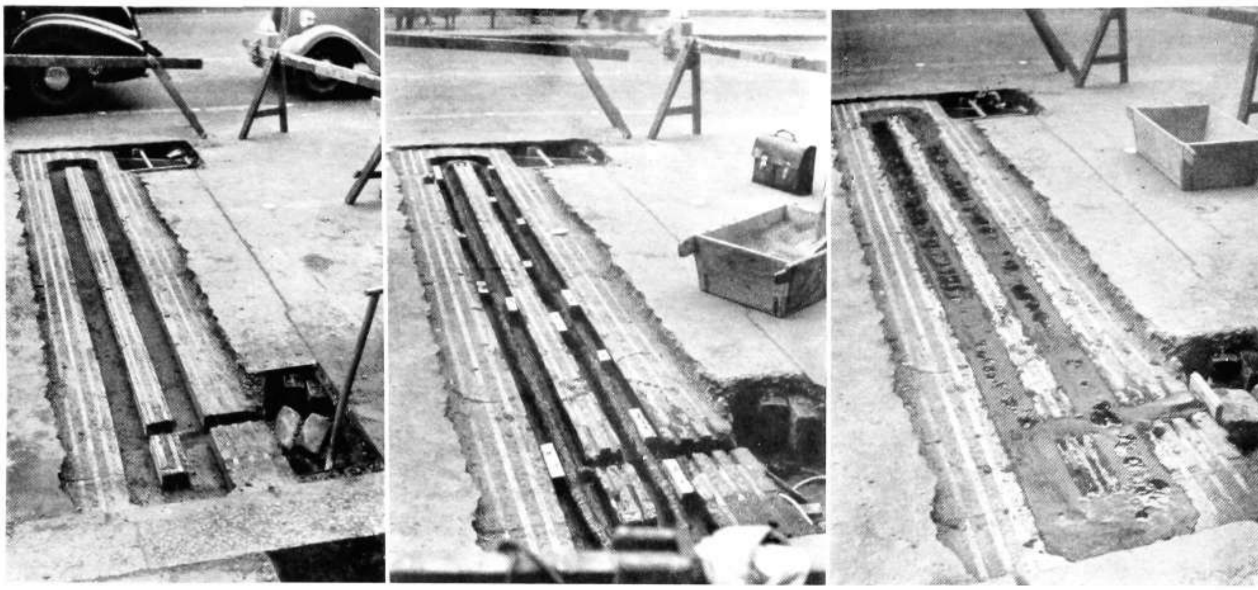


Fig. 4 X 7569

Laying and casting in the impulse coil for a vehicle detector

Left: concrete foundation ready-cast, centre: coil laid in position, right: coil cast in position.

Control Apparatus

Fig. 5 shows the control apparatus which is assembled in two cabinets mounted on a concrete foundation and either placed back to back or side by side. One cabinet, the control cabinet, contains the controlling gear and the relays, etc., for the signals, whilst the other, the amplifying cabinet, contains the amplifier and auxiliary equipment for the detectors.

In the lower part of each cabinet a limited space is available for cable boxes for the incoming and outgoing cables. The conductors from the cable boxes are connected to terminal panels located close to the boxes. The cable boxes as well as the relays and amplifiers are accessible from the fronts of the cabinets, but only to the service staff who are provided with special keys.

In the upper part of the cabinet a special compartment is reserved for the equipment which must be accessible to the traffic police. This compartment is closed by a door with a lock opened by a normal key for fire alarm boxes.

The relays and amplifiers are mounted in units with connecting devices of the plug-in type. These units can therefore be exchanged very quickly. Each amplifier has a spare set of electron valves which are connected up automatically in

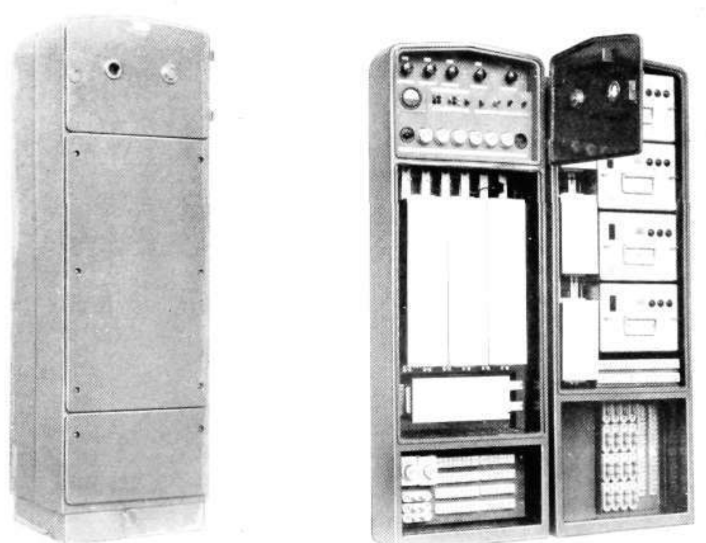


Fig. 5 X 6510

Control apparatus

assembled in two cabinets, left: mounted back to back, right: control cabinet and amplifier cabinet open the event of a valve burning out, so that the valves need not be replaced immediately. A lamp in the control apparatus indicates when the spare valve set is functioning.

The control cabinet is equipped with a press-button for controlling the signals manually. On pressing this button the signals will be changed. The press-button can be actuated from the outside of the cabinet even when the door is closed. No change of signals can be effected by pressing the button, however, unless the control apparatus has been switched over for manual operation.

In its standard form the control apparatus is designed for two or three traffic phases with an additional arrangement for a pedestrian phase if required.

For the signal-changing system adopted in Sweden the 2-phase control apparatus is constructed for the following signal periods

Period	*Traffic Phase A*	*Traffic Phase B*
1	Green	Red
2	Green + amber	Red
3	Red	Red
4	Red	Red + amber
5	Red	Green
6	Red	Green + amber
7	Red	Red
8	Red + amber	Red

Where a pedestrian phase is employed, a pedestrian period is inserted between 3 and 4 and possibly between 7 and 8 also. The pedestrian period can be switched on and off by a switch mounted on the operating panel of the control apparatus.

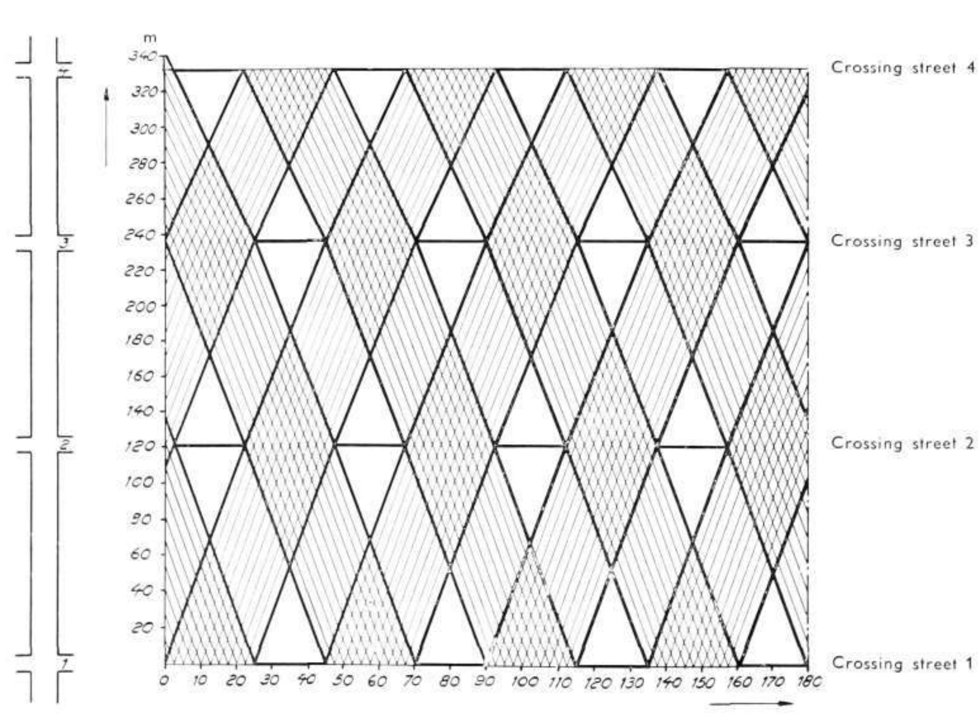
The control apparatus can also be constructed for other signal-changing systems.

Functioning of the Installation

The light signals are controlled by the traffic through the vehicle detectors. When a vehicle passes over a detector an impulse is generated which is transmitted through an amplifier to the relay panel where it is registered either as an indication calling for a change of signal or as a demand to retain the right of way in the traffic phase concerned. If the registration calls for a change of

Fig. 6
Traffic diagram

X 6486



signal from a red to a green light, this change will take place immediately provided that registrations calling for the retention of the right of way in the crossing street are not being received. On the other hand, if the green light lights up in the street in which a vehicle is calling for the retention of the right of way, this latter vehicle registration will result in a prolongation of the green period so that the vehicle will have time to pass the stop line. No street can retain its green period beyond a given maximum time which can be adjusted for each street separately. The green light will nevertheless continue to show in a street when no registration calling for a change of signal has been received from the crossing street. From the foregoing it will be realised that vehicles in one street cannot interrupt a consecutive flow of traffic in the other street, whilst on the other hand, a consecutive flow of traffic in one direction cannot delay the traffic in the crossing street for a time exceeding the maximum period for which adjustment has been made in advance. A vehicle can interrupt a thinning stream of traffic in the other street, however.

The time within which impulses should be received from vehicles in order to retain the right of way in the street under such conditions can be adjusted by means of knobs located in the control apparatus. Adjustment is made for this period, as for the maximum period, when the signal installation is placed in service. The knobs are accessible for any readjustment of the times which may be found necessary.

When changing from a green light in one street to a green light in the other street, the vehicles are allowed a certain clearing period so that the street intersection will be cleared of vehicles from the immediately preceding traffic phase. During the time all signals will first show a red light, followed by a red + amber light in the previously »red» street. The period during which all signals show a red light is arranged in accordance with the width of the street intersection, etc., and is likewise adjustable.

On changing from red to green light in a street, a green period is allowed for the waiting vehicles which is dependant upon the number of vehicles registered.

If it is desired to equip the installation with pedestrian signals, the control apparatus is supplemented by relays for this purpose.

Where two or more street intersections are so located, along a main street for example, that it is necessary to coordinate their installations, the whole of the controlling apparatus is connected to a common time distributor mounted in one of the cabinets which is referred to as the master apparatus. The time distributor then transmits current impulses to the different controlling apparatus at such time intervals that the traffic in the main street is progressively signalled in one direction or the other or in both directions simultaneously where the distance between the intersecting streets permits. Switching over for varying speeds of travel in the main street at different times of the day can be carried out automatically in dependence upon the traffic density.

Fig. 6 shows a traffic diagram for progressive signalling in both directions along a main street.

L M Ericsson at the St Eriks Fair

Most of the sections in the L M Ericsson group's Swedish undertaking participated in a common exhibit at the 8th St Eriks Fair which was held in Stockholm this year at the beginning of September. At this fair, which was the greatest hitherto held in Stockholm, some 50 000 articles were shown by approximately 1 700 exhibitors from 19 different nations.

On L M Ericssons stand, located in the recently erected C-Hall, telephone equipment, telesignalling apparatus and new forms of wires and cables were exhibited. Great interest was aroused in the manager's telephone-, intercom-telephone and domestic telephone installations amongst other things, as well as the telesignalling material, including the staff locator which was described in the previous number of this journal. In addition to electricity meters and electric measuring instruments, L M Ericssons Mätinstrument AB also exhibited balancing machines. The new type which is intended for balancing motor car wheels and is also described in the Ericsson Review No 2, attracted considerable attention. The exhibit of the Svenska Radio Aktiebolaget included an echo-sounding equipment and a radio link connection whilst AB Alpha showed a press for plastic materials of their own construction, material testing machines and electrical installation material. New types of electric capacitors were shown by AB Rifa.

U.D.C. 542.1
621.317.2

NORDELL, R: *Sieverts Kabelverk's Laboratories.* Ericsson Review 27 (1950) No. 3 pp. 70—76.

Description of the laboratories installed at Sieverts Kabelverk in connection with the firm's building extensions. The materials laboratory. Research laboratory for power engineering. Teletechnical research laboratory. The other laboratories; test rooms of the rubber-covered conductor factory, the installation department and the cable and capacitor factories.

U.D.C. 621.314.6:621.391
621.314.6:621.395.72

BERGSTRÖM, H: *The Ericsson Type BMN Battery Eliminators.* Ericsson Review 27 (1950) No. 3 pp. 77—83.

In order to meet the growing demand for battery eliminators for small telephone- and telesignalling installations Telefonaktiebolaget L M Ericsson has designed a new series of battery eliminators, type BMN. The principle of the design is described in the article and electrical data are given for the series of sets.

U.D.C. 621.395.74

RAPP, Y: *On the Planning of Networks for Telephone Plants.* Ericsson Review 27 (1950) No. 3 pp. 84—96.

Summary of the viewpoints advanced in the author's more comprehensive paper "The Economic Optimum in Urban Telephone Network Problems" published in Ericsson Technics No. 49.

I. General principles for the economic optimum in network construction. Number of exchanges. — Extent of exchange areas. — Location of exchanges and exchange boundaries. — Economic conductor dimensions. — Division of junction cable traffic into two bunches. — Differentiation of conductor dimensions within the same exchange area. — Junction cable network. — Practical methods.

II. Types of installations for the subscriber network. Basic connections. — The rigid network system. — Other types of installations. — Planning the cable routes.

U.D.C. 621.316.541.11

EKWALL, S: *Vehicle-actuated Road Traffic Signals.* Ericsson Review 27 (1950) No. 3 pp. 98—103.

L M Ericssons Signalaktiebolag has designed an entirely new vehicle detector without moving parts, with which contact is established between the vehicle and the detector by electromagnetic means when the vehicle passes over the detector. The article gives a general description of an installation in accordance with this system for a simple street intersection, together with particulars of the apparatus included in the installation.

U.D.C. 656.053

JENSEN, E: *Alpha Three-way Wall Socket.* Ericsson Review 27 (1950) No. 3 p. 97

Brief illustrated description of the three-way wall socket manufactured by AB Alpha.

The Ericsson Group

Associated and Cooperating Enterprises

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Cía Entrerriana de Teléfonos S.A.	*Buenos Aires*, Peru 263
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No 4
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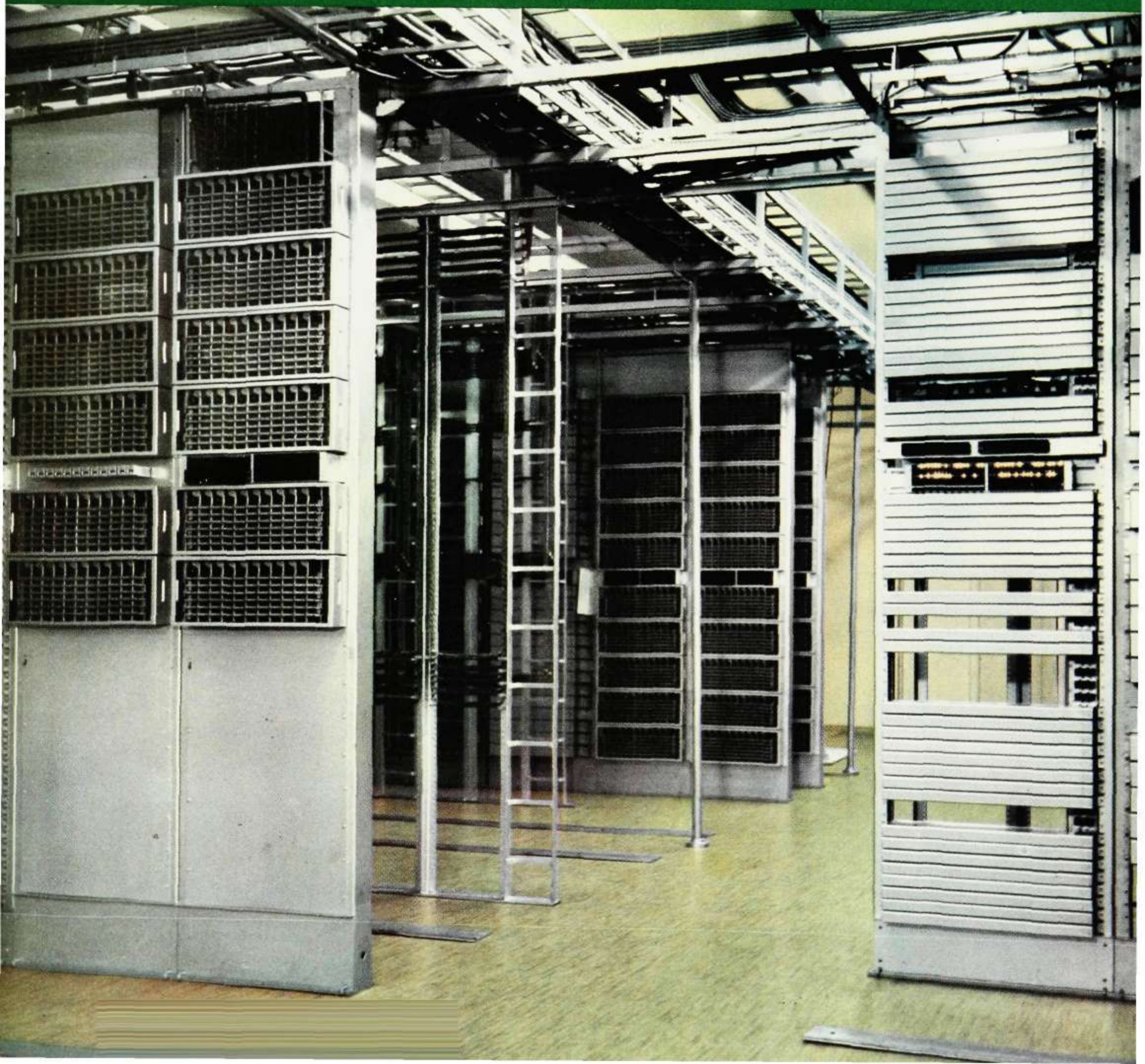

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CONTENTS

On cover: Interior of the automatic telephone exchange Sörnäs in Helsinki carried out in accordance with the L M Ericsson by-path system with crossbar switches.

