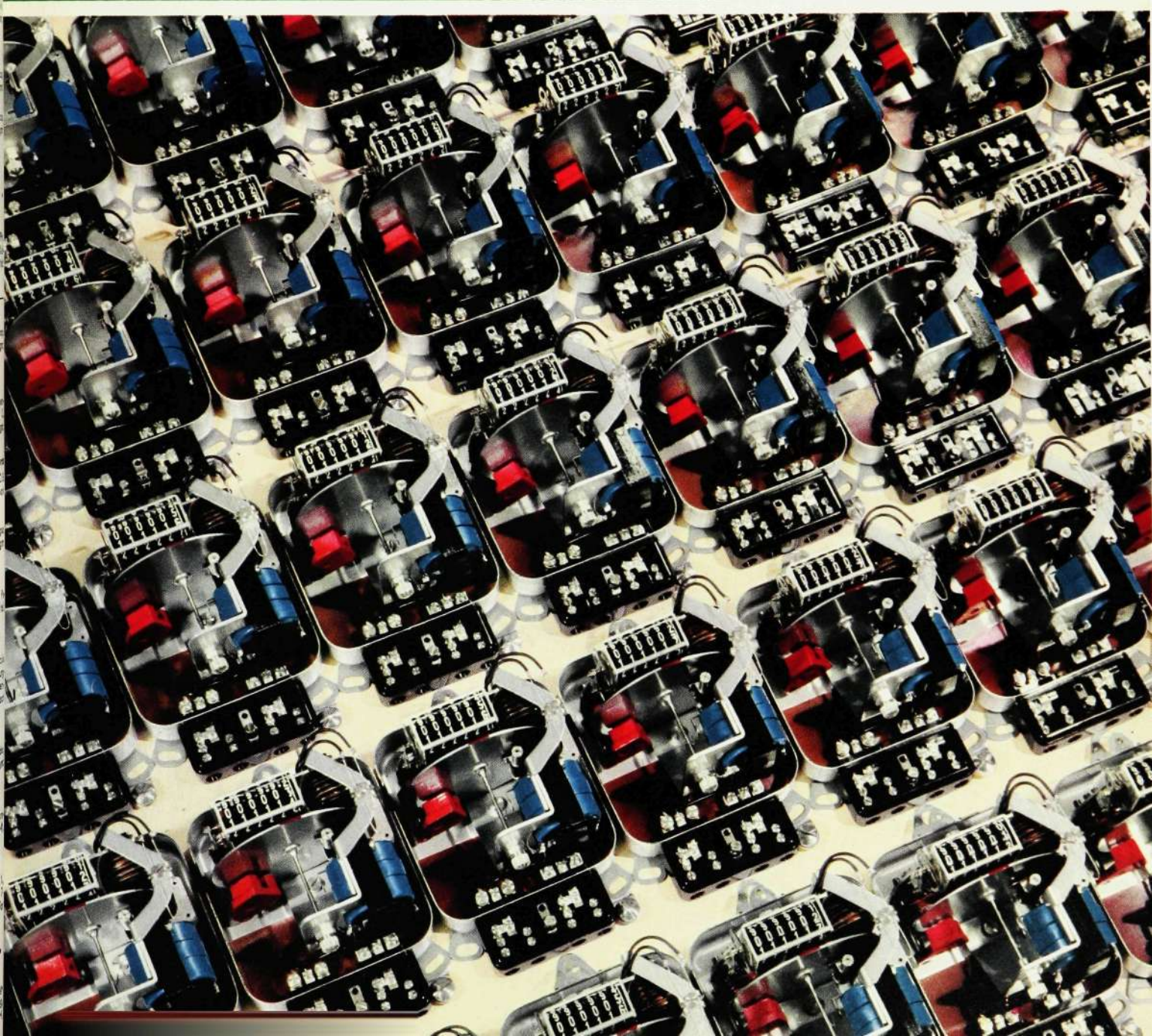
ERICSSON Review

3
1958



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Facilities Offered by Modern Private Automatic Exchanges

H BJÖRK & A HAGLUND, TELEFONAKTIEBOLAGET LM ERICSSON, STOCKHOLM

U.D.C. 621.395.25

Users of private telephone systems are coming to expect a greater measure of convenience and rapidity in telephoning than they have been used to in the past. Entirely new means of meeting these demands have been provided by developments in marker switching as applied to crossbar exchange. Some of the new facilities developed by Telefonaktiebolaget L M Ericsson are described in this article, which deals principally with a private automatic exchange for up to 800 extensions, type ARD 231.

The first obvious requirement on a private automatic exchange is that it shall provide rapid and reliable internal communication. But a modern P.A.X. or P.A.B.X. should also include one or more of the following services to the customer's choice:

1. Group calls
2. Priority
3. Interworking with other exchanges
4. Conference facilities
5. Paging (Staff location)
6. Night watchman control
7. Centralized dictation facilities
8. Immediate access

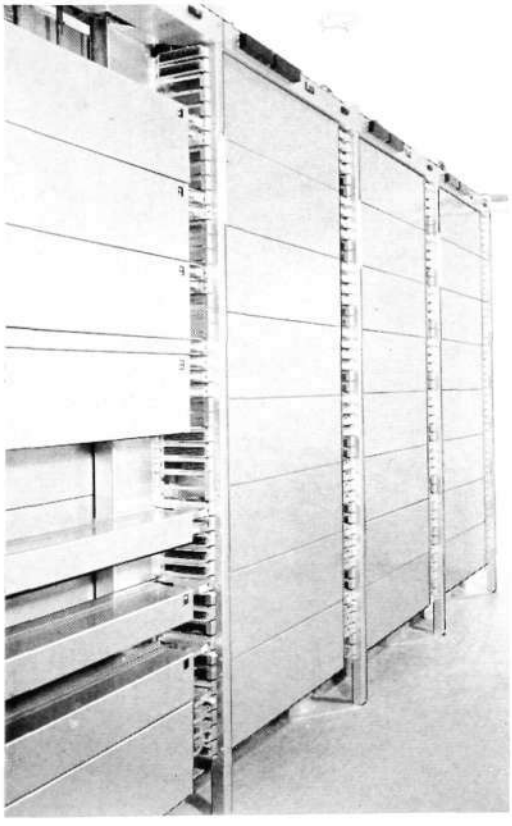


Fig. 1 X 2323

Automatic exchange type ARD for 200—800 lines

Switching bay

In certain of L M Ericsson's private exchanges several of these services have been improved, while the following facilities have been added:

9. Call-back facility
10. Automatic interception
    a. Redirection to other telephone number
    b. Redirection to telephone answering machine

For these services supplementary equipment is added to the exchange.

1. *Group calls*

In exchanges which employ conventional types of switches the method of operation of the switch has made it difficult to combine extensions, not in sequence in the selector multiple, into a group with a common group number. One consequence of this has been the impossibility of adding further extensions to a group when a certain extension number is already utilized. This drawback has been eliminated in the new exchanges in which, within any one hundred's group, the extensions can be combined into groups of five with a group calling number. The possibility still exists, nevertheless, of calling each extension in the group individually.

2. *Priority*

All extensions with numbers ending in the digit 9 can be given priority. If a priority extension meets an engaged signal, the user can obtain contact with the engaged extension by dialling the digit corresponding to two impulses, i.e. "2"

on a dial numbered 1—9, 0. A faint warning tone is issued to the conversing extensions when a third party enters the line. The latter, if he wishes, can deliver a short message and then cut out of the connection by replacing his handset; or he can request the two parties to finish their conversation and hang up, after which the wanted extension is automatically rung.