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The LM Ericsson Crossbar Switch System in Helsinki

DR S A KARLSSON, THE HELSINKI TELEPHONE SOCIETY, HELSINKI

U. D. C. 621.395.344

At the end of the war the Helsinki network group was exclusively composed of automatic exchanges, based on the step by step system, with a capacity of approximately 65 000 numbers. In spite of this it was decided to carry out the required extensions in accordance with the LM Ericsson by-path system with crossbar switches. The author attributes this decision to the superior essential features of the new system, describes the principles of the system and gives an account of operating results obtained so far and the extension schemes which have later been decided upon.

All telephone calls in and around Helsinki are carried out over automatic exchanges. In the centre of the town there are exchanges at Centrum, Tölö and Sörnäs with 31 000, 15 200 and 6 800 numbers. To these exchanges are connected 9 end exchanges containing a total of 7 300 numbers, see Fig. 1. The Helsinki network group covers in addition some 40 automatic rural exchanges for approximately 5 000 numbers.

The exchanges, all according to the Siemens and Halske step by step system, were practically without number reserves already during the later phases of the war. Material for this system could, however, not be obtained at that time and it was necessary to decide on some other system, which was readily available.

The new system should, as a primary condition, operate efficiently and economically with the existing Siemens exchanges. In the first place it seemed as if another step by step system would best meet this condition. In spite of this such a system was not ordered for the extensions of the Siemens exchanges in Helsinki, but the crossbar switch system according to the by path principle offered by L M Ericsson. The reasons for this were in the main:

1) *The superior contact performance in the crossbar switch.* Experience has shown, that non-precious sliding contacts are not quite satisfactory, and that selectors with such contacts are subject to rattle and require expensive main-

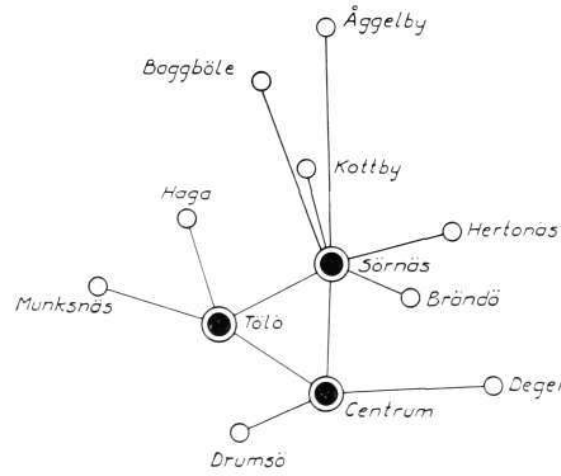


Fig. 1 X 6536
The telephone exchanges in Helsinki

tenance. In the crossbar switch twin silver contacts are used, the contact is equal to that in relay spring sets, which according to experience are free from rattle and do not require appreciable maintenance.

2) *Absence of selector cords.* The selector cords require expensive maintenance and give rise to rattle and faults difficult to trace.

3) *Small magnet load.* The high power and current required to operate the selector magnets in the step by step system causes substantial contact wear and expensive maintenance.

4) *Reduced selector maintenance.* The operating forces and movements in the crossbar switch are small. This results in reduced wear and adjustment work as compared with the intricate mechanismus in the step by step and power-driven systems.

5) *Extremely fast operation.* The slow operation of the step by step selector limits the number of rotary steps to 10, which means an inefficient utilization of the connecting elements, as the availability of the gradings is limited to 10. The fast operation of the crossbar switch makes it possible to form large well utilized element groups. The fast operation of the crossbar switch enables the use of registers and partial registers for direct operation, combining the advantages of the register systems and the direct operation systems.

The crossbar switch appears, therefore, to meet the principal conditions on selectors for fully automatic long distance telephony, whereas the step by step selector can fulfil these requirements only to a very limited extent.

The crossbar switch exchange Sörnäs in Helsinki will be described below. The Sörnäs exchange is the first stage in an extensive scheme of exchanges for Helsinki and is the first crossbar switch exchange put into service based on the L M Ericsson by-path system.

Circuit Lay-out

The system in Helsinki has been devised so as to co-operate efficiently with the Siemens exchanges. This means that calls from and to the Siemens exchanges do not require matching repeaters. The operation voltage 60 V is, therefore, maintained also on the new system.

The subscribers are divided into 1 000-groups for finders and final selectors (*SL*, Fig. 2). The selectors form two link systems, one for outgoing and one for incoming traffic. The outgoing link system consists of selector stages A and B and the incoming link system of stages A, B, C and D. The A-stage is consequently common for incoming and outgoing traffic. The subscriber group has in addition a common marker *M*, 10 registers *R*, 60 incoming »connector» circuits *LKR* and 60 outgoing finder circuits *SR*. Six incoming connector circuits are connected to one register. One connector circuit only can be connected to the register at one time, and the remaining free connecting circuits belonging to the register are blocked during the engaged period of the register. The marker selects and marks the connection routes for incoming and outgoing traffic. The subscriber's number in the 1 000 group is marked in the marker by 10 relays for the unit, 10 for the ten digit and 10 for the hundred digit. For outgoing calls the subscriber's line relay *LR* identifies the subscriber's number. By means of a translator (identifier) in the marker the unit, tens and hundreds relays are operated corresponding to the subscriber's number. The marker is then selecting a free connection route from the marked subscriber's line to a free outgoing junction over a by-path circuit in the marker, whereupon the marked actual connection is established.

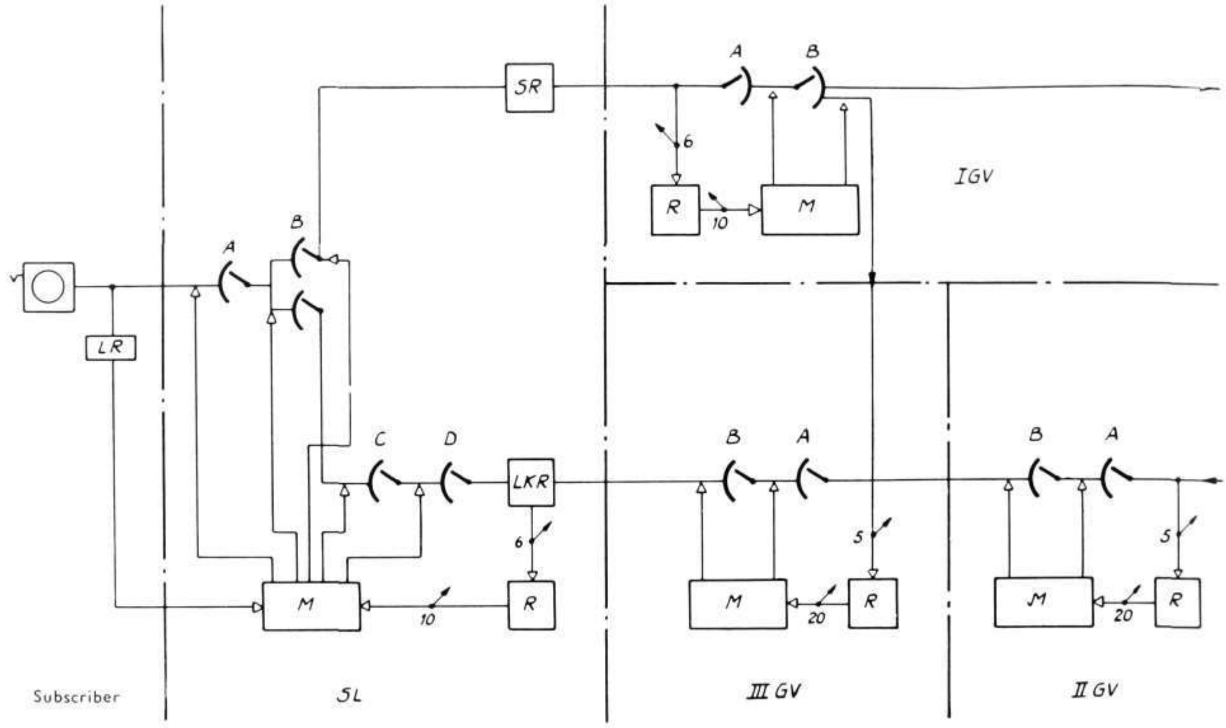


Fig. 2

X 7575

Skeleton diagram of finders and final selectors (SL) and group selectors (GV)

When the actual connection is established the marker is released and connection is obtained by means of the vertical unit magnets in the A- and B-stages. For an incoming call a connector circuit *LKR* and corresponding register *R* is engaged. The register receives the three last digits in the dialled number, which are transferred to the unit, tens and hundreds relays in the marker. The marker then marks, through a by-path circuit, a free connection between the connector circuit engaged and the subscriber corresponding to the number dialled. The marked route is established and the marker and the register are released. The connection is held by the vertical unit magnets in the A-, B-, C- and D-stages. The total operating time for the marker is 350 ms approximately.

The outgoing junction is connected over an outgoing finder circuit *SR* to a first group selector *I GV*. Six outgoing finder circuits *SR* are connected to one register *R* in *I GV*. Ten registers are combined with one marker *M* which, therefore, is common to 60 *I GV*. The group selector consists of two stages A and B. The outgoing finder circuit feeds the microphone of the A-subscriber, serves as impulse repeater, checks the call metering etc. *I GV* is operated with one or two digits in 10 decades or traffic channels. The 10 two-digit codes all start with the same figure, at Sörnäs figure 7. The 9 one-digit codes are made up of the remaining first figures. The register *R* for *I GV* receives the code and sets the marker, which connects the call to a free outlet in the required direction. If one of the one digit routes is dialled, connection takes place immediately on receipt of the impulse train. If a two-digit route is dialled, the register receives both figures. When the second dial train is completed, connection takes place in the required direction. At Sörnäs exchange the two-digit routes are internal. In this way one group selector stage is eliminated for these routes.

For internal calls in Sörnäs a third group selector *III GV* is thus directly taken from the *I GV*. The *III GV* is fundamentally similar to *I GV* and as *I GV* it may be operated by one or two digits. At Sörnäs exchange, however, one digit operation only is used and the *III GV* works in the same way as a Siemens *III GV* which it may replace. Five incoming lines have a common register *R*, and 20 registers are connected to a common marker *M*, which consequently serves 100 lines or group selectors.

The incoming traffic from other exchanges is received by a second group selector *II GV* which is identical with *III GV*.

Incoming lines from other exchanges and outgoing lines to other exchanges end up in either Siemens exchanges or crossbar switch exchanges. The two systems are thus co-operating without matching repeater equipment.

The Marker Principle

As follows from the plan, the system consists of *GV*-units and *SL*-units with markers and registers. To give an idea of the function of the marker and the by-path principle employed, the fundamentals of a group selector marker will be outlined by means of simplified general diagrams.

Fig. 3 shows a grouping plan for one *II GV* unit. The A- and B-stages each consist of 10 crossbar switches, referred to as *1 A—10 A* and *1 B—10 B* respectively. The switch consists of 10 vertical units with 2 groups of 10 outlets designated *I, 1—10* and *II, 1—10*. In the A-stage the outlets are multipled over two switches. There are consequently $5 \times 20 = 100$ connecting links between the A- and the B-stage. In the B-stage the outlets from each vertical unit are multipled over 5 switches resulting in $20 \times 20 = 400$ outlets. These 400 outlets may be grouped to vias in different ways. In the Sörnäs *II GV* and *III GV*, the outlets are grouped in 10 vias with 40 outlets per via. Each via will contain 2 of the decades 1—20 shown in the plan. The 20 outlets in

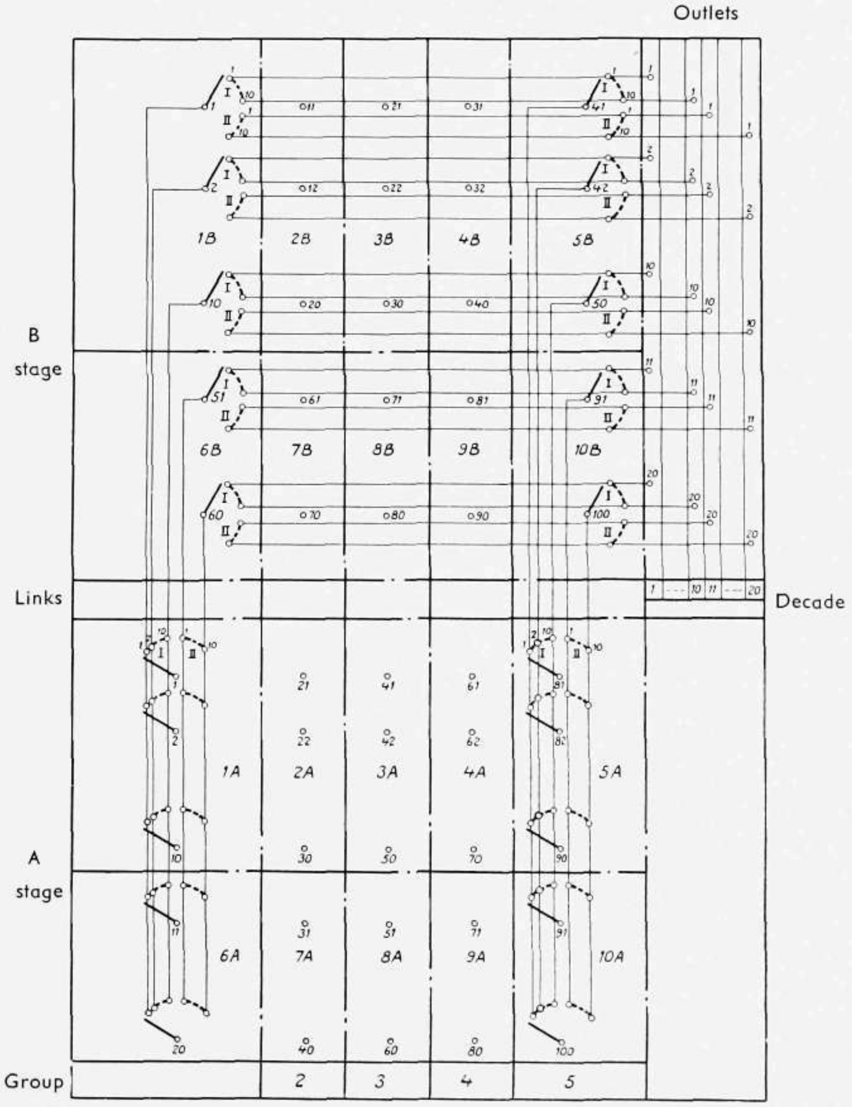


Fig. 3
Grouping plan for II GV-unit

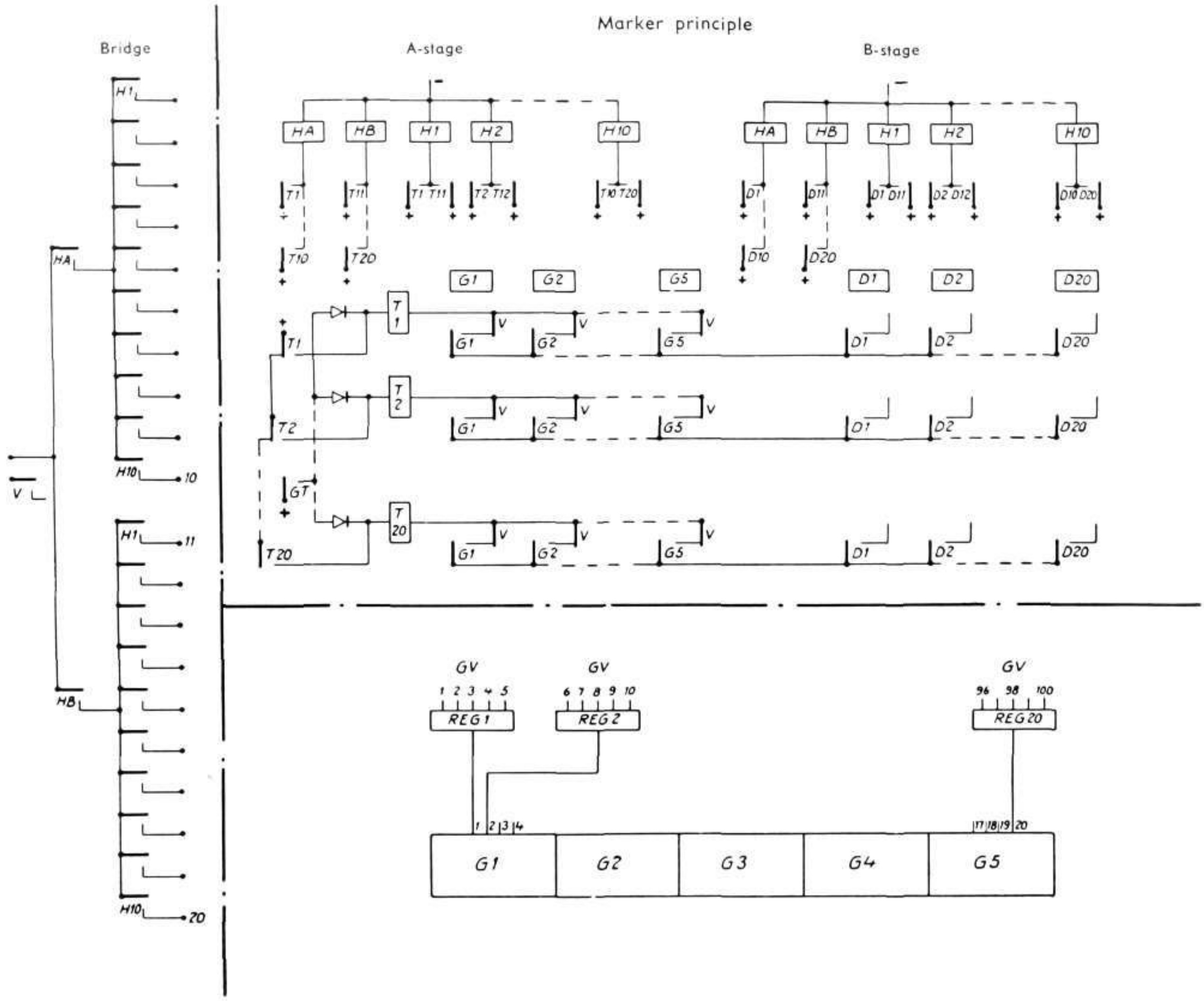


Fig. 4 X 7577

Marker principle for group selector

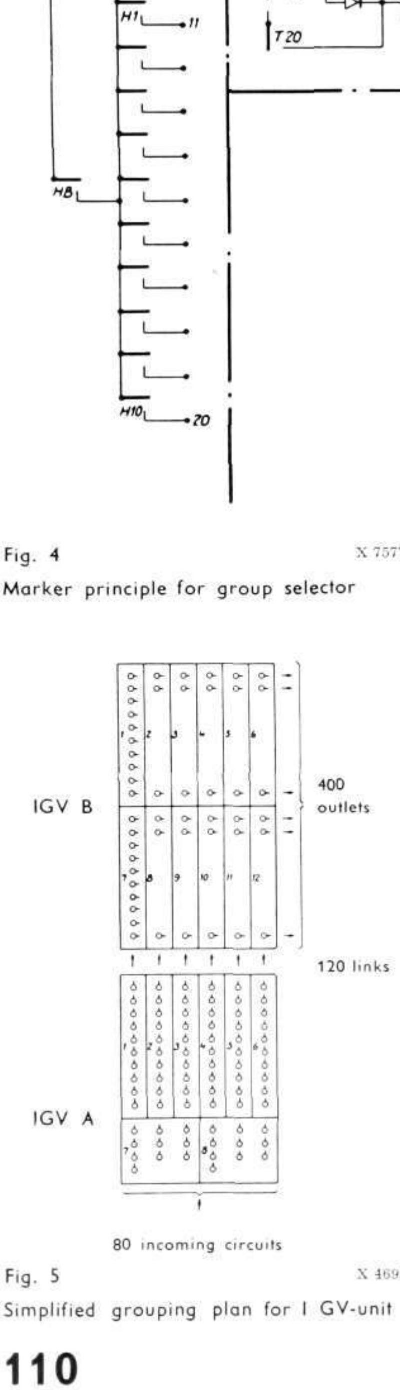


Fig. 5 X 4695

Simplified grouping plan for I GV-unit

each decade are distributed over the 20 multiples in the B-stage. In Fig. 3 each decade is represented by a column stating the numbers of the outlets. The incoming lines are connected to A-vertical units and are numbered in 1—100. To increase the reliability the switches, registers and the marker are devided into 5 groups. The grouping of the switches follows from Fig. 3 which illustrates that a call will only engage elements in the same group.

Fig. 4 shows a vertical unit with 20 outlets, as well as the grouping and the marker principle. The unit contains 12 contact groups. Ten of these groups are duplicated, indicated in the figure as two groups of 10 contacts designated *H 1—H 10*. Two of the groups are single groups referred to as *HA* and *HB*. The 10 duplicated groups are selected by bar magnets *H 1—H 10* and the single groups by bar magnets *HA* and *HB*. From the figure it will be seen, that the vertical unit selects a certain outlet through operation of *HA* or *HB* and one of magnets *H 1—H 10*. The outlets in the unit is consequently marked by the bar magnets which are, therefore, also termed selecting magnets. Each vertical unit has in addition a contact group *V*, which is operated by the unit magnet.

Five group selectors have a common register and four registers belong to the same group. Each of the 5 groups designated *G 1—G 5*, therefore, contain 4 registers and 20 *GV*.

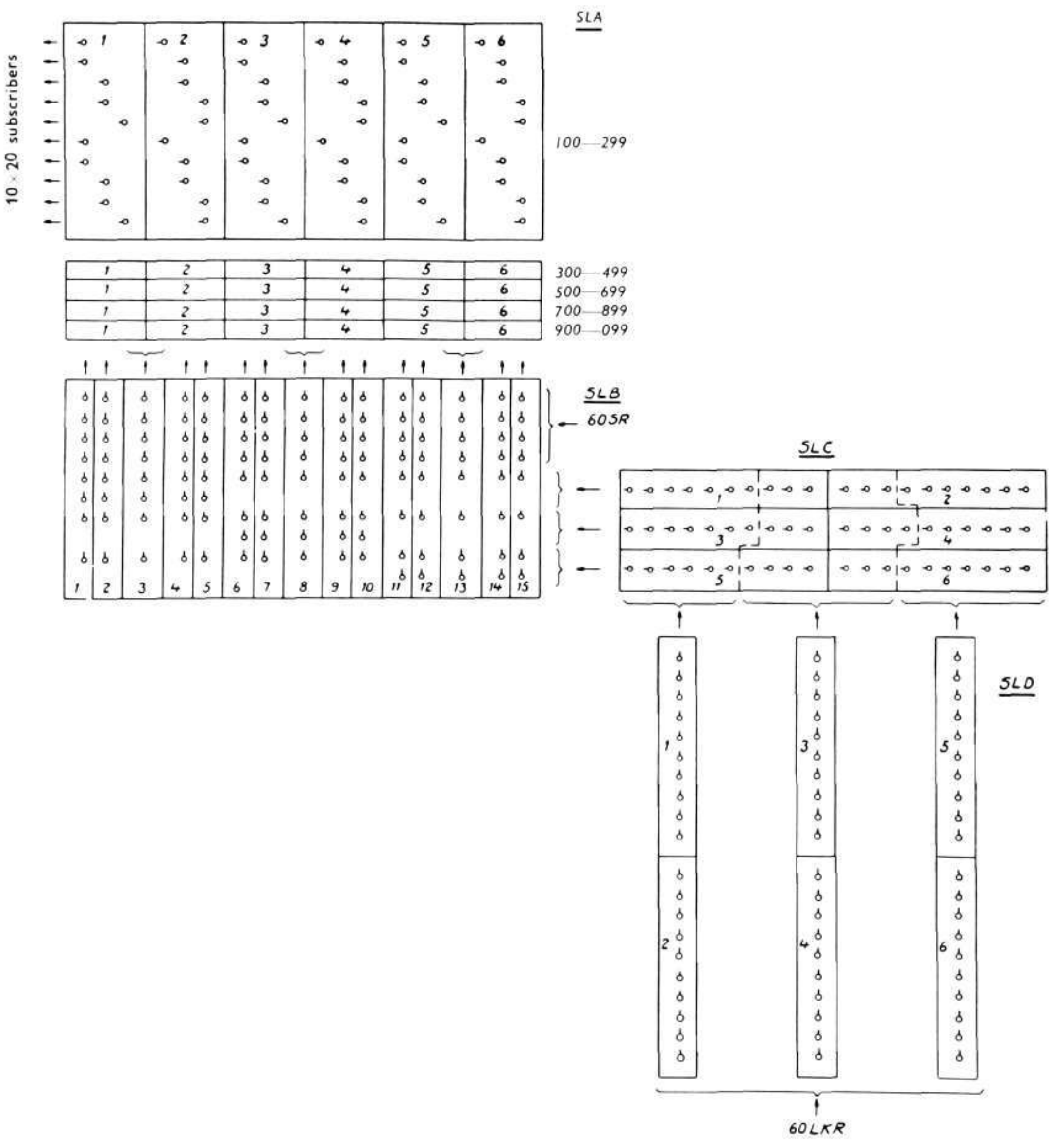
A group selector may be operated only if the corresponding register is disengaged and one *GV* only may be connected to the register. We assume that

GV 2 has been engaged, and with this register 1 belonging to group 2. The subscriber dials figure 1. The dial impulses are stored in the register, engaging the marker and operating decade relay *D 1* and group relay *G 1*. As each via is consisting of two decades, via 1 contains decades I and II. Decade relay *D 1* connects, in group 1, selectors *1 B* and *6 B*, bar magnets *H 1* and *HA* (Figs. 3 and 4) and connects the 20 outlets to test relays *T 1*—*T 20* over contacts on relay *G 1* and the 20 vertical unit contacts *V* in selectors *1 B* and *6 B*. Disengaged outlets are connected to negative whereas engaged and blocked outlets are connected to positive and open potential respectively. Only those outlets meeting a disengaged vertical unit in selectors *1 B* and *6 B* are connected to the test relays. The test takes place during a limited period during which all test relays are connected to positive over contact *GT*. All test relays corresponding to disengaged vertical units and outlets are connected during the test period and are operated instantaneously. Only one relay will remain operated viz. the one nearest *T*, which is the origin of the positive.

We assume that relay *T 2* remains operated after test. Contacts on *T 2* connect bar magnets *H 2* and *HA* in selectors *1 A* and *6 A*, marking outlet 2 in the A-stage of group 1 corresponding to link 2 and the second vertical unit in selector *1 B*. In the B-stage, *HA* and *H 1* in group 1 will mark decade 1 and in the A-stage, *HA* and *H 2* outlet 2. When the marking has been completed, the connection is established by operation of unit magnets in vertical units *A 2*

Fig. 6 X 7576

Grouping plan for finders and final selectors



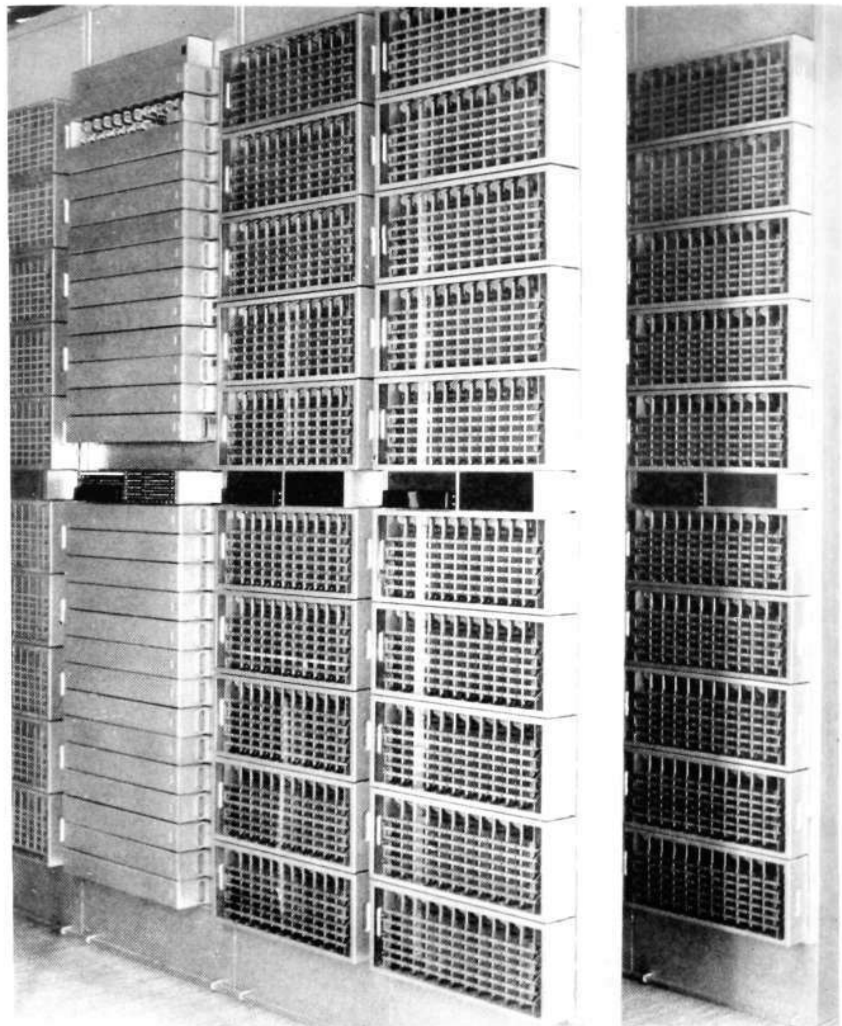


Fig. 7 X 6545
The front row contains all GV-unit covering 100 II GV

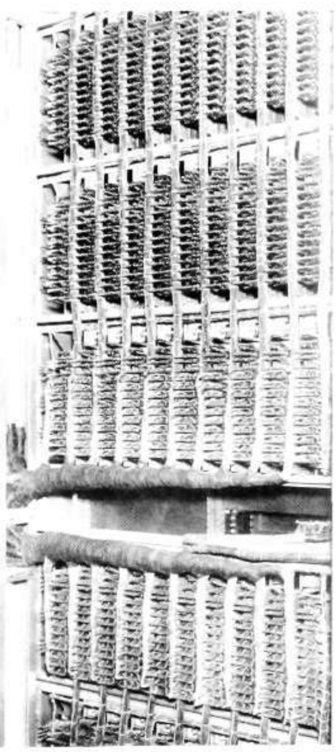


Fig. 8 X 4700
Rear of the selector rack
cover removed

and $B\ 2$. The marker and the bar magnets are then released. The total operation time for the marker is 100 ms approximately. If no T-relay operates during the test period, decade relay $D\ 1$ is released and $D\ 11$ is operated followed by retest of outlets in decade II.

Relays $T\ 1$—$T\ 20$ are connected in a lockout circuit. Such circuits constitute a very important part in crossbar switch systems. The safe performance of the circuit is depending on the series connected contacts on the chain relays. If one of the contacts is faulty the T-relays farther away in the circuit are disconnected. To increase the safety of the relay circuit, parallel contacts are used. Another method of increasing the reliability is to move the starting point for the circuit one step on each operation of the marker. With this method a more even distribution of the load on the outlets is also obtained.

Expansion or Contraction

The group selector units are characterized by the grouping plan which may be varied within wide limits. The *II GV* described above has the same number of selectors in the A- and the B-stages. If the number of selectors in the B-stage is increased, resulting in a link connection with expansion, the internal blocking is reduced and the outlets may take a heavier traffic. A simplified grouping plan for such a link connection is shown in Fig. 5, which is the grouping plan for *I GV* of the Sörnäs exchange. The small circles indicate vertical units and the arrows the multiple direction. Each arrow thus represents 20 outlets. The A-stage contains 80 vertical units and the B-stage 120 units. The expansion is, therefore, 1 : 1.5.

If the vertical units in the A-stage carry a light load it is economical to employ contraction i. e. a smaller number of B-selectors than A-selectors. This is the case for the A- and B-stages in *SL*. Fig. 6 shows the grouping plan for *SL* in the Sörnäs exchange. The A-stage contains 300 vertical units, whereas the B-stage has 120 units. There is, consequently, a contraction of 1 : 0.4. The D- and C-stages have the same number of vertical units and thus no contraction or expansion. The same applies for the C- and the B-stages. The vertical units in the A-stage reach 20 subscribers. There are 6 vertical units for 20 subscribers. In order to balance of the traffic the vertical units are divided in two groups, 3 of the units are accessible from the same 20-group and the remaining 3 from another 20-group. The unit and ten digit figures in the first group are reversed in the second group. A subscriber's multiple of this kind is termed a transposed multiple.

Mechanical Lay-out

Fig. 7 shows part of the *II GV*-group. To the right in the nearest rack row are two selector racks each fitted with 10 crossbar switches and to the left of these a relay rack. This part constitutes one *II GV*-unit containing 100 *II GV*. The front of the selectors and the relays are protected by a cover. The selector covers are provided with glass fronts to enable supervision of the selector positions from the outside. The rear of each rack is enclosed by a protection cover.

Fig. 8 shows the rear of a selector rack with protection cover removed. It will be seen that the selector multiple is a wire multiple.