3. *Interworking with other exchanges*

One extension line is required for every tie line. Three-digit numbers are normally used for calling associated exchanges. If a number of tie lines lead to the same exchange, a group calling equipment will be required as under point 1.

4. *Conference facility*

Every extension can establish a conference connection with any other four extensions simply by means of the dial. If a record of the conference is desired a dictating machine can be connected, in which case the number of participators is reduced from five to four.

5. *Paging*

This service has been considerably improved and expanded. Paging can be initiated from any extension. Despite this, the paging extension can be used for normal telephone communication while paging is in progress. No connecting circuit is occupied during paging. The paging equipment is immediately released when telephone communication is established between the two parties.

One hundred paging combinations are available. These combinations can be used within four different sectors, so providing a potential capacity of 4×100 persons. But as persons who are to be paged in more than one sector will naturally have the same combination throughout all sectors, the total capacity will be reduced accordingly. Two persons can be paged simultaneously, each in his own sector.

When a person is to be sought within more than one sector, the signals start immediately in the sector or sectors that are disengaged. The remaining sectors are switched in as soon as the previous paging has terminated.

The paging equipment is called by a two-digit number. If it is free, it returns dial tone and the caller dials the telephone number of the sought party. An analyser translates the telephone number into a lamp combination, at the same time selecting the sector in which the wanted person is to be sought.

When the wanted person notices his lamp paging combination, he uses the nearest telephone to dial a three-digit page answering number which establishes a normal connection with the calling party. The paging equipment is thereby released.

If the caller is engaged on another call while paging is in progress, the wanted person is connected to the conversation when he answers. This connection is equivalent to a priority circuit, and if the conversing parties conclude their conversation a normal connection is established between the original caller and the paged party.

6. *Night watchman control*

If a patrolling night watchman is to perform his duties effectively, the following provisions must be made:

Automatic issue of alarm if anything untoward happens to the watchman
Rapid establishment of his probable whereabouts when alarm issued
Means of requesting rapid assistance in an emergency
Possiblity of varying rounds and times of passing given points.

These requirements are met by the night watchman control system which can be connected to L M Ericsson's automatic telephone exchange type *ARD 231*. Any extension telephone can be used as control point without special arrangements being required. This makes it simple to vary the rounds. The extension number of the control point and the time of the call are recorded in the control office when the patrolling watchman dials a two-digit number from the control point extension to call the control office. Thus the control office has a record of the time and place of the last call. If an alarm is issued owing to a missing control call within the prescribed time, assistance can be immediately directed to the place where the watchman should be. The watchman is able to contact the control office from the nearest telephone.

Direct contact can be made with the patrolling watchman from the control office by pressing a button. The next call from the watchman then goes automatically to the control office telephone.

If indications are required from locations where no telephone exists, additional circuits can be installed for push button operation.

7. *Central dictation*

Dictating machines for control from a telephone instrument can be connected to the switchboard. If the central transcribing department has more than one dictating machine, the machines are called by a group number. The first free machine is then connected to the calling extension via control relays. The dial is thereafter used for the various controls of the machine such as playback, correction indexing, end-of-letter indexing etc. (See Ericsson Review No. 1, 1958.)

8. *Immediate access*

This facility enables direct calls to be made to certain selected extensions by pressing a button corresponding to the extension number.

9. *Call-back service*

Repeated unsuccessful attempts to reach engaged extensions are irritating and entail poor economy both in the use of the switching equipment and in staff time. The introduction of automatic call-back service has led to a great reduction in annoyance and to better utilization of the exchange. The engaged extension is automatically supervised from the calling extension without occupying any speaking circuit and without preventing the caller from using his telephone for communicating with other extensions during the supervisory period. As soon as both extensions are free, the party who initiated the supervision is called and, when he lifts his handset, a ringing signal is issued to the wanted extension. When the latter answers, a normal connection is established. Accordingly the call-back equipment is not occupied during the conversation but is immediately released for a new call.

If the initiating extension is engaged on another conversation when the supervised extension becomes free, he is reminded of the waiting call by a discreet tone. He then has 20 seconds to complete the present conversation. If he

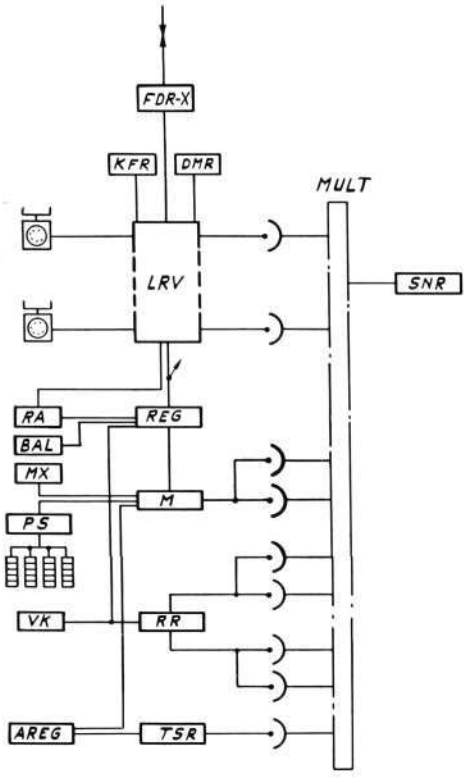


Fig. 2 X 2320

Trunking diagram for automatic exchange type ARD 231

AREG	interception register
DMR	dictating machine relay set
FDR-X	tie-line to other switchboard
KFR	conference equipment
M	marker
MULT	multiple
MX	group marker
PS	paging equipment
RA	register connecting relays
REG	register
RR	call-back equipment
SNR	link circuit
TSR	telephone answering machine relay set
VK	night watchman service relay set

does so within this time, he is automatically rung by the call-back equipment. If he takes more than 20 seconds, the supervision terminates and he must make a new call in the normal way.

On receipt of engaged tone the caller can put through a new call through the call-back equipment. He dials the two-digit call-back number, waits for dial tone, dials the number of the wanted extension once again and then replaces his handset. His telephone is now free for other calls.

On receipt of a ringing signal from the call-back equipment the caller raises his handset; he hears the ringing tone and knows that he can expect a reply from the called extension.

10. *Automatic interception*

a. *Redirection to other telephone*

This service enables an extension user to redirect his incoming calls to any other extension number in the system. It is a simple means of giving him practically the same facilities as if he had taken his telephone with him.

b. *Redirection to telephone answering machine*

When a person does not wish to be disturbed by unimportant calls, it is possible to direct incoming calls to a telephone answering machine. The telephone answerer announces to callers that the wanted person is engaged and does not wish to be disturbed, but that, if their business is urgent, they can speak to him by dialling a prefix followed by his extension number.

A number of centrally located telephone answering machines can be called for individual recording of brief messages. These machines can be placed at the service of persons who only need them on sporadic occasions and thus do not require a machine of their own. After the recording of a message, incoming calls are automatically directed to the right telephone answerer, which delivers the recorded message.

To make use of these services the extension user dials the two-digit number for the service in question, followed by his own extension number. Cancellation of the service is effected in the same way, but by the dialling of a cancellation number followed by the extension number.

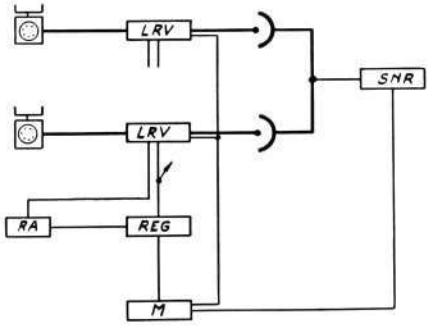


Fig. 3 X 2321

Trunking diagram for normal telephone communication

LRV	line equipment
M	marker
RA	register connecting relays
REG	register
SNR	link circuit

Automatic telephone exchange ARD 231

This exchange can be used for from 200 to 800 extensions. Up to 44 link circuits can be installed, permitting a corresponding number of simultaneous conversations.