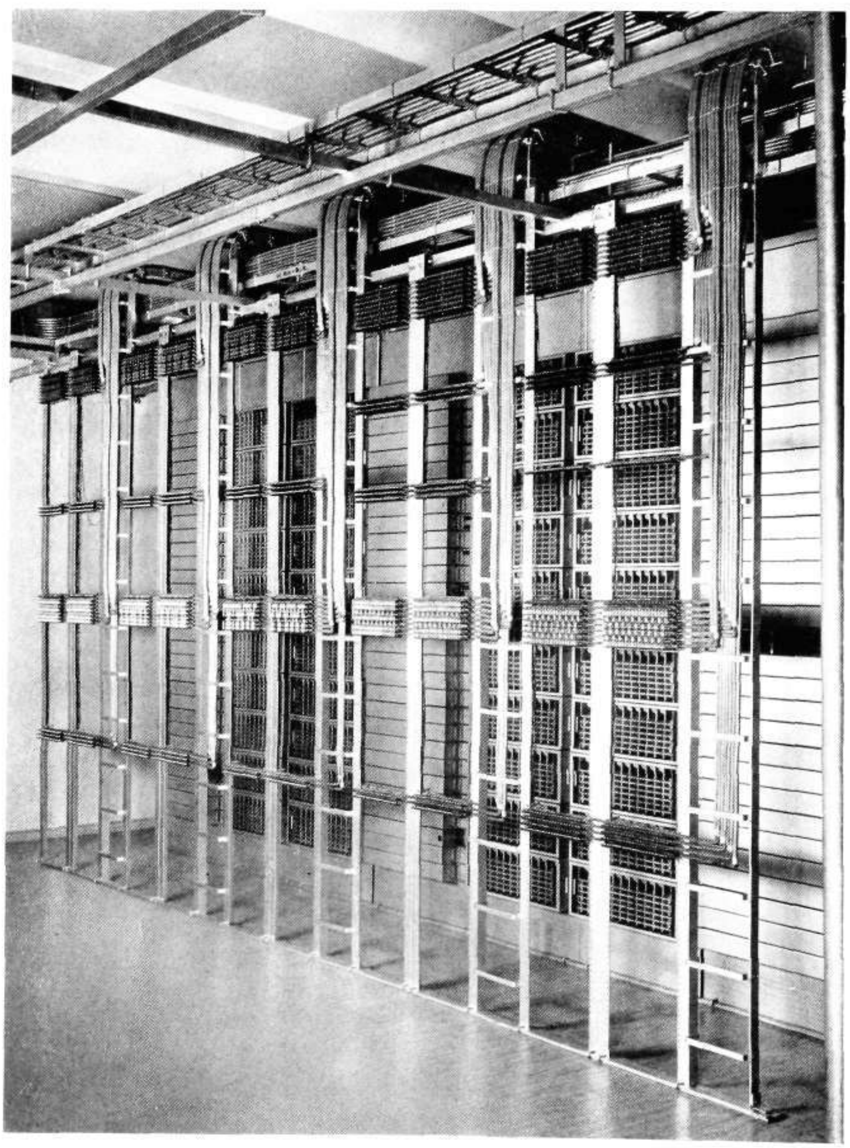
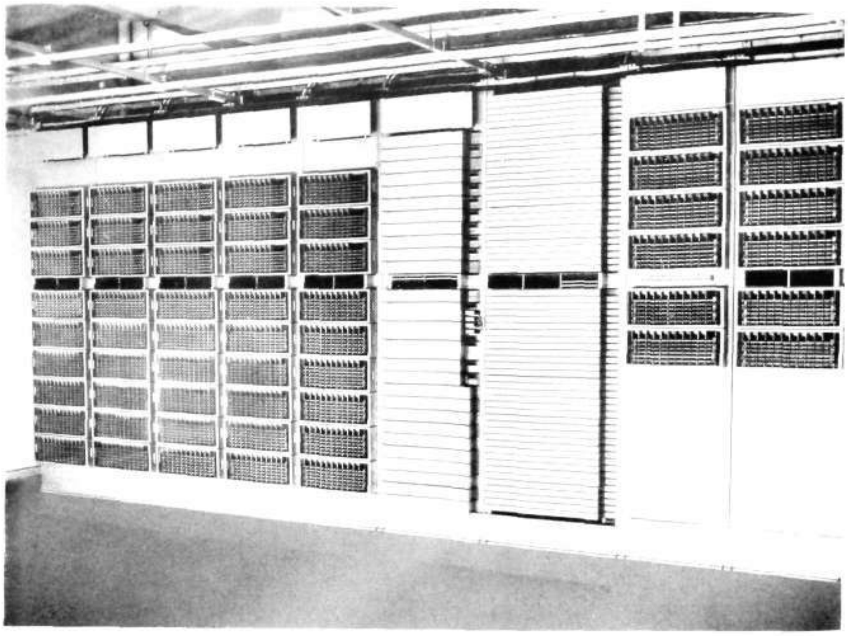


Fig. 9 X 6546

In the foreground grading rack (IDF) for II GV



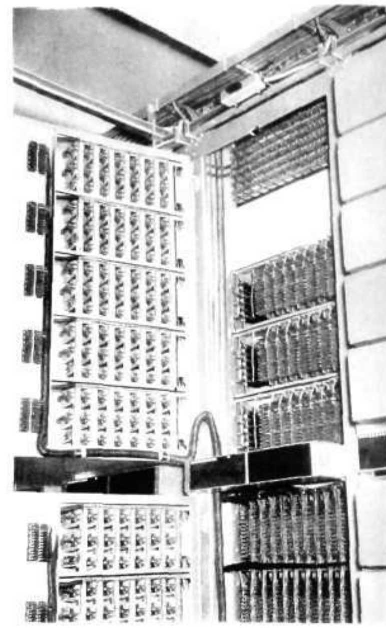


Fig. 10 X 6547

Rack containing a finder and final selector group for 1000 numbers

Fig. 11 X 4701

Rear of the finder and final selector rack for the A-stage

showing line relay gate opened

Fig. 9 shows in the foreground the grading rack, *IDF*, for the *II GV*. The grading is carried out with bare wire but insulated wire may be used when required. The grading frame is designed by the Helsinki Telephone Society.

Fig. 10 shows the *SL*-group. To the extreme left are 5 selector racks. Each rack contains selectors and line relays for a subscriber group of 200 numbers. On the front are 3 B-selectors and below these 6 A-selectors. The line relays are mounted on gates at the back of the racks as shown in Fig. 11. Relays for 20 subscribers are assembled in exchangeable units. The selector racks are

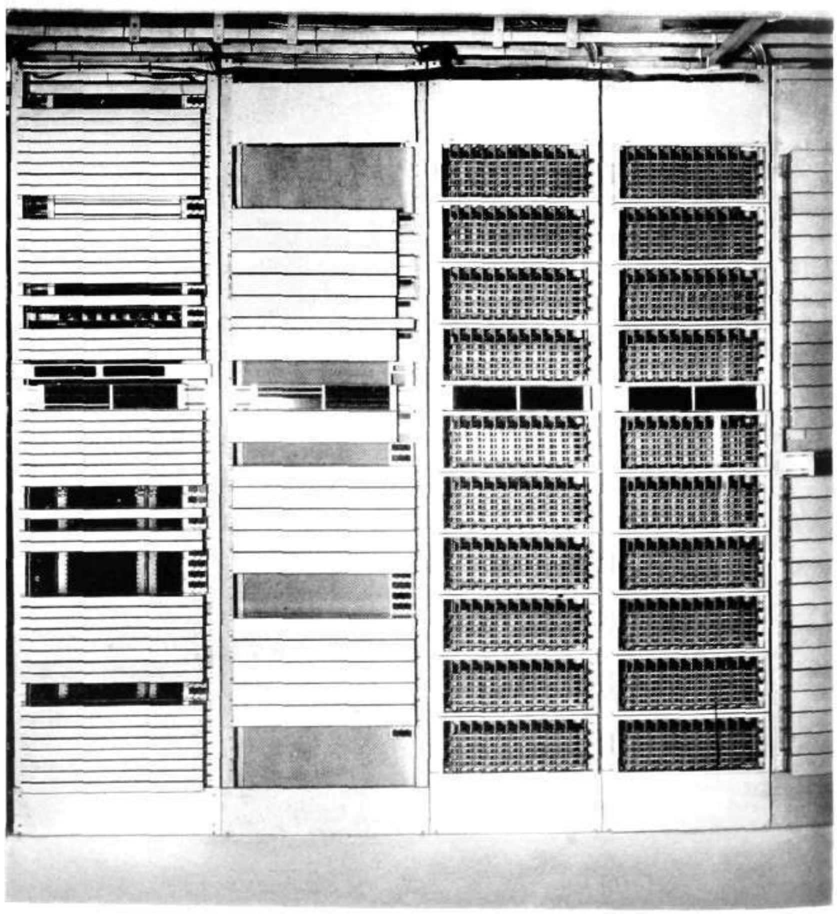


Fig. 12 X 6548

Row of I GV-units containing 80 I GV

In the rack for finder circuits, shown to the left, a number of finder circuits have been removed.

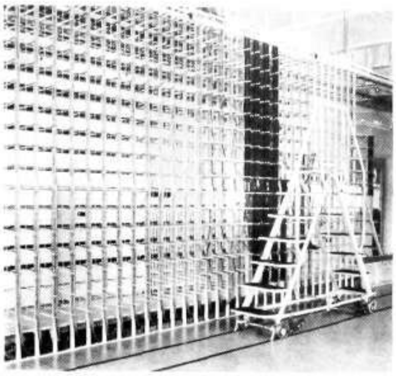


Fig. 13 X 4702
Main distribution frame

followed by the marker rack, which also contains 10 registers for incoming traffic. Then follows 60 incoming connector circuits *LKR* and finally the selector racks for 6 C- and 6 D-selectors.

Fig. 12 shows one *IGV*-unit containing 80 *IGV* and 60 outgoing finder circuits *SR*. The finder circuit rack will be found to the extreme left, followed by a relay rack with the *IGV*-marker mounted at the top and 10 *IGV*-registers below. At the end of the row two selector racks will be seen, each containing 4 A-selectors and 6 B-selectors.

Fig. 13 shows the main distribution frame for the Sörnäs exchange. This frame is of a new design developed by the Helsinki Telephone Society. Test jack strips without fuses are arranged on the line side as well as on the exchange side. The line and the exchange cables in the frame consist of 100-pairs cables distributed on 5 20-pairs strips. The cable and the branches are lead sheathed right up to the strip. The frame is a tube construction. The jumper wires are insulated by two layers of rayon and one layer of PVC.

Operating Results and Extension Schemes

A trial group consisting of 100 *IIGV* was put into operation in February 1948. Extensive tests were carried out with this group both as regards the performance of the system and its traffic carrying properties. The anticipated results were verified in both these respects. Certain minor modifications were then made in the system and in March and April 1950 800 *IIGV* were put into service and after that complete equipment for 1 000 subscribers in Sörnäs.

The installation have as yet been in operation too short a time to establish the *most efficient procedure for the supervision and maintenance of the new system*, nor has the training of the staff been completed. The faults, which usually appear when a new exchange is put into service, have been few. Although the circuit and the lay-out of the system differs from that, which the staff has been used to, the maintenance has not caused appreciable difficulties. As long as the maintenance has not been definitely organized, detailed figures cannot be published regarding reliability and maintenance cost, but the results so far obtained have entirely come up to expectations and indicate that the system enables very reliable and inexpensive operation. The confidence of the Telephone Society in the system has just recently resulted in further orders being placed for extensions of 11 000 numbers in addition to the 15 200 numbers ordered previously.

The Crown Prince of Ethiopia visiting L M Ericsson

Early November the Crown Prince of Ethiopia visited the L M Ericsson works at Midsommarkransen, Stockholm, and made a tour round the premises studying the production with interest. The photograph shows the distinguished visitor in front of a scale model of the works which was demonstrated by the Managing Director of the Company, Mr. Helge Ericson.

A Midget Telephone Relay

E. WIBERG, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

U. D. C. 621.318.5:621.395

The majority of connection elements in a telephone exchange consists of the ordinary telephone relay. In the lay-out of a telephone system it frequently happens that full advantage cannot be taken of the technical possibilities of the telephone relay and the use of this relay will in certain cases require unnecessary space at excessive cost. For this reason there has been an increasing demand for a small and cheap relay of simple design. A description will be made below of a new relay RAG 500 developed by Telefonaktiebolaget L M Ericsson with a fewer number of contact combinations than the ordinary telephone relay and requiring considerably less space.

The new relay, type *RAG 500*, Fig. 1, which has only one spring set, resembles with regard to shape, size and build-up the spring sets used on the L M Ericsson normal telephone relay.

A maximum of four contact springs may be used and the contact combinations may be varied as far as the number of contact springs will permit. The outside dimensions of the relay with four contact springs are, width $^5/_{16}''$, height $^7/_8''$ and length $3^{21}/_{32}''$ ($8 \times 22 \times 93$ mm).

Mechanical Lay-out

The components of the relay are shown in Fig. 2.

The flat type magnet system consist of a straight square core (1) with a bakelite moulded *flange* at one end (2). The purpose of the latter is to support the winding and guide and support a paper bakelite comb (3) serving as buffer for the stationary contact springs (4). The opposite end of the core is provided with a moulded bakelite flange (5) shaped to support the winding and to carry two soldering tags (6) for connection of the winding (7).

The soldering tags, which must have small dimensions, are made of wire. One end of the wire is flattened and has a hole for the external wiring. The opposite end is provided with a notch for the terminations of the winding.

Fig. 1
Telephone relay RAG 500

X 6543

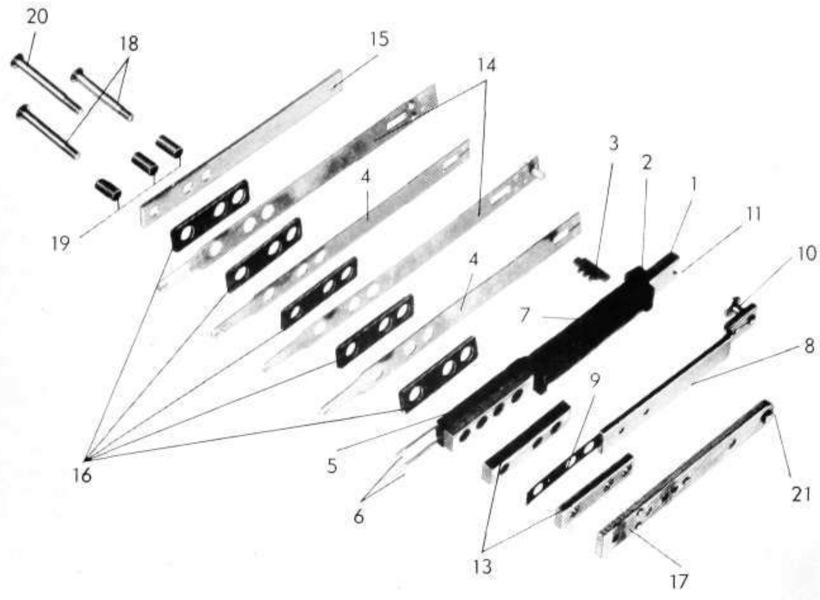


Fig. 2 X 6560

Telephone relay RAG 500 dismantled

Figures refer to the description in the article.

The centre of a tag has a parallel knurl locking the spring in longitudinal direction when placed in the bakelite flange. The tags are secured by list pressing the bakelite.

On the armature (8) is rivetted a thin flat spring (9) serving as hinge for the armature. The armature may be pre-tensioned by bending this spring.

The front end of the armature carries a setting screw (10) entering the forked slot (11) in the core. This screw is used for the adjustment of the armature gap. The same screw also transmits the movement from the armature to the spring set the head of the screw operating the lifting stud (12) on one of the contact springs. The iron circuit also includes spacing plates (13) clamping the armature spring on both sides when the relay is assembled.

The contact springs are of conventional type and do not require further description.

The moving contact springs (14) are provided with lifting studs for the armature movement whereas the stationary springs (4) are resting on the prongs of the buffer comb (3) as mentioned above.

The buffer comb is secured between the top guard plate (15) and the slot in the front bakelite flange on the core. This plate provides mechanical protection and serves as clamping plate for the fixing screws in the assembly.

The contact springs are insulated by means of conventional insulating bakelite plates (16).

The components are mounted on a robust base plate (17) by means of two screws (18) insulated from the contact springs by tubes (19).

The relay is mounted with one screw (20) and is kept in position sideways by means of a pressed up projection (21) on the base plate.

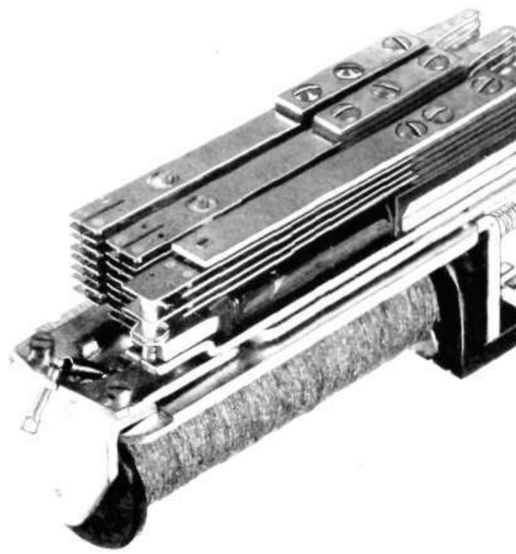


Fig. 3 X 6544

Relay RAG 500 assembled with a large telephone relay

Application

Apart from being employed as a separate element relay RAG 500 may be used assembled with the larger normal telephone relay. The midget relay is then fitted in spring set positions not utilized as shown in Fig. 3. In this way up to three relay functions may be obtained in the same space as that required for one ordinary telephone relay.

In addition to this it is possible to arrange functional co-operation between the larger relay and the midget relays as the armatures of the latter may be operated mechanically by the armature of the large relay.

When rebuilding and extending existing telephone exchanges and there is insufficient room for ordinary telephone relays, the midget relay offers possibilities, which have hitherto not been available.

L M Ericsson Exhibition in Helsinki

O Y L M Ericsson A B in Finland took part with a much frequented stand at the Finnish fair »Stormässan» opened in Helsinki on September 30th. The exhibition gave an interesting survey over the production and sales program of the Finnish LME company.

Plug-in Type Safety Signal Relays

S ENGER, L M ERICSSONS SIGNALAKTIEBOLAG, STOCKHOLM

U.D.C. 621.318.5:656.25

L M Ericsson's Signalaktiebolag has developed a series of plug-in type safety signal relays. The aim has been to design relays having the same high sensitivity and reliability as the safety signal relays now in general use, but of smaller size and having the added advantage of the plug-in feature, which eliminates the risk of making wrong connections when the relay is inserted.