The principal switching elements are crossbar switches and relays which are combined to form the following main units:—line equipments, registers, markers and link circuits.

A line equipment unit serves 10 extensions and consists of a 10-vertical crossbar switch, 10 line relays and 7 group relays. Thus each extension disposes of one vertical of the crossbar switch. The line equipment crossbar switch has 30 positions in the multiple. Twenty-nine positions are used for connection of link circuits and one position for busying and line lockout. Every group of ten extensions possesses two common links for connection of the registers. The registers are made up of crossbar switches and relays. Every group of one

Fig. 4 X 2304

Keyset telephone type DBH 16 for v.f. impulsing

hundred extensions has access to two registers. The markers and link circuit equipments consist of relays.

The link circuits are multipled to the extension selector banks. In all extension selectors to which a given link circuit is multipled the link circuit reappears at the same multiple position. Consequently, to set up a connection between two extensions, all that is required is that the selectors of the two extensions be connected to the same multiple position. During the period in which an extension is connected to a register, no link circuit is occupied. By the use of a graded multiple it has been possible to arrange for 44 link circuits.

Switching procedure

On the raising of an extension handset the extension line relay operates. The register connecting relays extend the circuit to a free register. The number of the calling extension is recorded in the register. The caller, on receipt of dial tone, dials the number. After each train of impulses the corresponding digit is recorded on a vertical of the register's crossbar switch. Upon receipt of the last digit the register is connected to the marker, which identifies the called extension and tests for the engaged condition. If it is disengaged a free link circuit is seized. The vertical of the called extension operates and the extension is thereby connected to the link circuit. Immediately thereafter the calling extension, which has been identified in the register, is seized and its vertical in the line equipment operates. The register and register link are thereby released and the calling extension is connected to the link circuit. A repeated ringing signal is sent from the link circuit to the called extension, and ringing tone is heard by the caller.

If the called extension is engaged, no link circuit is seized. Instead, the circuit is extended to the position in the selector multiple used for engaged condition and line lockout, immediately followed by operation of the calling extension's vertical. The register and marker release.

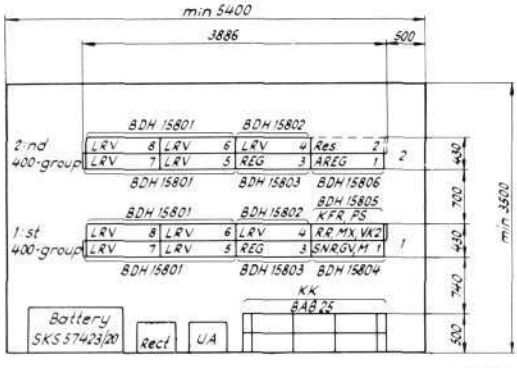


Fig. 5 X 2322

Layout of ARD 231

AREG	interception register
GV	selector for connection of RR to link circuits
KFR	conference equipment
KK	M.D.F.
LRV	line equipment
M	marker and common test and supervisory relays
MX	group marker
PS	paging equipment
REG	register
RR	call-back equipment
SNR	link circuit
UA	desk for test instrument
VK	night watchman service relay set

Free ceiling height : 2500 mm
Rack height : 2200 mm

Keyset type telephone

Keyset or dial type telephones, or both types together, can be connected to the switchboard.

The use of keyset type telephones enables the rapidity of the switchboard to be utilized to the full. Dial impulsing is in such case replaced by v.f. signalling to a v.f. receiver in the register. The signals are amplified in a transistorized amplifier before being used for operation of the registers. In other respects the switching follows the normal procedure.

Constructional features

The switchboard equipment is accommodated on 2200 mm high racks, which may be single- or double-sided. A double-sided rack occupies 430 × 961 mm of floor space. The racks can be placed in one or more suites; single-sided racks can, if desired, be placed against a wall. All relay sets and switches are plug-in units.

Power supply and ringing equipment

The exchange operates off 24 V, with tolerances between 20 and 30 V. A rotary converter operated off the switchboard battery generates the necessary ringing current and tone signals. The converter and its associated impulsing relays etc. have been combined into a single unit of plug-in type.

P.M.B.X. Type ADF 162 for C. B. Systems

W ADENSTEDT, TELEFONAKTIEBOLAGET LM ERICSSON, STOCKHOLM

U.D.C. 621.395.23

Although we live in the automatic age, there is still a wide use for manual telephone switchboards. In this field as well, L M Ericsson has always striven to offer its customers switchboards of the most modern and efficient design. To this end a new single-position P.M.B.X. has been designed, typed ADF 162, which possesses a number of technical and practical finesses.

The new P.M.B.X. *ADF 162* is a single-position floor type switchboard for C.B. extensions and has a maximum capacity of 180 extensions, 16 exchange lines and 18 cord circuits. It will operate in conjunction with all manual and automatic public telephone systems. The novel features of *ADF 162* are the following:

All equipment except the power plant is placed in the switchboard.

Automatic interrupted ringing as soon as the plug is inserted in the called party's jack. At the same time the caller hears ringing tone. Simple switch-over to manual ringing which allows a less disturbing signal which is a valuable feature at nighttime in hotels and hospitals.

Secrecy of conversation through transmission of warning tone if the operator enters the circuit.

Splitting key which permits operator to converse with one party without the other being able to hear.

Waiting jack with lamp which slowly flashes to remind operator of a waiting call.

Supervisory jack enabling operator to supervise a line while continuing to dispatch calls on other lines.

The switchboard also fulfils the following normal requirements of a modern P.M.B.X.:

Direct dialling facilities for all extensions.

Automatic holding of exchange lines on all incoming calls and on outgoing calls established by operator, so providing transfer and enquiry facilities.

Exchange lines can be switched to night service by means of the normal cord pairs.

No current consumption during night service.

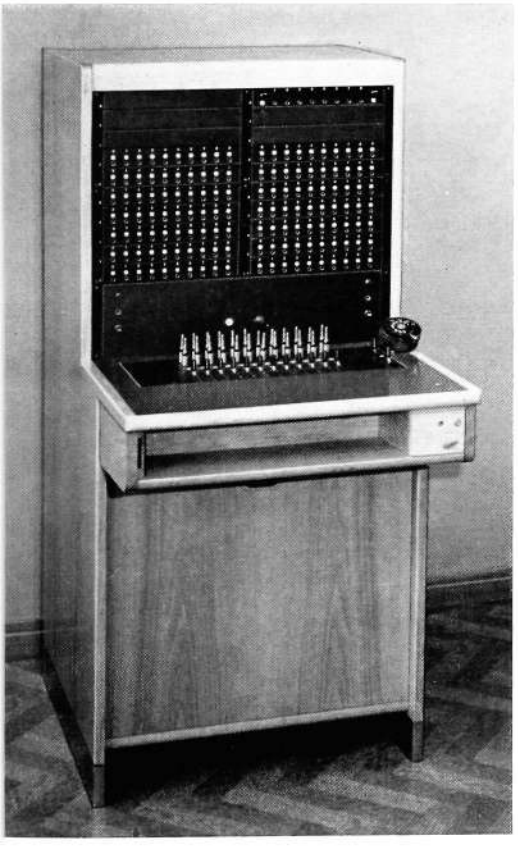


Fig. 1 X 2210

P.M.B.X. type ADF 162

equipped for 140 extensions, 8 exchange lines and 12 cord circuits

Switchboard Construction

As in L M Ericsson's other switchboards, the cabinet consists of oak veneered laminated boards and the keyshelf is lined with green linoleum. A new feature is that the cabinet is shipped in separate parts, so reducing the volume and the risk of damage in transit.

The switchboard is 1322 mm high, 636 mm wide, and 845 mm in depth including the keyshelf.

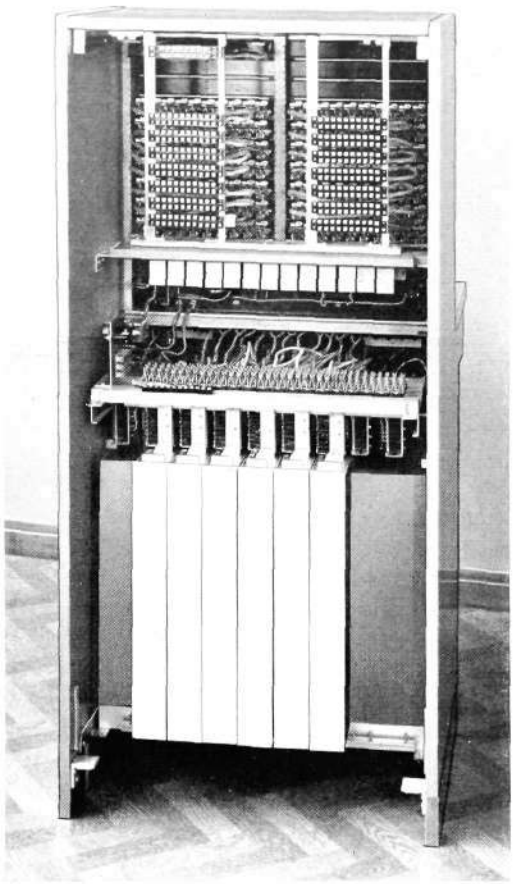


Fig. 2 X 2219

P.MB.X. type ADF 162

rear view with panelling removed

A switchboard type *ADF 162* equipped for 140 extensions, 8 exchange lines and 12 cord circuits is shown in figs. 1 and 2.

All switchboard equipment consists of separate, factory-wired units ready for assembly on site. The advantage of this is that the switchboard can be initially equipped solely for immediate requirements and later added to, when desired, without interruption of the service. Maintenance is also greatly facilitated, as a faulty unit can be readily replaced or removed for repair. It may be mentioned that only one unit has been newly designed for *ADF 162*, and that is the line unit for the exchange lines. The extension line unit is the same as in switchboards ADE 12 and ADF 14, and the remaining units are the same as in the multiposition switchboard ADF 30.

All cabling between the switching sets, position sets and relay sets meets on a *switchboard wiring unit* (fig. 3) to which the other units connect by plug and jack. The switchboard wiring unit also contains the switchboard fuses.

The *position set* (fig. 4), at the bottom of the jack field, contains all common relay equipment, waiting jack with lamp, supervisory jack, pilot lamp for clearing signals, fuse alarm lamp, and two keys for cutting out automatic ringing and connection of night bell.

The *dial* is placed on a bracket at the right of the keyshelf, and immediately to the left of it is a splitting and ringing key unit with lamp (fig. 5).

On the keyshelf is also the *switching set* (fig. 6). This set accommodates the cords, a clearing signal lamp, and a speaking and night connection key.

The *cord relay set* (fig. 7), serving two switching sets, is placed vertically in the rear of the cabinet as seen in fig. 2. The relay set contains transmitter feed and ring trip relays, test relays which prevent the connection of two cord circuits to the position equipment simultaneously, and certain identification relays.

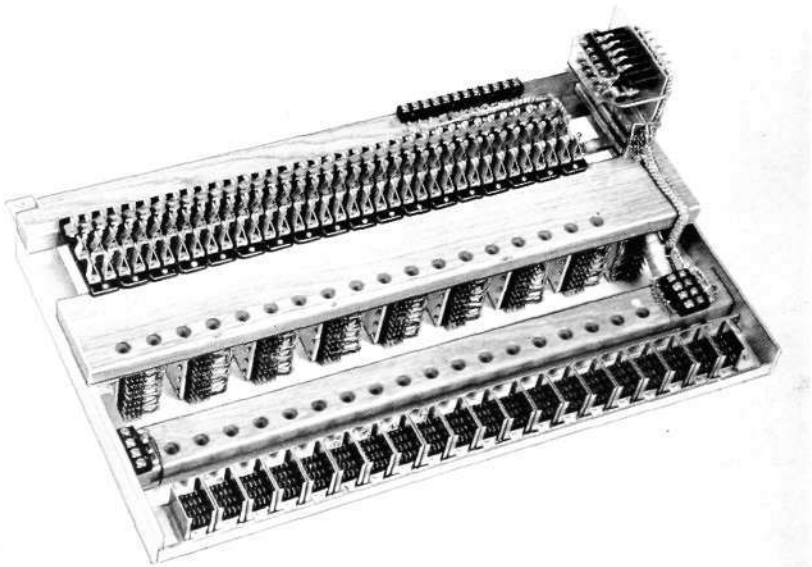


Fig. 3 X 8021

Switchboard wiring unit

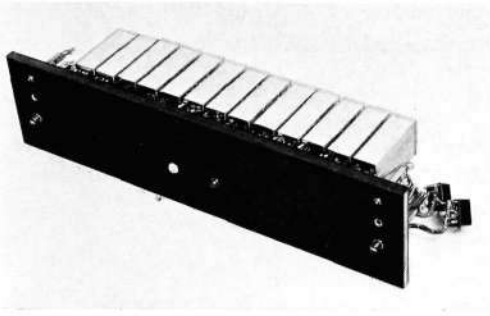


Fig. 4 X 2215
Position set

The *line units* are of two types, one for extensions (fig. 8) and one for exchange lines (fig. 9). Both types are complete cabled units with terminal block for direct connection of the incoming cables.

The extension line unit contains calling lamps and jacks for 10 lines. The actual calling device consists of a relay jack type *RNC 20*.

The exchange line unit is of a type less usual in C.B. switchboards, since it has drop indicators in place of calling lamps. The advantage of indicators over lamps in a single-position switchboard, in which a single device must be relied on for signalling a call from the public exchange, is the very much greater certainty of the call being indicated at the switchboard. Lamps inevitably burn out after a period of use; and unless they are checked daily, a call from an exchange line may remain unanswered, which always creates irritation. The same argument, of course, applies to the extensions; but if a lamp is faulty on an extension line, it is likely to be immediately reported. On exchange lines, on the other hand, lamp faults merely result in a general complaint that the operator is not answering incoming calls. The indicator used in the exchange line unit is the normal combined indicator and jack type *RNE 15*, which restores automatically when the call is answered.

Normally ten indicator jacks are mounted on one line unit, but in this case the two end indicators have been replaced by pilot lamps, so that the unit contains equipment for eight exchange lines.

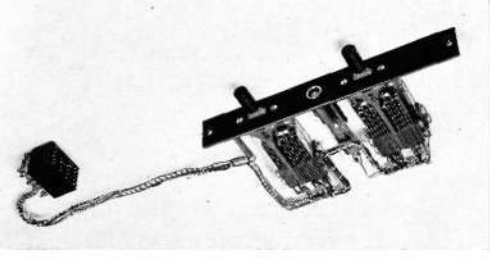


Fig. 5 X 2216
Splitting and ringing key set

Connection to Magneto System

ADF 162 can also be connected to a magneto public exchange, but in such case requires a signal repeater for every exchange line. The signal repeaters are placed in a separate bay. The signal repeater effects automatic transmission of calling and clearing signals when the operator plugs up or removes a cord pair. Under night service conditions the calling and clearing signals are controlled direct from the extension's C.B. telephone.