Among the demands considered in the design of the new relay series the following may be mentioned:

1) The contacts shall be forcibly guided in order to ensure that all circuits actuated by the relay shall receive indications having the same signification.

2) The relay shall be enclosed in a sealed case to prevent the adjustment from being disturbed and the relay from being improperly acted upon. The contacts shall be visible through the case.

3) The relay shall be of the plug-in type, *i. e.* the relay terminals shall be automatically connected to the wiring terminals of the relay rack when the relay is inserted in its proper place in the rack.

4) It shall not be possible to connect a relay in a relay position where it will not function properly.

5) The electrical apparatus shall be built to allow a normal working voltage of 220 V. The apparatus shall have the necessary air gaps and surface leakage distances and shall also withstand the dielectric and insulation tests required for this working voltage.

6) The relays shall have a low power demand, as many safety signal circuits are normally closed circuits.

7) The relay shall be of small size and weight.

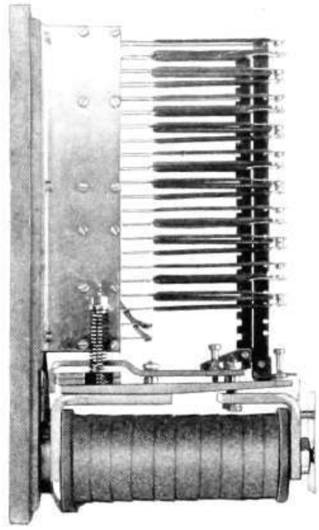
The track relays, which are the measuring apparatus for the track circuits, shall also fulfil the following demands:

8) The relay shall have a low ratio of operating voltage to drop-away voltage. The power required for the track circuit is largely dependent upon this ratio and may be many times greater than the power consumed by the relay.

9) When the relay voltage is gradually changing, the moving system shall remain in the starting position until the voltage has reached the change-over value. Thereafter the relay shall move to the opposite position without any tendency to stop in an intermediate position. This will ensure that all the working contacts are closed and receiving full contact pressure, thus preventing the contacts from becoming heated and at the same time ensuring that all the connected circuits will receive co-significant indications.

The new relay series consists of the following types:

Relay type	Supply system	Power demand W	Number of contacts	Width mm	Height mm	Depth mm	Weight kg
JRJ 11	2 phase local track	15.0 0.300	12	125	250	170	6.2
JRK 10	D.C.	0.065	10	62	250	170	3.6
JRK 11	D.C.	0.140	22	125	250	170	6.6
JRK 12	D.C.	0.350	54	125	525	170	0.2



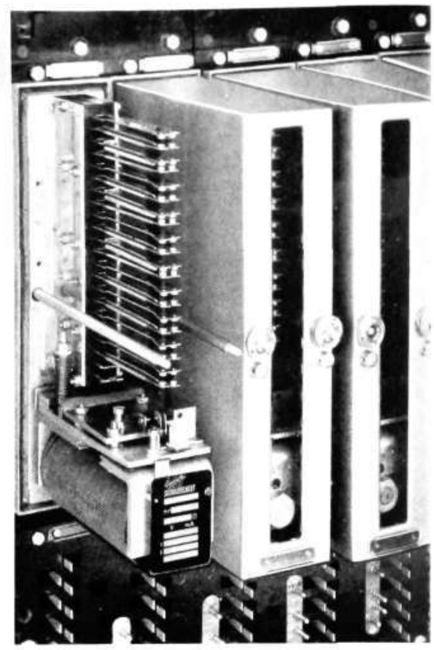


Fig. 1 X 6552

D.C. relay JRK 10

On the left: the relay with the case removed. At the bottom the driving system is visible, the contact system with the contact spring is seen above; the left end of each spring is fixed in the contact spring block, the right end being guided by one of the strips on the right. The left strip is attached to the magnet frame and the right strip to the armature. The winding is connected to terminals at the bottom of the contact spring block.
On the right: relays inserted in a relay rack.

Design

The relays, see Fig. 1, consist of a cast aluminum frame plate carrying the contact spring system with the connecting jacks, the driving system, the case and the registering code plate. The relays are inserted and connected to bakelite panels mounted on relay racks. The wiring is located at the back of the panels.

The main parts of the different relay types are very similar with the exception of the driving systems. Thus, a description is first given of the parts common to all types, and is followed by a description of the different driving systems.

The Contact Spring System

The contact springs are flat springs of german silver, see Fig. 3. The front ends carry solid silver contacts. The rear ends are enclosed and rigidly held by slotted bakelite blocks. Onto the rear end of each contact spring eight forked thin plates are spot-welded and form a multiple prong having sixteen contact points for connecting the contact spring to the corresponding rack panel terminal. During manufacture the quality of each spot-weld is tested by subjecting the weld to a shearing force of 15 kilograms.

In the front end of the contact springs oblong holes are punched for the spring-supporting and actuating strips. These strips are made from phenolic laminate.

The lower end of the front strip, the actuating strip, is attached to the driving system. The upper end is guided by the movable spring of the upper contact spring pair, Fig. 1. In the front edge of this strip slots engage the movable spring of each contact spring pair. The lower end of the rear strip — the supporting strip — is fastened to the relay frame and is thus stationary. Its upper end is guided by the upper stationary spring. The rear edge of this strip has slots for supporting the stationary contact springs.

Fig. 2 X 4711

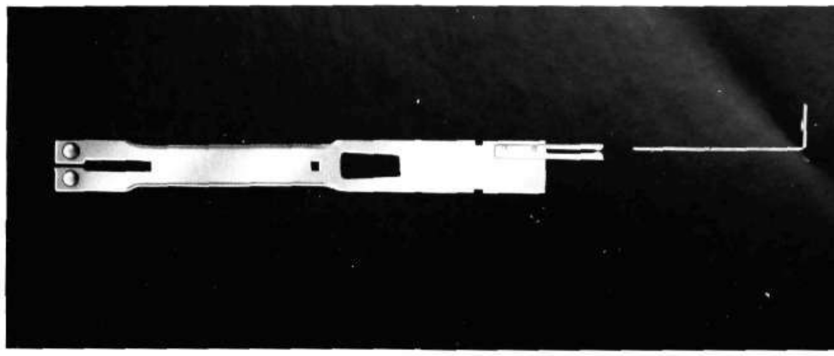
D.C. relay JRK 11

The edges of the contact springs are bent up in order to stiffen the springs, so that the contacts are positively guided by the motion of the strip, see Fig. 3. The rear ends of the springs are left flat and are recessed in order to make them flexible. The »front» contact springs carry twin contact studs, the stationary contact spring being slotted at the front end to give individual alignment to each twin contact stud.

Fig. 3 X 6549

Contact spring

On the left: twin contacts with silver contact studs. At the right end of the contact spring a multiple forked prong for connection to the rack panel terminal plate which may be seen on the right.



The front ends of the stationary contact springs are supported by stiff springs, resting with their front ends in the slots of the supporting strip and having their rear ends fastened to the contact springs. During the closing of a contact, the movable spring moves towards the stationary spring until the contact studs engage each other. The motion continues until the stationary spring has left its support. The contact pressure will then have attained the full value for which adjustment has been made by the preliminary bending of the stationary spring.

Independent front and back contacts are built up from stationary and movable springs, following each other in proper sequence when the contact spring group is being assembled. A special movable spring with contact studs on both faces is also made. This is used together with the ordinary stationary contact spring for building up dependent contacts. Thus, any desired contact combination may be built up with a few elements.

The contact spring system also contains the terminal plates for the relay windings. These terminal plates carry multiple connecting prongs of the same type as the contact springs.

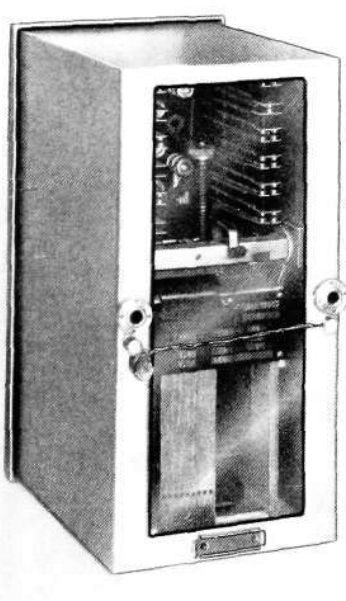


Fig. 4 X 4705

A.C. relay JRJ 11

On the front of the cover to the right and left of the window are the heads of the tubular screws sealed with a lead seal.

Relay Cases

Each relay is enclosed in an aluminum-laquered sheet brass case, see Fig. 4. A window of transparent plastic material is fitted in the front through which the contacts and the data plate of the relay are visible. The case fits into a felt-packed groove which runs along the edge of the relay frame. It is retained by tubular screws, which also serve as guides when the relay is inserted in the rack.

Relay Racks

The relays are plugged into moulded bakelite panels, mounted on racks. The relay rack consists of a supporting framework, constructed of aluminum-laquered sheet steel profiles, at the same time forming a dustproof, fire-resistant cover for the wiring, see Fig. 5. The wiring is connected to the rack panel terminal plates by screws with hexagonal nuts. The terminal plates pass through the panels and project on the relay side of the latter.

Guide rods are mounted on the rack panels, which pass through holes in the relay frame and the tubular screws, see Fig. 6, and serve as supports for the relays. When the relay is inserted, the rack panel terminals enter the forked prongs of the contact springs and terminals of the relay windings, thus ensuring reliable electrical contact.

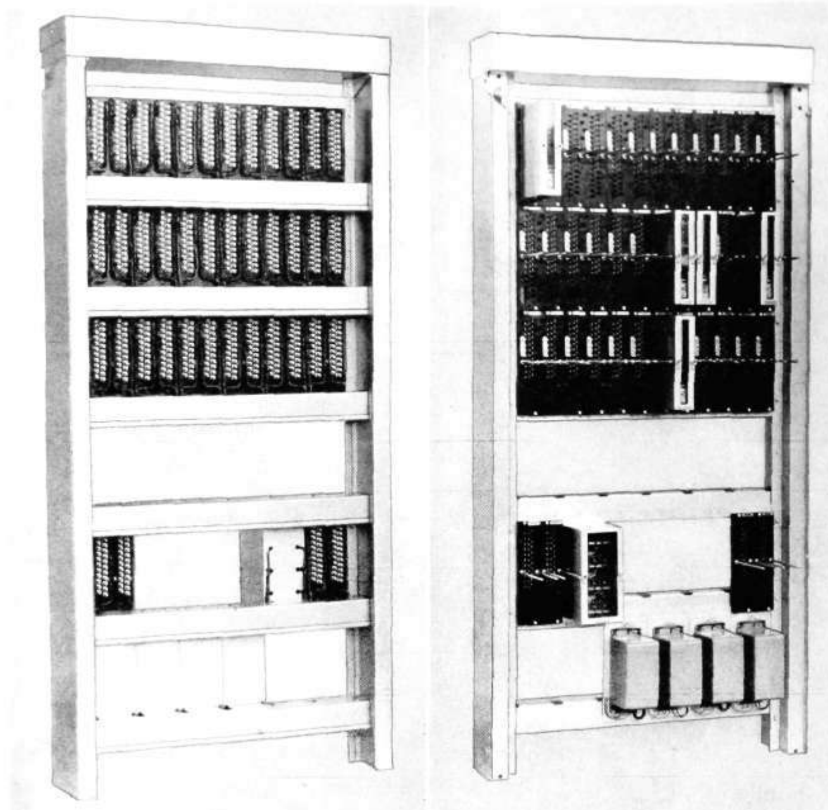


Fig. 5 X 6553

Relay rack

Left: the wiring side with three filled panel rows. The cables connected to the terminal screws run in horizontal and vertical channels formed by the sheet steel profiles of the rack frame. Right: the relay side with only five relays inserted.

In order to prevent a relay from being plugged into a panel intended for a different relay, each relay position on the panels carries a registering code plate with four pins. The location of these pins is determined by the type number of the relay, according to a certain code giving 3 240 possible combinations. A similar code plate with four holes is provided in the relay frame. Each hole must fit a corresponding pin in order to allow the relay to be connected to the rack panel.

If the arresting screw has not been removed before the relay is inserted, the connection of the relay is prevented by a projection on the panel which comes up against the head of the arresting screw.

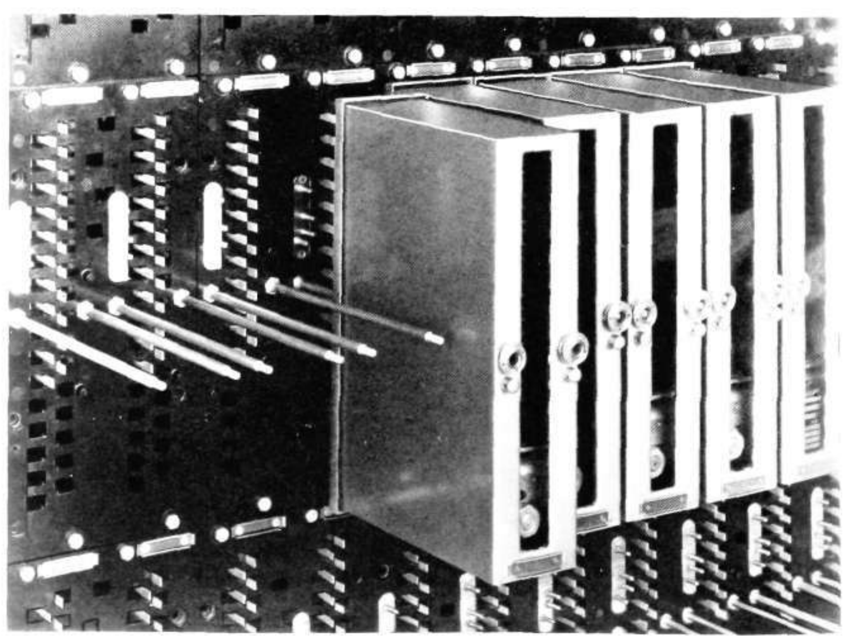


Fig. 6 X 6551

Panel row in relay rack with JRK 10 type relays

On the bakelite panels to the left the terminals and guiding pins may be seen. Above the latter are the registering code plates, each with four code pins. The *lefthand* relay is not fully inserted. The relays and relay positions on the panels are provided with a designation strip which indicates the function of the relay.

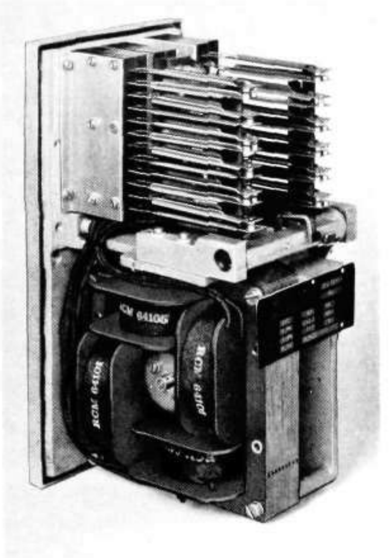


Fig. 7 X 4703

A.C. relay JRJ 11

with the case removed, seen from the motor side

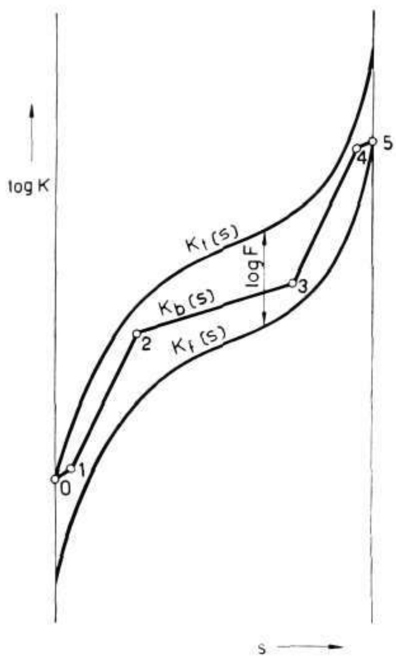


Fig. 8 X 4697

Load and driving forces shown as functions of the contact spring movement

F operating voltage/drop-away voltage
K_b load from the contact spring system
K_t driving force at operating voltage
K_f driving force at drop-away voltage
S movement
0 resting position
5 operating position

The bakelite panels are made in one size only which can take one relay *JRJ 11* or *JRK 11*. Two relays *JRK 10* can be mounted on each panel, whilst the relay size *JRK 12* requires two panels located one above the other.

The rack panels as well as all other bakelite parts of the relays are injection-moulded from mineral-filled bakelite, and have an exceedingly low water absorption and electric surface leakage.

The A.C. Relay Driving System

The Motor

The A.C. relay is driven by a two-phase induction motor, see Fig. 7. The stator has a laminated iron core. This takes the form of a square frame with four legs projecting inwards through the coils. The ends of the legs form arc-shaped pole-pieces surrounding the cylindrical air gap in which the rotor revolves. The rotor consists of a cylindrical brass drum, surrounding an iron core with a shaft running in ball bearings.

Each opposite pair of coils are connected in series, thus forming one phase winding. The winding which surrounds the horizontal legs constitutes the local phase winding and is fed with a constant alternating current.

The track phase winding surrounds the vertical legs and is connected to the track circuit protected by the relay. The power required in the track phase winding for operating the relay amounts to 300—500 mW, depending on the frequency of the current and on the contact combination.

The voltage in a phase winding drives a current through this winding. The current produces an alternating magnetic flux which passes diametrically through the rotor. Around the flux a voltage is induced which drives an alternating current through the rotor drum. This current circulates around the generating poles, and passes under the other pole faces. When this current is acted upon by the flux from these other pole faces, the resulting force produces a torque on the rotor.

On account of the symmetry of the rotor and the magnetic system, no voltage is induced by one phase winding in the other when the rotor is at rest. For the same reason, the rotor torque is independent of the rotor position.