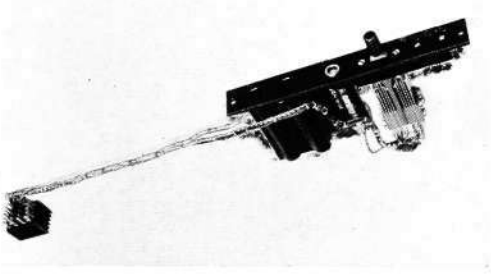


Fig. 6 X 2211
Switching set

Technical Data

The maximum capacity of the switchboard is 180 extensions, 16 exchange lines and 18 cord circuits. As the line units consist of detachable units, however, the number of extensions can be increased by reducing the number of exchange lines. With only 8 exchange lines, the extensions can be increased to 190; if exchange lines are discarded altogether, the switchboard can be converted into a P.A.X. for 200 extensions. Theoretically the number of exchange lines could be increased at the cost of the extensions; but such an arrangement would lack any practical value since the number of cord circuits cannot be increased above 18, so that not more than 16 exchange lines could be served.

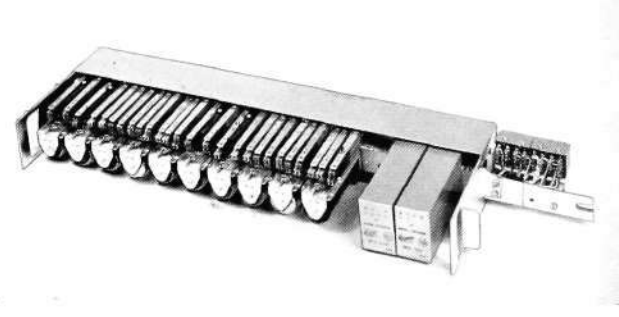


Fig. 7 X 7718
Cord relay set
with front cover removed

Fig. 8 X 2213

Line unit for 10 extensions

The switchboard is designed for a supply voltage of 24 V, but will operate satisfactorily between 20 and 28 V. When installed to full capacity, the busy hour current consumption is 2 A.

The resistance of extension lines should not be above 500 ohms, and the insulation resistance not below 15000 ohms.

The resistance values of the exchange lines will be governed by the operating limits of the public exchange equipment, since the drop indicators on the exchange lines permit a line resistance of up to 2000 ohms.

The microphone feed circuit incorporates 2 × 250 ohm transmission bridges.

Fig. 9 X 2214

Line unit for 8 exchange lines

Power Equipment

The switchboard requires a 24 volt d.c. supply and an automatic ringing current generator.

The most dependable source of power is undoubtedly a battery and charging unit for the 24 volt supply, in which case a pole changer, driven off the battery, can be used for the ringing current.

If a.c. mains are available, and there is little risk of current failure, a mains-operated power unit can be used for the 24 volt supply and a frequency transformer for the ringing current.

Wide Range Single-Phase Meter

S E L I N D B E R G, A K T I E B O L A G E T E R M I, U L V S U N D A

U.D.C. 621.317.785.025.1

Electricity meters of today must be able to measure electric energy accurately even under conditions of widely varying load. A single installation consumes large quantities of energy consisting, on the one hand, of small loads from lamps, wireless sets and the like, which are switched on for considerable periods, and, on the other, of stoves, washing machines and other apparatus which impose a high load during much shorter periods.

ERMI manufactures *wide range* meters suited to all types of installations. In the present article a single-phase meter is described, type *VEN 23*, which will measure loads of up to 360 % of its rating within an error of not more than 2.5 %. It is designed to measure single-phase energy with great accuracy even if the line voltage and ambient temperature vary within wide limits.

Error at Varying Load

The factor which limits the effective working range of a meter at *very small loads* is the variable forces of friction which are high in relation to the driving forces involved at these loads. Consequently, the frictional forces should be low and the driving force high.

In the present meter the friction in the register (fig. 2) is very small compared with that in the bottom bearing. Despite the comparatively low efficiency of the worm-gear on the rotor spindle, the friction is not greater than 0.4 mgcm. This low value is obtained by pivoting the register spindles and by the

Fig. 1 X 7735

Single-phase meter VEN 23

(right) with cover removed. The meter components are easily accessible. For ratings up to 10 A the cover is of aluminium and the base of sheet steel. The cover is not enamelled inside.

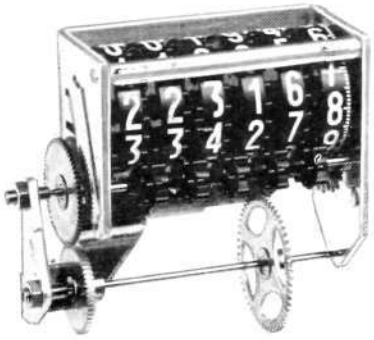


Fig. 2 X 2341

Register of VEN 23

with plastic drums and pinions, and stainless steel spindles with pivot bearings

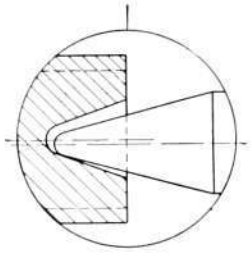


Fig. 3 X 2278

Journal of pivot bearing type register

Cone angle of spindle = 30°
Radius of spindle tip = 0.15 mm
Diameter of spindle = 1.2 mm
The pivot bearing reduces the radius of the spindle at the pivoting point from 0.6 to 0.15 mm

low weight of the moving parts such as the gear wheels and figure drums. The radius of the spindles at the pivoting point is as little as 0.15 mm (fig. 3), despite their otherwise robust construction with cylindrical portion 1.2 mm in diameter. The six figure-drums and the five pinions weigh only 4 g. Redesign of the rotor hub has reduced the weight of the rotor to only 22 g. Every gram eliminated from the weight of the rotor has a great effect on the friction in the bottom bearing, and so on the life of the bearing.

The torque could be improved by increasing the dimensions of the driving element, and so of the entire meter. But this would be undesirable, and the friction has therefore been reduced instead.

The error curve of a meter under varying load (fig. 4) sooner or later falls to negative values at high loads. The physical reason for this is that the driving flux in the current system brakes the rotor with the square of the current. The smaller the driving flux in relation to the permanent flux of the brake magnet, the less unfavourable will be its effect.

As a first measure to this end, therefore, the meter has been given a strong brake magnet.

It is the magnetic shunt in the current system, however, which contributes most to the straightness of the error curve (fig. 6). The effect of the shunt is that, at loads above 150 % of the current rating, the driving flux of the current system increases very much more quickly than the current through the meter. In this way the rapidly increasing braking effect is compensated until the shunt becomes saturated.

But the design of the magnetic shunt is such that it causes the driving flux to concentrate towards the centre, where the voltage flux cuts the rotor, so causing a further increase in the driving torque (fig. 6). At high loads, i.e. at high values of the current I, the shunt has a high magnetic resistance, so that the flux tends to take the path across the limbs of the shunt which face the rotor rather than across the shunt itself.

Effects of Variation in Voltage, Frequency and Temperature

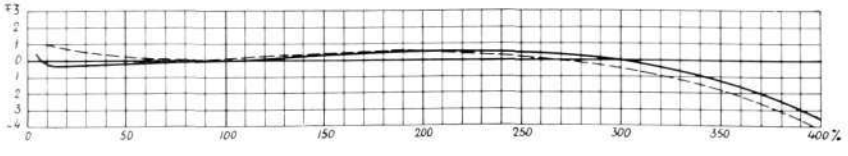
Unfortunately, the term "exact" as applied to measurement does not exist, for a measuring apparatus is always subject to error to a greater or lesser extent. And electricity meters are no exception to the rule.

The diagram in fig. 4, showing the error of the meter at different loads, is typical of the meter when fed with the rated voltage at rated frequency and at a rated temperature of + 20° C, and must be supplemented by data of the meter's behaviour at varying voltage, frequency and temperature.

At varying voltage, frequency and temperature, additional errors arise which are referred to as voltage error, frequency error and temperature error.

Fig. 4 X 8102

The meter can be loaded from values of below 5 % up to 360 % of the current rating without the error in indication exceeding 2.5 %. At intermediate loads from 10 % to 320 % the error curve follows the zero line.



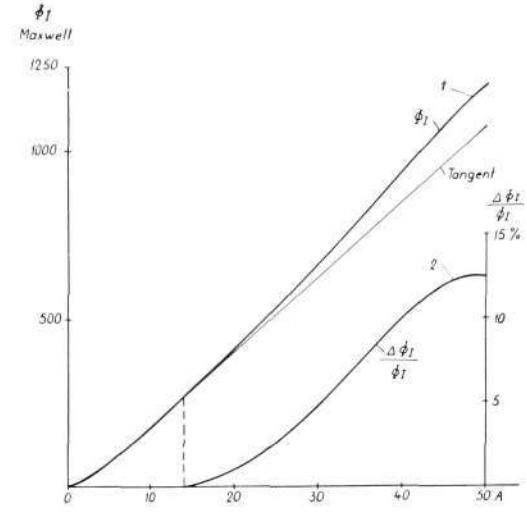


Fig. 5 X 2330

The driving flux due to current Φ_I through the rotor increases more than proportionally up to a value at which the magnetic shunt is saturated.

1 The absolute increase of Φ_I
2 The per cent increase of Φ_I

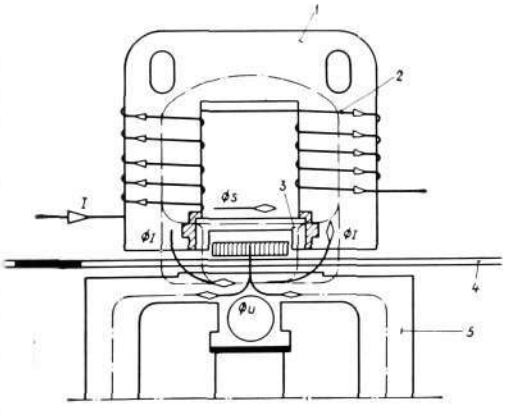


Fig. 6 X 2331

The magnetic circuits of the current system under non-inductive load

1 Core of current system
2 Current coil
3 Magnetic shunt
4 Rotor
5 Core of voltage system

I Current through meter
Φ_I Flux of current system
Φ_S Shunt flux
Φ_U Flux of voltage system

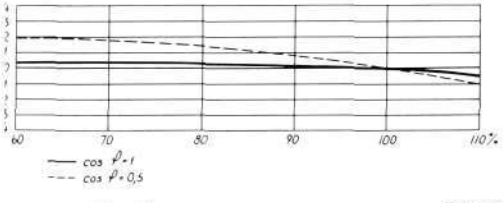


Fig. 7 X 2332

The voltage error is below ± 0.5 % although the voltage varies from 60 % to 110 % of the rated voltage. This is true for cos $\Phi = 1$.

For phase lag cos $\Phi = 0.5$ corresponding values are + 2 % and — 1 %.

The line voltage does not generally vary by more than ± 10 %. But meters rated for too high a voltage are sometimes used provisionally in networks which are to be converted from, for example, 127 V to 220 V. If the meter is to be used at around half of the rated voltage, it is obviously necessary to know the magnitude of the voltage, frequency and temperature errors (fig. 7).

By suitable design of the magnetic shunt in the voltage system, a good balance is obtained between the driving and shunt fluxes (fig. 8). The main flux, generated by the voltage coil, divides into a driving flux through the rotor and a shunt flux, in order to produce a 90° phase displacement of the driving flux in relation to the line voltage. This phase displacement is necessary in order that the meter may register active energy. The magnetic circuit of the shunt is so designed as to compensate for the braking action on the rotor due to the driving flux, the braking action varying as the square of the voltage. This is in analogy with the conditions in the current system under varying load. The shunt flux divides into two branches on the two sides of the large hole in the shunt, where the areas of iron are comparatively small. At the rated voltage they become almost saturated. Between the centre limb and the shunt is an air gap which is filled by a copper disc roughly 0.5 mm thick.

The effects of *variation in frequency* are normally of little significance since the line frequency is generally very accurately regulated. Deviations as high as ± 5 % of the rated frequency very seldom occur. The frequency errors are therefore very small, as seen in fig. 9.

The effects of *variation in temperature* (fig. 10) are important since meters are often placed out-of-doors in places where the winter temperature may be as low as − 10° C and summer temperature up to + 40° C, i.e. a range of up to 50° C.

Temperature errors of the meter, which are complicated by a variety of causes, are compensated by suitable design of the magnetic circuits, and also by a temperature-sensitive device on the brake magnet. Changes in temperature cause variations in resistance in, among other parts, the voltage coil and rotor, which alter the phase angles of the fluxes and, to some extent, affect their amplitude.

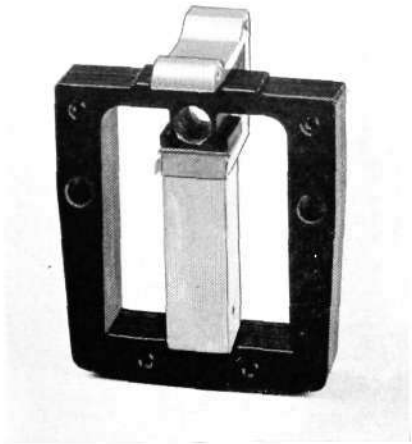


Fig. 8 X 2342

The voltage system consists of laminated cores cut from sheet steel containing 3.5 % silicon, by which the core losses are reduced.

The central core or limb is surrounded by the »frame», on one side of which is an inward-pointing section which forms part of the sensitive magnetic shunt.

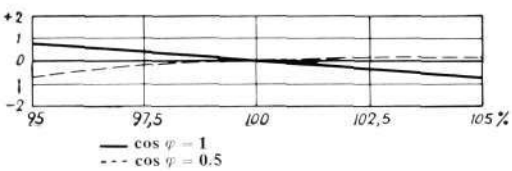


Fig. 9 X 2334

The frequency error remains within ± 1 % for a change of from 95 % to 105 % of the rated frequency.

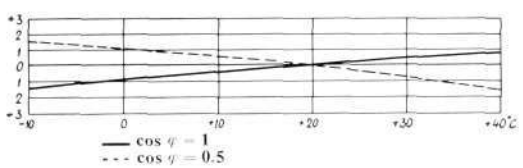


Fig. 10 X 2333

The temperature error is less than 0.5 % per 10° C within the range — 10° C to + 40° C.