Transmission

The load from the contact springs varies during the relay movement. In order to make the relay follow up the motion during the operating- as well as during the return movement, it is necessary to transform the driving torque in a suitable manner. This transformation must also be such, that the ratio between the operating and the drop-away voltages will have a minimum value.

Load Characteristic

The actuating strip carries the load from the movable springs at both the front and back contacts. In the resting position (*0* in Fig. 8), the back contacts are closed and the stationary springs, which are raised from their supports, take up the contact pressure and thus partly relieve the load on the actuating strip. When the operating movement starts, the tension in the moving springs increases while he back-contact stationary springs relax. The load on the actuating strip increases accordingly. When the back-contact stationary springs touch their supporting strip, position *1*, the contact pressure rapidly decreases and a corresponding part of the tension in the back contacts' movable springs must therefore be taken up by the actuating strip. In the position *2* the back contacts open after which only the movable springs move until in position *3* the front contacts close. The front contact pressure then increases rapidly thus raising the load on the actuating strip. When in position *4* the front contact stationary springs leave their supports, the front contact pressure increases more slowly and finally, the working position, 5, is attained. Thus, the load increases according to the broken curve *0—1—2—3—4—5*, shown in Fig. 8, which is plotted in accordance with a logarithmic scale.

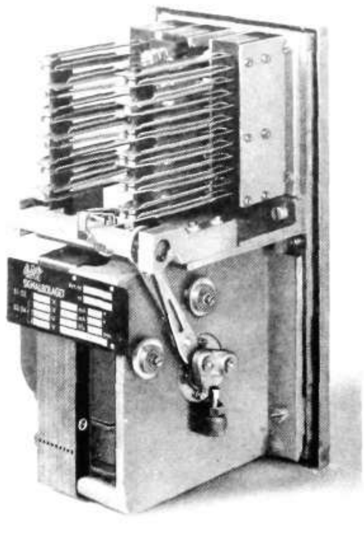


Fig. 9 X 4704

A.C. relay JRJ 11

with the case removed, seen from the linkage side. Above are the contact spring groups actuated by a horizontal intermediate shaft carrying a crank which is connected by a link to a crank on the rotor shaft.

To enable the relay to follow up the motion, the driving force must exceed the load during the whole operating movement. Under such conditions the relay will not exhibit any tendency to stop in an intermediate position. Similarly, the load must exceed the driving force during the whole drop-away movement.

The torque at the rotor shaft is proportional to the track phase voltage if the local phase voltage is maintained constant. In the logarithmic diagram, Fig. 8, the driving forces at different voltages are represented by congruent curves situated at different heights. The difference in height represents the logarithm of ratio between the voltages. The shape of the desired driving force curves may then be determined in the following way:

Two parallel, congruent driving force curves should be drawn, the one through point *0* and running entirely above the load curve, the other through point 5 and running entirely below the load curve. The difference in height between the curves should be as small as possible.

When the desired function has been determined, the next step is to construct a mechanical transmission which will transform the constant rotor torque into a driving force proportional to the given function. The transmission chosen takes the form of a simple link mechanism: a crank on the rotor shaft is connected by a link to a crank on an intermediate shaft. This latter shaft moves the actuating strip of the contact spring system, Fig. 9. This combination of two cranks and a link offers a very wide range of transmission possibilities. By choosing suitable lengths for the two cranks and the link in relation to the distance between the shafts and by determining the limiting angles of the rotor crank movement a fairly close approximation to the desired driving force function can be obtained. The mechanism is simple, strong and stable, and there is very little friction as the shafts run in ball bearings.

The D.C. Relay Driving Systems

The driving systems of the D.C. relays are electromagnets. In the relay type *JRK 10*, the magnet consists of a coil with a cylindrical iron core and two pole pieces, bent at right angles so that they form two parallel pole faces above the coil, Fig. 1. The armature moves above the pole pieces. The relay types *JRK 11—12* have magnets with two coils, at the rear united by a yoke and are provided at the front end with pole-pieces. The armature is located across the two pole faces, Fig. 10.

In both types of magnets the armatures are balanced to eliminate the influence of mechanichal vibrations. The armatures move downwards during the operating movement. The actuating strips of the contact spring systems are directly attached to the armatures.

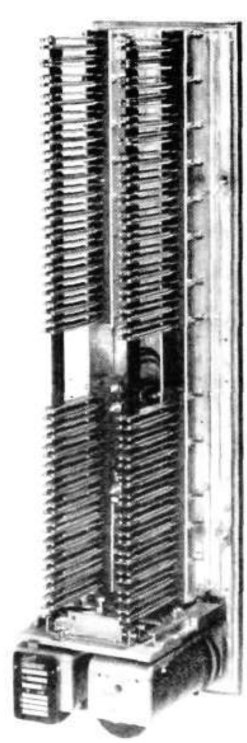


Fig. 10 X 4712

D.C. relay JRK 12

with the case removed

The driving force characteristic has been adapted to the load characteristic by suitable dimensioning of the air-gap area.

New Models of Engaged Signalling Equipment

A TRÄGÅRDH, TELEFONAKTIEBOLAGET L M ERICSSON, TELESIGNAL WORKS, STOCKHOLM

U.D.C. 654.915.2

Executives and others who often receive callers, do not want to be disturbed during important conferences. A caller on the other hand will feel rather uncomfortable if he is unwittingly interrupting a conference by looking in to find out if the wanted person is engaged or if the conference is an important one. With an engaged signal system the wanted person is able to signal that he cannot receive the caller without the latter having to open the door to obtain this information.
L M Ericsson have for a long time been marketing equipment for engaged signal systems but new models have recently been developed which differ from earlier ones.

An engaged signal system consists of a desk control set, wall signal box and optional cradle contact on the telephone instrument.

The desk control set, Fig. 1, moulded in white plastic material, is placed on or near the writing desk. It contains a push button switch with pilot lamp for indication of ENGAGED signal, four push buttons for COME IN and WAIT signals as well as for service and secretary signals. The set is provided with a $6^1/_2$ feet cord connected to a wall terminal box with buzzer. On the front part of the control set there is a space for a designation strip protected by transparent acetate which carries directions for the use of the buttons.

The wall signal box, Fig. 2, is intended for installation on the wall at the side of the door outside the room. The box contains three lamps with lenses, a push button and a buzzer. There are two types of boxes, one having lenses in green, red and amber and the other carrying designations COME IN, ENGAGED and WAIT on white paper.

The external cradle contact, Fig. 3, is fitted on the telephone instrument. When the receiver is lifted the amber lamp or the lamp carrying designation WAIT is operated in the signal box, indicating that the occupant of the room is engaged on the telephone.

Fig. 1
Desk control set KEM 1101

X 6556

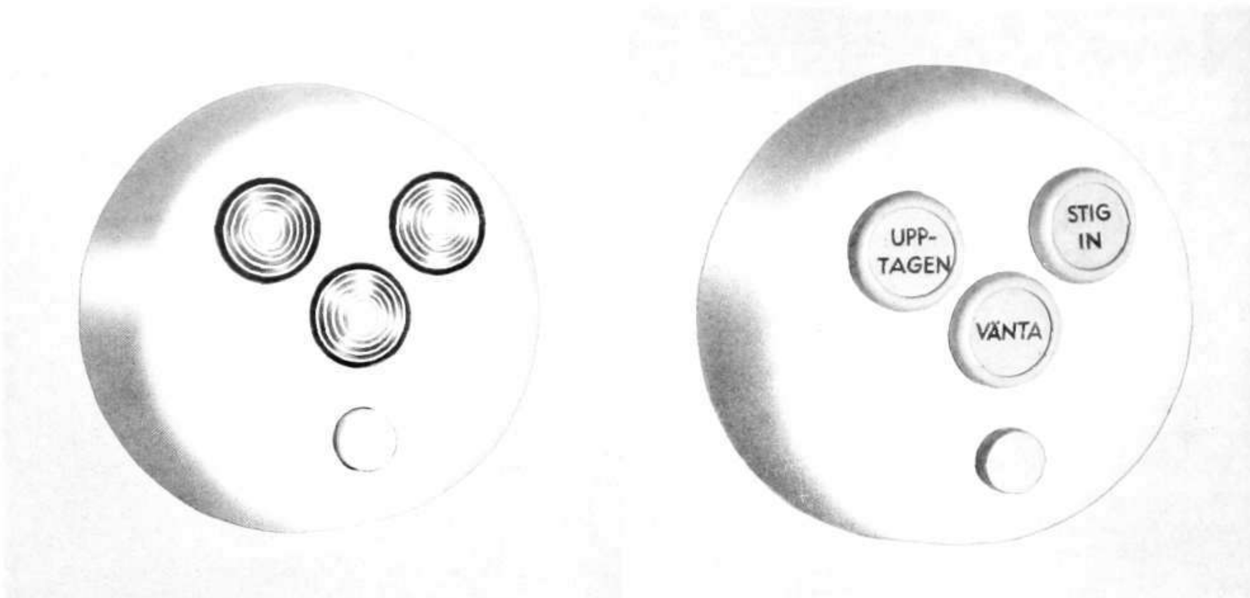


Fig. 2 X 7582

Wall signal box

left with coloured lenses KNH 8401, right with designations KNH 8402

Function

When a caller wishes to enter, he presses the button operating the buzzer in the wall terminal box for the control set. If the wanted person is disengaged, he will press button COME IN in the control set. The green lamp or the COME IN designation will be alight during the time the button is pressed at the same time as the buzzer is sounded in the signal box. If the person, on the other hand is engaged, he will press the ENGAGED push button switch operating the red lamp or the ENGAGED designation in the signal box as well as the pilot lamp in the control set. Both these signals remain operated until the ENGAGED push button switch in the control set is restored. The pilot lamp is serving as a reminder that the ENGAGED signal is in operation and that it should be restored, when the conference is terminated. The ENGAGED signal may, of course, be operated at the commencement of a conference without waiting for a call from the signal box.

The occupant of a room may not want to be disturbed during his telephone calls. For this purpose an external cradle contact is fitted on the telephone instrument. As soon as the receiver is lifted the amber lamp or the WAIT

Fig. 3 X 6557

External cradle contact KEM 4004 for telephone instrument designation in the signal box is operated. This indication remains in operation until the receiver has been replaced.

If the wanted person is expecting to be disengaged in a few moments after being called from the signal box, he may press button WAIT in the control set and operate the amber lamp or designation WAIT at the same time sounding the buzzer in the signal box. This signal will remain in operation during the time the button is pressed. The caller may then remain outside the door and await the COME IN signal.

The control set contains a further two push button which may be used for service signals or to call the secretary.

The system is operated from 24 V A.C., the power consumption being approximately 0.25 A. The power supply may be 110 V, 127 or 220 V A.C. mains connected over a transformer.

The Most Northerly Automatic Exchange in the World

The most northerly automatic exchange, supplied by Telefonaktiebolaget L M Ericsson, was for many years the exchange at Skellefteå. Last summer, however, the new automatic exchange Akureyri on the north coast of Iceland was put into service depriving Sweden of this record. This state of affairs was not, however, allowed to continue until the middle of October, when the automatic exchange at Kiruna supplied by L M Ericsson was put into operation. This town, the northernmost in Sweden and the largest in area, does now possess within its boundaries the most northerly automatic exchange in the world, as far as is known.

The exchange is equipped with the L M Ericsson automatic telephone system with 500-line selectors for 2 500 numbers *of which about 500 are arranged for group numbers.* The exchange contains toll circuit equipment for two terminal exchanges and equipment for automatic trunk call dialling.

The above photograph shows the exterior of the new exchange building.

Equipment for Power-supplying at Constant Voltage and Frequency

S E LINDBERG, LM ERICSSONS MÄTINSTRUMENT AB, STOCKHOLM

U.D.C. 621.316.721.078:621.311

When carrying out precision measurements with indicating instruments, the voltage supplied to the measuring equipment must be constant and must also have a suitable wave form. These conditions are not satisfied by the voltages of the ordinary supply mains.

When calibrating electricity meters a testing outfit with built-in wattmeters is sometimes employed. For feeding current to testing outfits of this kind, Ermi, L M Ericssons Mätinstrument AB, has produced a series of power-supplying equipments which are described below.

The accuracy with which a voltage is to be maintained constant must be such that voltage variations will not exceed ± 0.1 % under normal service conditions, and that following a disturbance, regulation should be completed within 0.3 secs. This regulating speed is defined as follows.

In the event of sudden variations either in the magnitude and frequency of the input voltage or in the output, the *output voltage* shall be restored to values lying between the guaranteed values within the time allowed for regulation.

Deviations of the voltage from a pure sine wave form are defined by the term *harmonic content* which is equal to the sum of the root mean square value of the harmonic voltages, divided by the total r.m.s. value of the alternating voltage. According to the Swedish Standard Specification for electricity meters, SEN 32, when checking faulty indications in meters, the harmonic content of the voltages and currents must not exceed 5 %.

The line frequency often varies by ± 1.5 %. In the case of electricity meters this gives rise to additional errors which may be of disturbing magnitude when carrying out precision measurements. The demand is therefore sometimes made that the frequency of the output voltage shall be maintained constant.

In view of this requirement Ermi has produced a series of power-supplying equipments for meter testing outfits which even when they are designed for the calibration of single-phase meters are supplied with three-phase alternating current. Older meter testing outfits require an output up to 3 kVA whereas more recent types take about 1 kVA. Needless to say, this value is dependant to some extent upon the number of meters connected up simultaneously to the testing outfit. The main power consumption is obtained in induction regulators and regulating transformers.

In order to meet the demand for a good wave form, the whole output is always generated by amply dimensioned synchronous generators in the Ermi power-supplying equipments. The output voltage from the generator is maintained constant by a valve regulator which fulfils the requirements with respect to speed of regulation.

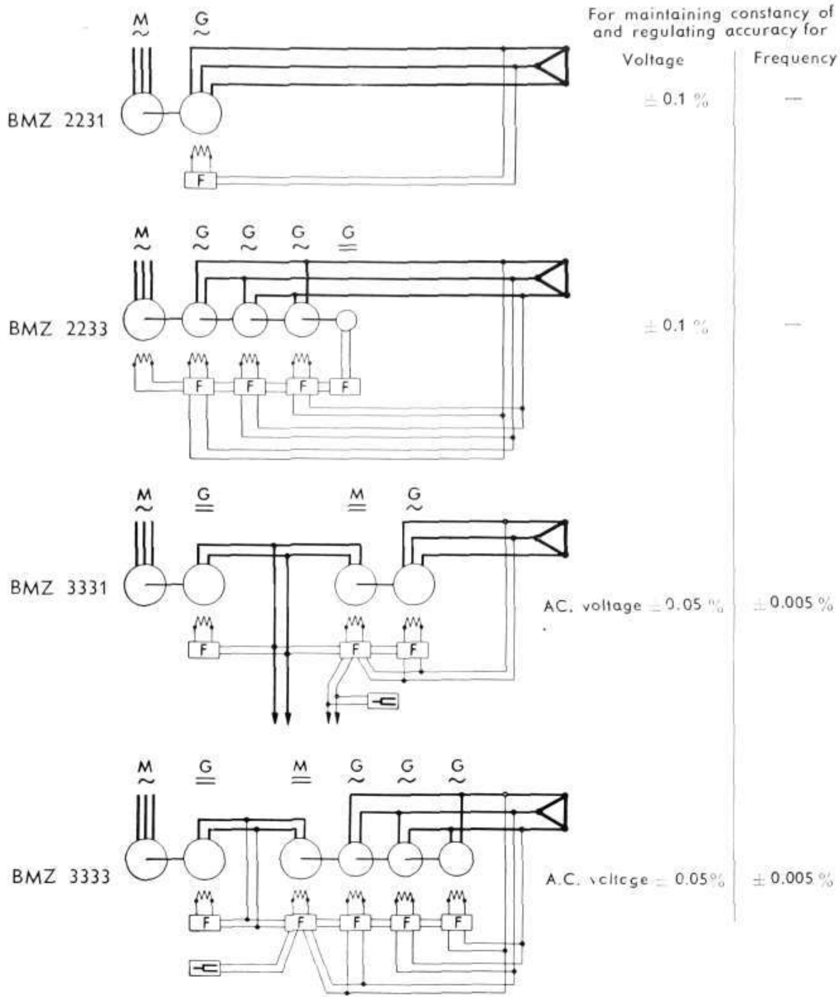


Fig. 1 N 6539

Schematic diagram for Ermi's power-supplying equipments

The values given apply to variations in the line voltage of ± 5 % and in the frequency of ± 2 %.

In such cases, as the influence of the line frequency on the measuring result is neglected, the generator is driven by a synchronous motor. When constant frequency is desired it is necessary to adopt a roundabout method with direct current, by which means the speed of the motor can be regulated. Ermi has chosen a method for synchronizing the output voltage with a very accurate frequency, from a tuning fork.

In installations where each meter testing outfit is fed by its own generator, equipments are employed in which the output voltage is controlled by only one of the three-phase voltages. The generator's exciter winding is common to all three phases. An installation of this kind cannot be used simultaneously for feeding two or more testing outfits as these will then interfere with one another.

For large installations it may be found economical to employ an equipment in which load fluctuations in one phase do not affect the others, that is to say, with which a number of outfits may be connected to the same equipment. This is effected by connecting together three-phase generators which are driven by the same motor and the output voltages of which are each maintained constant individually by valve regulators in the excitation circuits of the generators.

Fig. 1 illustrates the four main types of equipments manufactured by Ermi.

BMZ 2231 — Equipment for one Measuring Outfit

The voltage is maintained constant against variations in the line voltage and frequency. The output frequency is the same as the input frequency. The motor in the rotary converter, Fig. 2, is a reaction motor which starts asynchronously and then falls into step with the network frequency since it is provided with

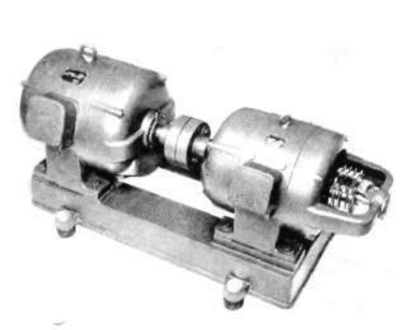


Fig. 2 X 4708

Rotary converter for BMZ 2231

salient poles. *In view of the fact that the excitation energy is taken from the* network the power factor is low, cos $\varphi = 0.5$. When starting a 380 V motor the starting current will be about 105 A but it is of such short duration that it will not cause a 25 A fuse with a time lag to blow.

The generator is rated for 3 kVA and is so amply dimensioned that the harmonic content is less than 2 %. The exciter winding of the generator receives *its D.C. voltage from a valve rectifier built into the control cabinet.* A resistance is connected in series with the winding and is so adjusted that the current flowing through the winding generates a field which gives the generator an output voltage of 80 % of the rated voltage. Three pentodes are connected in parallel with the series resistance and serve as a variable resistance of sufficient size to maintain the output voltage constant, that is to say, the remaining 20 % of the excitation current should pass through the valves on no-load. Under load, it will of course be more.

The pentodes are controlled by a voltage which is taken out between *R* and *S*, Fig. 3, and rectified in a valve and compared with a constant D.C. voltage obtained through a glow-discharge tube (voltage regulator). The potential difference is amplified one stage before acting on the grids of the pentodes.

The voltage which in this way regulates the output voltage depends on a peak value or mean value of the sine wave output voltage. Any harmonics may thus influence the final result. With this equipment only one testing equipment can be supplied, however, and this may be regarded as a constant load and there will then be no variation in the harmonics.

The valve regulator is mounted in a well-ventilated control cabinet which can be hung on a wall or placed on a bench, see Fig. 4. The dimensions of the

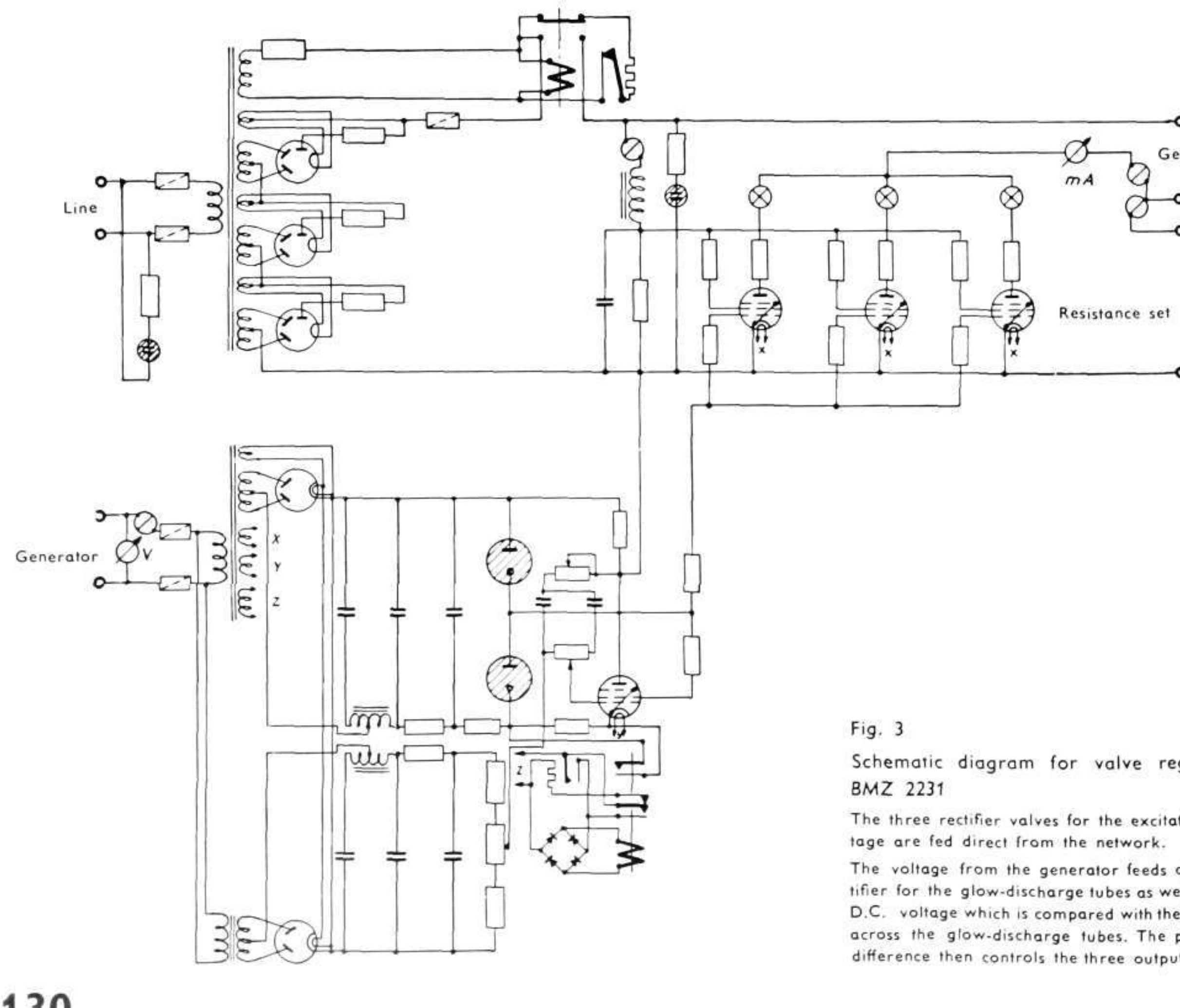


Fig. 3 X 7578

Schematic diagram for valve regulator BMZ 2231

The three rectifier valves for the excitation voltage are fed direct from the network.

The voltage from the generator feeds one rectifier for the glow-discharge tubes as well as the D.C. voltage which is compared with the voltage across the glow-discharge tubes. The potential difference then controls the three output valves.

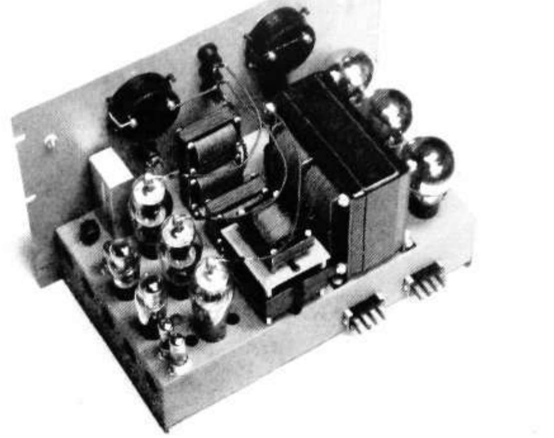


Fig. 4 X 7581

Valve regulator for BMZ 2231

On the right, chassis withdrawn from the control cabinet.

cabinet are 530 × 335 × 305 mm. The series resistance for the exciter winding is enclosed in a box placed in the vicinity of the rotary converter.

The regulator is connected in the cabinet by flat pin contacts and is normally currentless when it is withdrawn from the cabinet. For trimming and inspection when necessary, the regulator can be connected by means of extension conductors.

The life of the valves is increased if the load is applied after the cathodes have been heated up. On this account two thermal relays are available, one of which connects up the load to the rectifier valve after about 45 secs, whilst the other opens the choked pentodes after a further 30 secs.

The equipment is started by means of a press-button which closes the motor's contactor. As an indication that the motor is under current a lamp lights up on the left-hand front side of the control cabinet. Another lamp lights up when the rectifier is connected in circuit. The loading current on the pentodes and the generator voltage may be read off from instruments mounted on the control cabinet. The three lamps between the instruments are series-connected to the anodes of the pentodes and light up under heavy loads. If one of the valves is defective, for example, this is indicated by one of the lamps failing to light up, whilst the two remaining lamps give a stronger light than usual.

If the regulator fails to function for some reason or other and a repairing staff is not available, the generators may still be employed, however, if the change-over switch at the bottom to the right is turned a quarter-revolution. A fixed resistor is then switched on in place of the regulator. In this way a voltage is obtained which although it is not regulated, nevertheless has a good curve shape.

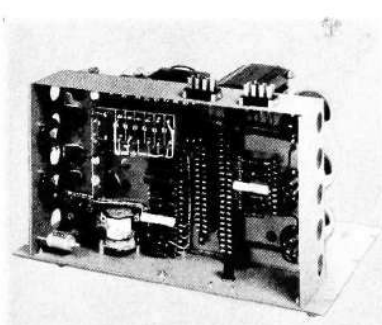


Fig. 5 X 4709

Valve regulator for BMZ 2231

viewed from below

BMZ 2233 — Equipment for a Number of Testing Outfits with Varying Loads

This equipment is designed for supplying a number of testing outfits the loads on which can be varied without interfering with the measurements at the different outfits. The voltage is maintained constant against variations in line voltage and frequency and against changes of load. The regulating speed is less than 0.3 sec with changes of load corresponding to half the rated output. The output frequency is the same as the input frequency.

The converter consists of a synchronous motor which drives three single-phase generators, each having an output of 3 kVA at $\cos \varphi = 0.8$, and an exciter. The speed of rotation is 1 500 r.p.m.

The exciter windings of the single-phase generators are divided into one winding for the fixed excitation and another for generating the flux required

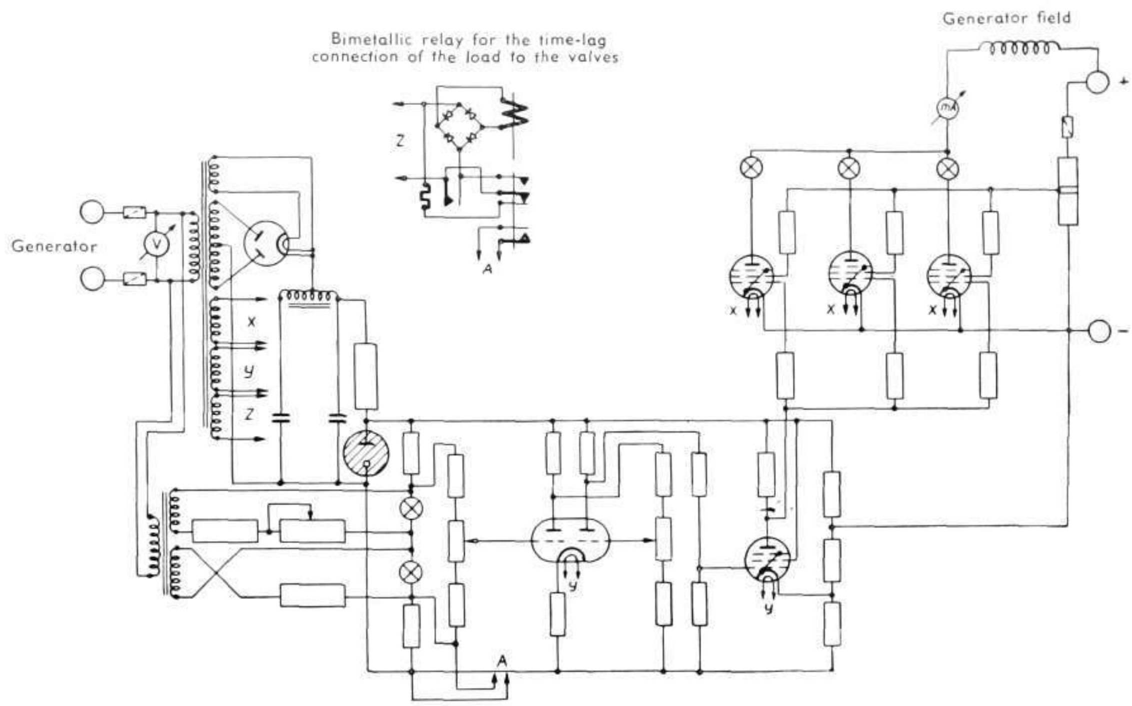


Fig. 6 X 7579

Schematic diagram for valve regulator BMZ 2233

for regulation. With this arrangement the output valves of the regulator are utilized to better advantage. The whole of the current flowing through the regulator winding passes through these valves.

The three generators are displaced in phase 120 electrical degrees in relation to one another, and are connected together in delta. With unbalanced loads harmonics are set up which, if the regulator's input circuit had the same form as that for *BMZ 2231*, would give rise to disturbances in excess of the permissible values. For this reason the regulators in *BMZ 2233* are differentiy connected so that they receive the r.m.s. value of the voltage instead of a peak value as in the previously mentioned type.

The generators are provided with effective damper windings and are amply overdimensioned in relation to the output so that the harmonic content will not exceed *2 % even under the most unfavourable unbalanced loads.*

The input circuit of the regulators, see Fig. 6, consists of a transformer with two secondary windings coupled in opposition to each other, to which two resistors with positive temperature coefficients are connected, which here take the form of incandescent lamps. The sum of the two alternating voltages across the lamps is zero. A direct current from a constant voltage source also flows

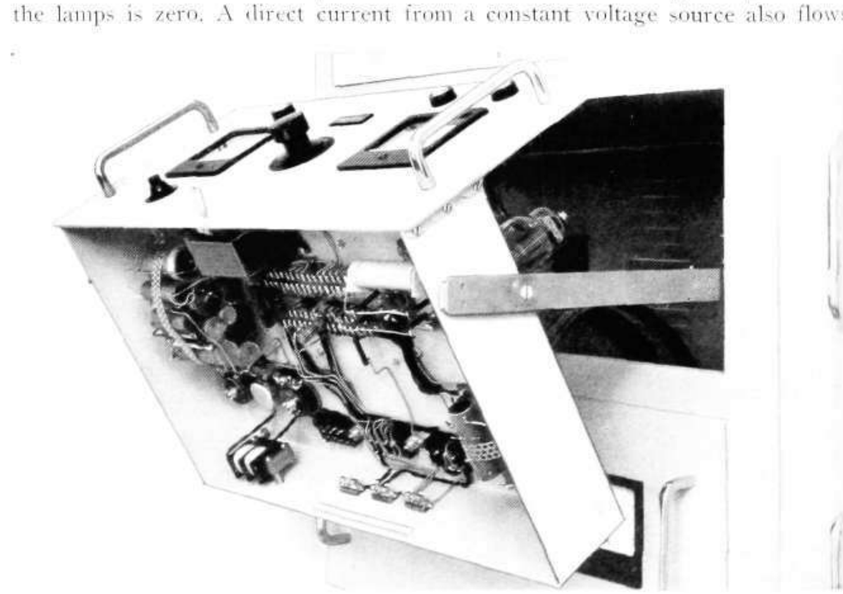


Fig. 7 X 6554

The regulator chassis in the control panels can be drawn out and turned over

thus rendering the regulators conveniently accessible

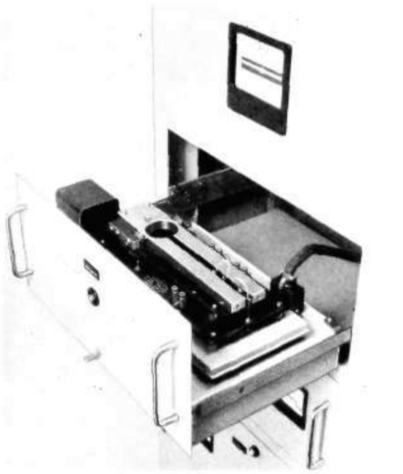


Fig. 8 X 4707

Tuning fork for 50 c/s

with the protective cover removed

through the lamps. If the alternating voltage taken from the distribution point of the three-phase system now changes in value, the current through the lamps will change, but the sum of the voltage drop due to the alternating current will still be zero.

The resistance of the lamps rises as the alternating current increases, and consequently the voltage drop due to the direct current also increases, this taking place in proportion to the change in the r.m.s. value of the alternating voltage. This voltage drop is amplified and controls the current flowing through the output valves of the regulator.

The regulators and control gear for the equipment are assembled on a control panel which is 600 mm wide and 2 200 mm in height. They are mounted on draw-out chassis which can be turned over, thus permitting trimming and inspection to be carried out during service, see Fig. 7. Each regulator is provided with an indicating instrument for the output voltage and for the current flowing through the output valves of the regulator. As in the case of *BMZ 2231*, each output valve is provided with a series-connected incandescent lamp to facilitate supervision.

The chassis can be locked so that unauthorized persons cannot come into contact with the relatively high voltages of the regulators.

BMZ 3331 — Equipment Driven by a Direct Current Motor

In cases where a more accurate output frequency is required, the generators must be driven by direct current motors. *BMZ 3331* is a development of *BMZ 2231*. When direct current is not available it must be generated in a separate rotary converter which in *BMZ 3331* has been selected of such a size that it can supply up to four converters.

To facilitate both frequency- and voltage regulation, the direct current voltage is maintained constant; as a voltage of 440 V has been selected, it is suitable for the excitation circuits with their valve regulators.

The regulator for maintaining the alternating voltage constant has the same input circuit as the regulator in *BMZ 2231*. The installation also includes a regulator for maintaining the frequency constant. The letter works on the principle that the generator frequency is synchronized with a very accurate frequency obtained from a tuning fork, Fig. 8. The output frequency is thus directly dependant upon that of the tuning fork. The tuning forks employed in the Ermi equipments have a calibrated accuracy of ± 0.0025 % and they have a temperature coefficient of 0.002 %/C°. Under continuous service conditions an accuracy of ± 0.005 % is obtained. Normally, no steps are taken to maintain the temperature constant since the frequency is sufficiently accurate for the calibration of electricity meters and for driving the stop watches used for this purpose.