Between the two magnetic elements in the lower part of the brake magnet (fig. 11) is a U-shaped strip consisting of a nickel-steel alloy. The parts of the strip in contact with the magnetic elements shunt part of the flux away from the rotor. The alloy, which consists of 70 % iron and 30 % nickel, has the property of being less conductive to flux at high temperatures, so that the braking effect of the magnet increases with the temperature.

The Driving Element

The meter is a small Ferraris motor, the rotor of which is driven by the driving element, consisting of a voltage system and a current system. In order that the disc may rotate at a speed proportional to the power, it is braked by the flux from a permanent magnet. The number of revolutions made by the disc is recorded by a register graduated in kWh.

In the assembly of the *voltage system* the large hole in the magnetic shunt is used for attachment of the low load device, which consists of a resilient piece of sheet steel (fig. 13). The low load device is of micrometer pattern and can be very accurately adjusted.

The centre limb, which carries the coil, is firmly fixed to the voltage frame. There are no screw connections which can become loose in service. In order that the meter may remain stationary when the loading current is zero but the line voltage is applied, a leakage flux is passed via a strip of iron on the voltage system to a piece of iron attached to the rotor spindle. These two pieces of iron have a mutual attraction which is so small that the meter starts at about 0.3 % of the rated power, and which is nevertheless sufficient to prevent the meter from rotating when not under load, even if the line voltage varies by ± 20 %.

The *voltage coil* (fig. 12) has very good insulation. It is surrounded by a case of polythene. The case consists of two halves which overlap over the coil and insulate it so effectively that no flash-over is possible between the thin, delicate winding wire and adjacent metal parts.

The other part of the driving element—the *current system*—has a U-shaped core consisting of silicon-steel laminations (fig. 14). The current coil is divided around the two limbs, between which is the magnetic shunt, made of sintered silicon iron. The shunt is held in position by two brass clamps which at the same time fix the air gap in the shunt circuit.

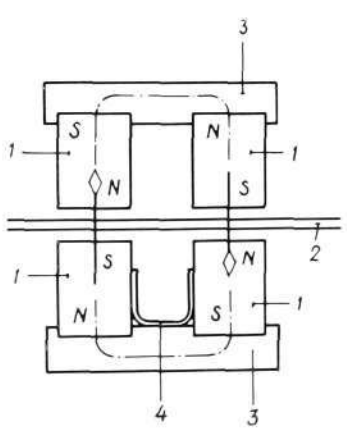


Fig. 11 X 2335

The brake magnet has four magnetic prisms which are so magnetized that the rotor is acted upon by two opposing fluxes.

1 Magnetic elements
2 Rotor
3 Pole pieces
4 U-shaped strip of nickel steel for temperature compensation

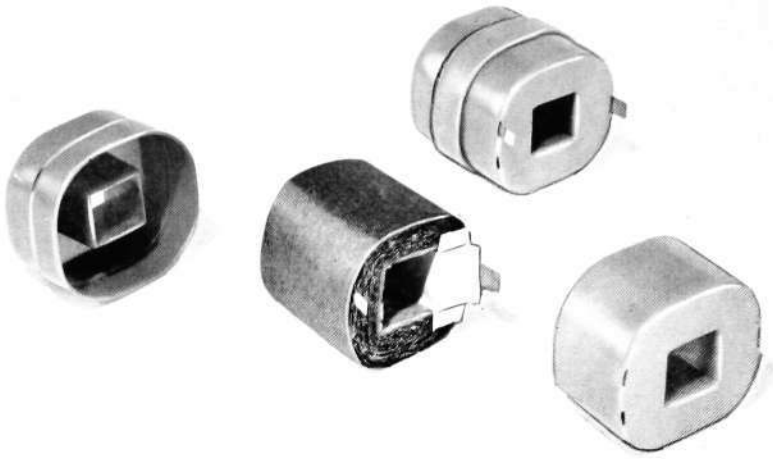


Fig. 12 X 8107

The coil, which has paper-insulation between the layers of windings, is effectively protected against over-voltages by a split cover of polythene, which enables it to withstand a surge voltage of about 14 kV.

The wire of the coil has a rectangular cross-section. The meter therefore stands a high overload current, which means that it can be used in systems which are protected by fairly heavy fuses.

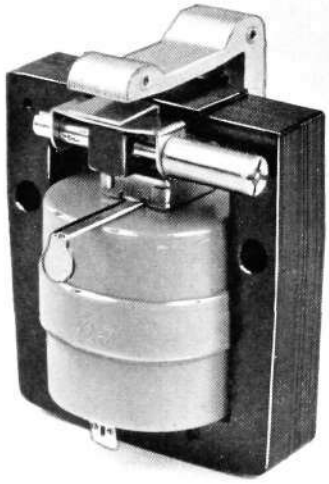


Fig. 13 X 2343

The coil is placed around the centre limb in the centre of the voltage system, and the flux generated by it is conducted by the cores partly through the rotor and partly through a shunt, the chief object of which is to displace the phase of the driving flux 90° in relation to the line voltage.

The Rotor

The driving element acts upon a 1.20 mm thick rotor of 99.8 % pure aluminium, which is diecast to a steel spindle. The entire rotor system is journalled at the lower end in a pivot bearing which terminates in a highly polished ball resting in a sapphire cup, and at the upper end in a highly polished and resilient needle type bearing which revolves in a lubricated sleeve.

The Brake Magnet

The rotor is braked by a powerful four-pole magnet with an air gap of at least 3 mm (fig. 15). This unusually large air gap has been possible thanks to

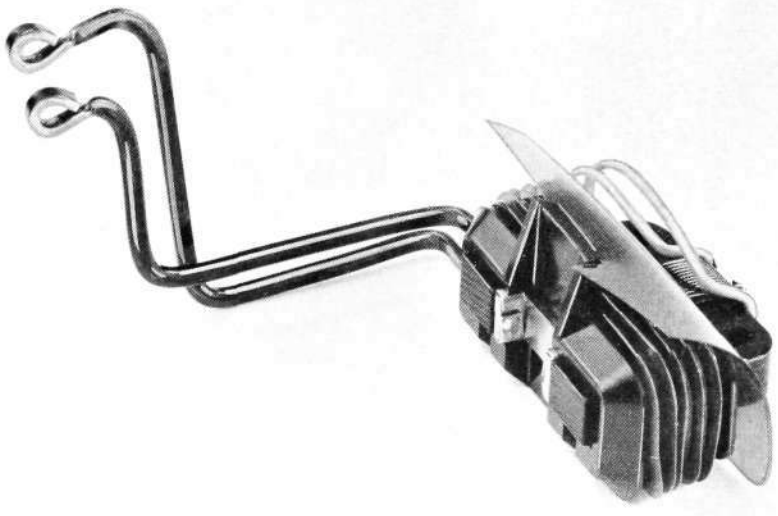


Fig. 14 X 8108

The current system is well insulated, both against surrounding metal parts and between the turns of the coil.

the high quality of the magnetic material, which has a remanence of 11 500 gs, coercive force of 650 oe, and a $(BH)_{max}$ value of $2.5 \cdot 10^6$ gsoe.

The flux of the brake magnet passes the rotor at two adjacent points, but in opposite directions (fig. 11). This eliminates the forces of vibration which arise when the alternating currents, generated in the rotor by the fluxes of the driving element, cut the permanent flux of the brake magnet. Since the forces are opposed and equal in magnitude, they neutralize one another.

Fig. 15 X 2344

The four magnetic prisms are attached to pole pieces of sintered iron, which are held together by a stainless steel cylindrical pin.

The asymetrical structure eases the magnetization of the magnet.