The voltage from the tuning fork is amplified by an electronic amplifier which maintains the output voltage relatively constant against fluctuations in the input voltage. The tuning fork voltage and a voltage from the generator are added and rectified and then control the valve regulator in the excitation circuit of the direct current motor. When the two voltages are at different frequencies, the vector E_X will rotate in relation to the vector E_N in Fig. 9. At a certain moment in which the vectors are in relation to one another, as shown by the full-line vectors in the figure, the regulator is connected up and the vector sum E_S will act upon it. With an increase in the load the vector E_X will lag behind and at the same time E_S will increase, thus providing the motor with an impulse to increase its speed. By this means changes of load from the generator are counteracted.

Fig. 9 X 4696

Vector diagram

showing the position of the voltage from the tuning fork, E_N, and the voltage from the generator E_X, as well as the vector sum E_S

As in the case of *BMZ 2233*, the regulators and control equipment are assembled on a control board with a panel for the conversion of the alternating network voltage to a direct voltage, and a panel for each of the direct current-alternating current converters. The tuning fork with its amplifier is also mounted on the first panel, see Fig. 10. The installation in its complete form may consist of five panels, each 600 mm wide and 2 200 mm in height. Here also certain automatic operation has been introduced for controlling the machines. The

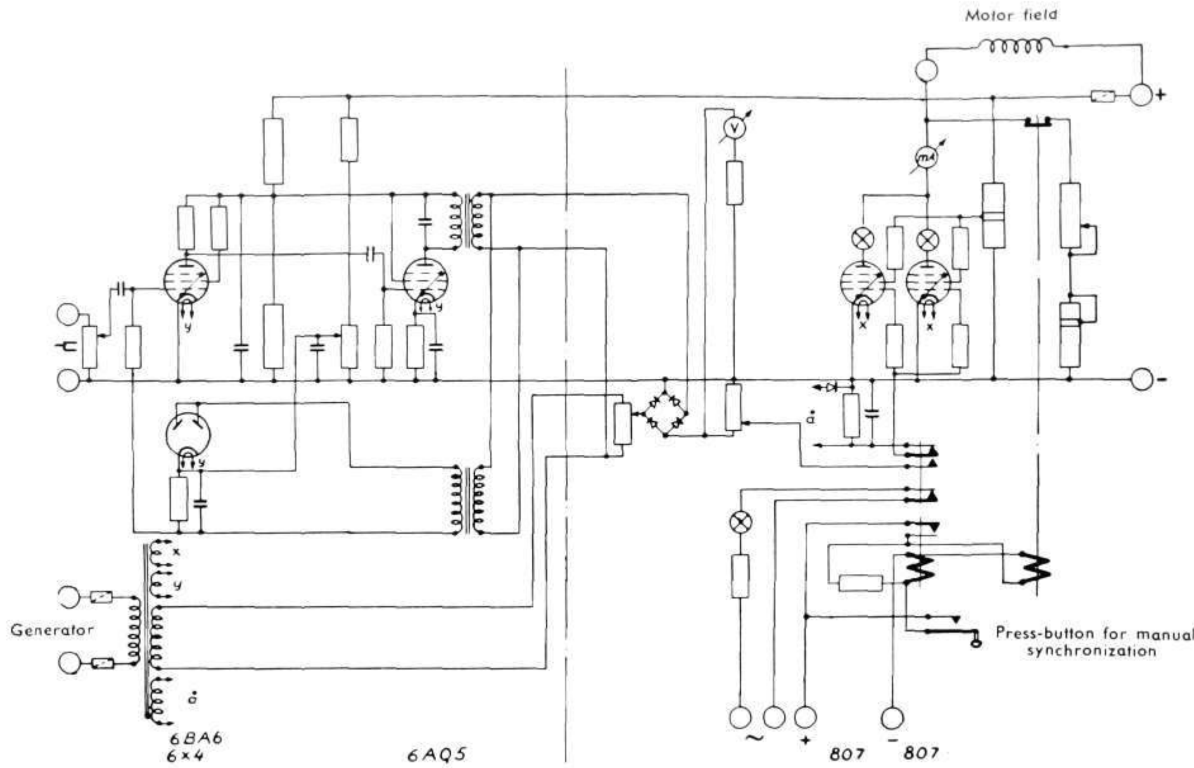


Fig. 10 X 7580

Schematic diagram for the tuning fork amplifier and D.C. motor regulator

valve regulators are connected in circuit after the cathodes have been heated up and signal lamps indicate that starting is taking place normally. Synchronization alone is carried out by hand. By throwing over the change-over switch the machines may be driven without regulators. Their voltages and speed of rotation are manually adjusted by knobs mounted on the lower part of the panels. The controls are blocked in such a way that when the change-over switch for the D.C. generator is set for hand regulation, the remaining regulators cannot be connected in circuit. Disconnection of the frequency regulator does not prevent the alternating voltages from being maintained constant. It is thus possible for the generators to give a constant voltage at frequencies between 46 and 54 c/s, but the frequency must then be adjusted by hand.

BMZ 3333 — Equipment with a Direct Current Motor Controlled by a Tuning Fork

The motor in the equipment *BMZ 2233* is here replaced by a direct current motor which receives its voltage from a generator driven by an asynchronous motor. As in *BMZ 3331*, the speed of rotation of the direct current motor is controlled by a tuning fork and the generators have the same regulators as in *BMZ 2233*.

The control board, Fig. 11, consists of two panels which, together, are 1 200 mm wide and in which the regulators are mounted on draw-out chassis which can be turned over. The tuning fork is placed at the top immediately under the frequency meter. The equipment is started automatically. The start is initiated by means of a press-button, after which the converters are started one at a time and the regulators are connected in circuit after the valves have been heated up. When all the regulators are functioning with the exception of the frequency regulator, a lamp lights up thus indicating that frequency synchronization can take place. This is effected manually by depressing a button at the moment in which the pointer on an instrument passes an index mark.

Loading is supervised by ammeters mounted at the top of the second panel. The same types of signal lamps are used here as for the equipments described previously. A change-over switch for passing from automatic operation to hand operation is mounted at the bottom of the panel, together with knobs for adjusting the frequency and voltages.

The equipments described above represent the main types manufactured by Ermi. These equipments can, of course, be modified and combined to meet the most varied requirements.

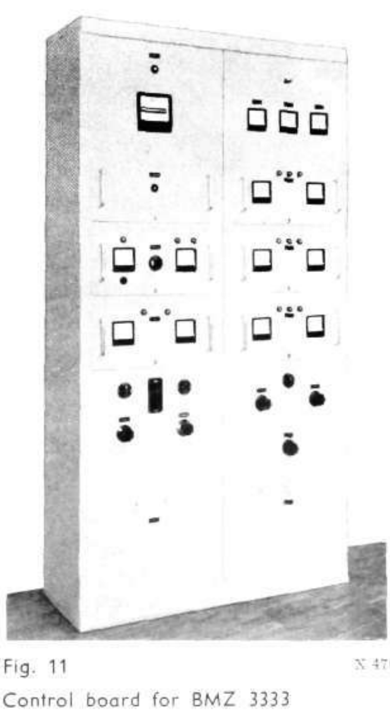


Fig. 11 X 4706

Control board for BMZ 3333

The ATU-system — a New Form of Light Fitting

E. JENSEN, SIEVERTS KABELVERK, SUNDBYBERG

U. D. C. 683.854

Sieverts Kabelverk have recently placed a new form of light fitting on the market to supplement the Gebe-system. This fitting, which is known as the ATU-system, was designed by Sieverts Kabelverk in collaboration with AB Alpha, and is produced exclusively by the latter firm. The new system differs from the Gebe system in the smaller size of the boxes employed and the construction of the lampholders to take threaded glass globes.

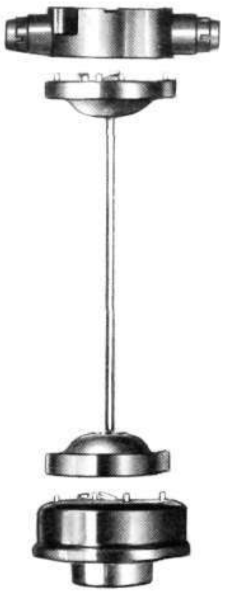


Fig. 1 X 4698
Connecting box, pendant and lampholder for the ATU-system

The ATU-system comprises a number of connecting boxes, lampholders and pendant covers which can be assembled similarly to the corresponding parts in the Gebe system, see Fig. 1. All parts are constructed of plastic material. The ATU-system is primarily intended for the connection of Gebe conductors. The box may, however, also be employed as a tight-fitting box for Kuhlo wiring, and as a conduit box by using nipples.

The internal diameter of the box is 70 mm and its internal depth is 26 mm. The inlets are provided with Pg 13.5 threads corresponding to a thread diameter of 20.4 mm. The boxes are constructed with a maximum of five inlets. The packing for the conductors consists of high grade rubber. The bottom of the inlet and the internal end surface of the packing are designed in such a form that the packing is prevented from creeping in through the hole when small conductors are used. Both the cylindrical surface and the inner end surface exercise a tightening effect.

Boxes with more than one inlet, see Fig. 2, and in which sheath connections can consequently be made, are fitted with a slotted clamp at the centre of the box in which the Gebe conductors' earthing wires are connected. The terminal plate is fixed by means of this clamp. In boxes with one inlet the plate is screwed down by means of an ordinary screw. The terminal plate, Fig. 3, is provided with two, three or four slotted clamps. The conductors are fixed in a clamp by a sliding nut which presses on the conductor over the whole width of the slot. The clamp is of such a length that it affords ample space for six 2.5 mm² conductors. The connection of the lampholder or pendant cover to the terminals on the plate is carried out by U-shaped phosphor-bronze springs with a spherical contact surface which fits into the rounded top of the clamp.

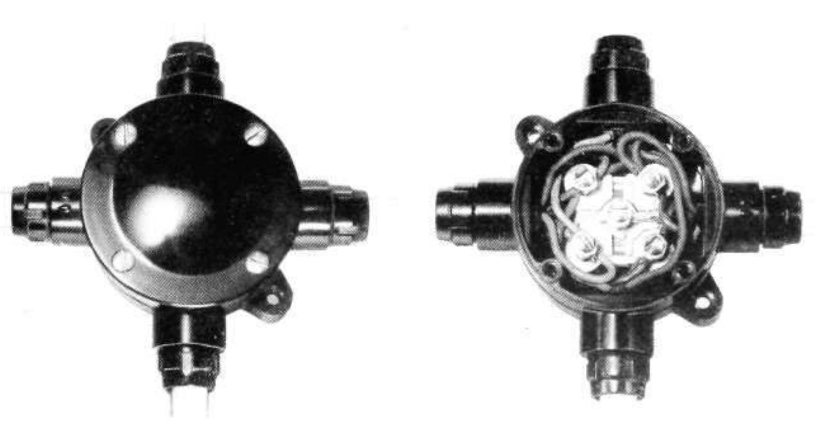


Fig. 2 X 6541
Connecting box
right: with cover removed and with four 4-core conductors and corresponding earthing conductor connected up

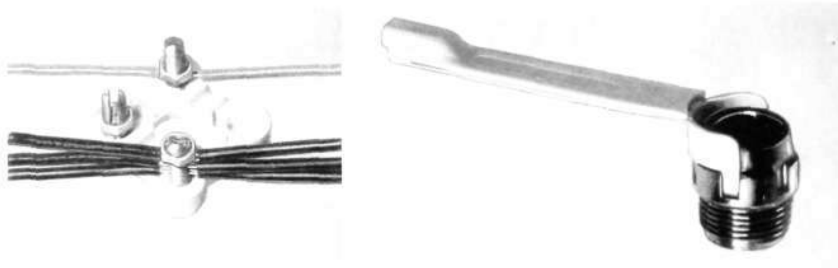


Fig. 3 X 6540

Terminal panel and spanner

for tightening the tubular screw securing the conductor packing and the nuts of the connecting clamps

The tubular screw by means of which the conductor packing is tightened is circular and is provided with six grooves around its circumference for the reception of the spanner used for tightening the tubular screw. Thus, when employing a double inlet where two screws are mounted close to one another, it is also possible to tighten the latter satisfactorily even when the box is installed in a position which is difficult of access. The spanner is further provided with a box key which fits the nuts for the connecting clamps, see Fig. 3.

The box has been designed in a low form, thus rendering the terminal plate conveniently accessible, and therefore the plate itself has not been constructed larger than is necessary for various reasons. Consequently, ample space is available for the maximum number of conductors a box is capable of taking, and it is easy to connect them up.

Fig. 4 X 4699

Lampholder with thread for holding the glass globe

The lampholder and threaded sleeve for screwing in the glass globe constitute a single unit, see Fig. 4. One type is available with an 84.5 mm thread and another with a 99 mm thread. Both the bottom contact and the side contacts are resilient. The tightening between the lampholder and globe is carried out with a packing which lies between the front flat flanged surface of the lampholder and the globe, and this packing is so shaped that a reflector can also be attached without the packing being affected.

The pendant cover is not provided with an external tubular screw and packing around the conductors, but is fitted instead with a packing on the inside which is tightened by a pressure ring and two screws. This imparts a more attractive appearance to the pendant cover amongst other features.

In designing the ATU-system an effort has been made to produce a system having small external dimensions and at the same time providing ample space, and which is convenient to work with whilst possessing mechanical strength. The intention has also been to retain smooth surfaces which do not collect dust, combined with an attractive finish.

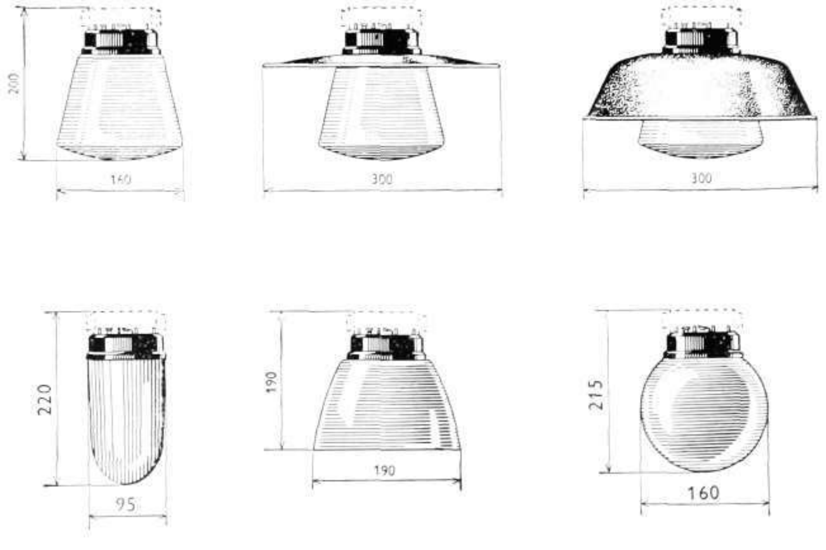


Fig. 5 X 6538

Some types of ATU-fittings

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CONTENTS

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U.D.C. 621.395.344

KARLSSON, S A: *The L M Ericsson Crossbar Switch System in Helsinki.* Ericsson Rev. 27 (1950) No. 4 pp. 106—115.

The article describes the principles of the L M Ericsson by-path system with crossbar switches and the features of the system making this to be used when extending the central telephone exchanges in Helsinki. The author gives an account of the circuit lay-out as well as the mechanical lay-out and gives an account of operating results obtained so far and the extension schemes which have later been decided upon.

U.D.C. 621.318. 5: 621.395

WIBERG, E: *A Midget Telephone Relay.* Ericsson Rev. 27 (1950) No. 4 pp. 116—118.

In the lay-out of a telephone system it frequently happens that full advantage cannot be taken of the technical possibilities of the telephone relay which causes unnecessary space at excessive cost. L M Ericsson has therefore developed a new relay, RAG 500, with a fewer number of contact combinations than the ordinary relay. An account is given of the construction and application possibilities of the new relay.

U.D.C. 621.318. 5: 656.25

ENGER, S: *Plug-in Type Safety Signal Relays.* Ericsson Rev. 27 (1950) No. 4 pp. 119—124.

L M Ericsson's Signalaktiebolag has developed a series of plug-in type safety signal relays having the same high sensitivity and reliability as the safety signal relays now in general use and having the added advantage of the plug-in feature. An account in given of the demands considered in the design of the relays as also of the design and of driving system for A.C. and D.C. respectively.

U.D.C. 654.915.2

TRÄGÅRDH, A: *New Models of Engaged Signalling Equipment.* Ericsson Rev. 27 (1950) No. 4 pp. 125—127.

Description of L M Ericsson's new engaged signal systems, their design and function.

U.D.C. 621.316.721. 078: 621.311

LINDBERG, S E: *Equipment for Power Supplying at Constant Voltage and Frequency.* Ericsson Rev. 27 (1950) No. 4 pp. 128—134.

L M Ericssons Mätinstrument AB has produced a series of power-supplying equipments for feeding current to testing outfits with built-in wattmeters for calibrating electricity meters. These equipments have a voltage which, as distinguished from that of the supply mains, is constant and has a good wave form. The author describes these features and gives an account of the main types of equipments, which are manufactured.

U.D.C. 683.854

JENSEN, E: *The ATU-system — a New Form of Light Fitting.* Ericsson Rev. 27 (1950) No. 4 pp. 135—136.

The ATU-system is designed by Sieverts Kabelverk in collaboration with AB Alpha, and is produced exclusively by the latter firm. The system supplements the Gebe-system and differs from that in the smaller size of the boxes employed and the construction of the lampholders to take threaded glass globes.

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