The Terminal Block

The sleeve terminals (fig. 16) permit satisfactory connection of multi-wire leads of 10 mm² and 25 mm² cross-sectional area for meters rated for 10 A and 50 A respectively. The conical opening, which is so amply dimensioned as to allow even for the conductor insulation, greatly facilitates the wiring up of the meter.

Both the long and the short covers over the terminal block are clamped by a *single* captive screw attached to the block and provided with a seal.

The earlier practice was to place the wiring diagram on the rear of the cover. This occasionally led to fatal errors, as the cover, which fits several types of meter, might be interchanged with that of another meter. On ERMI meters, therefore, the wiring diagram is placed on the rating plate in clear association with the meter data.

The rating plate has space also for a name plate, 13 × 40 mm, for identification figures of the energy supplier.

Insulation

Before delivery every meter is subjected to the 8 kV surge voltage test recommended in the Swedish meter standards.

An alternative model, having a plastic case, is typed *VEN 23B*.

Maintenance

Provided that the correct ratings have been chosen, and that the meter is not exposed to heavy variations in temperature, nor to dust, gases or damp, it will operate correctly without supervision for a very long period. It is extremely difficult to state exactly how long a meter can be left without attention. This would require many years of thorough statistical study. As a result of the improvements which have been incorporated in ERMI meters, however, the period of seven or eight years which was earlier recommended between overhauls can now be greatly extended. Even so, the maintenance of meters is a considerable burden on the supply undertaking. ERMI meters are therefore designed to cut the costs of overhaul and adjustment to a minimum. The various parts of the meter and its calibrating members are readily accessible (fig. 17). The air gaps in the driving element and brake magnet are clearly visible for purposes of inspection; and if a part must be replaced for reorganizational or other reasons, there is no difficulty in doing so.

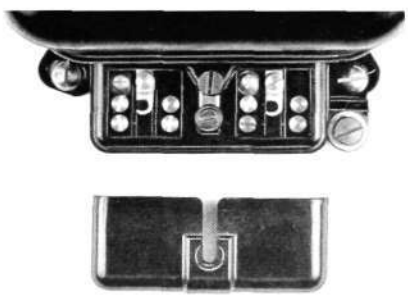


Fig. 16 X 2345

The voltage circuit must be disconnected from the current circuit during adjustment of the meter.

The two swinging straps are used for this purpose. They do not obstruct tightening of the terminal screws.

The stroboscopic marks on the rotor enable methods of adjustment to be adopted which involve a great saving of time (fig. 18). Furthermore, the calibrating members, all of which can be adjusted with a screwdriver, can be continuously set with great accuracy.

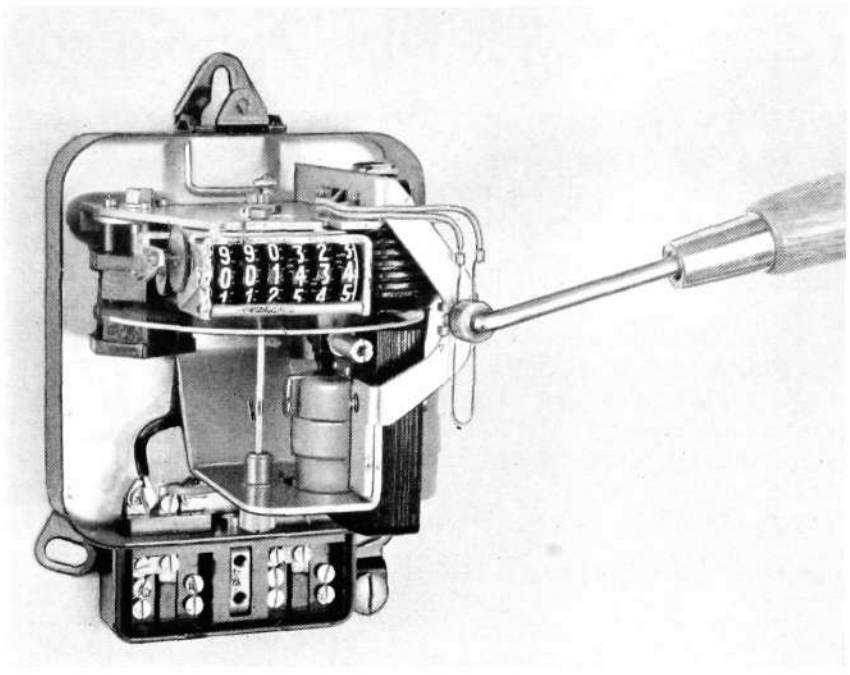


Fig. 17 X 8109

The clamp for the adjustable resistance in the quadrature loop can be released and tightened with *one* hand since it is firmly positioned on the frame.

Dismantling of the entire register for overhaul is expensive. For this reason the practice has long been to clean the mechanism by submerging it in petroleum spirit, which dissolves dust and other sediment. The spirit soon evaporates, especially if the mechanism is placed in a slight air current. This simplified method was elaborated for mechanisms with tin drums; and in order that it may be employed for the new registers with their plastic drums and pinions, ERMI has chosen an acrylic resin which is unaffected by petroleum spirit or mineral oils.

As already emphasized, all mechanical friction must be eliminated as far as possible. At the same time, the friction must not change during the years, as the error in indication will then change as well. The spindles of the register are of stainless steel and require no film of oil as protection against corrosion. The pivot bearings likewise require no oil for their lubrication. The register is thus completely free from oil, and the risk of change in the friction on account of aging of oil is totally precluded.

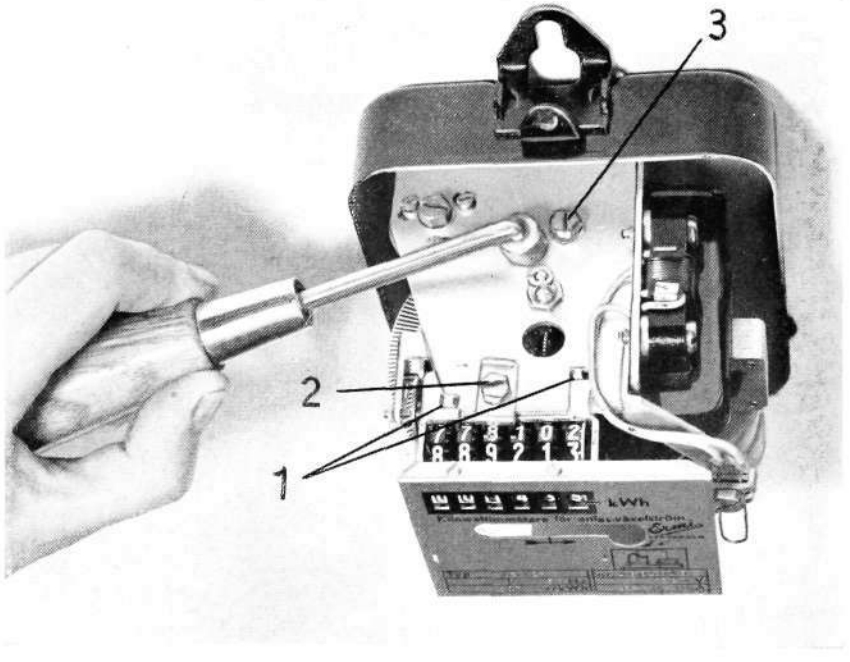


Fig. 18 X 8110

The register has a fixed position in relation to the frame (1), and so to the rotor spindle. It is secured to the frame by a *single* screw (2), which simplifies zeroing of the register in, for example, a long-time test.

The brake magnet is set to the correct braking effect by turning an eccentric (3) with a hollow key. The rotor has 150 marks for stroboscopic adjustment.

Telephone Set with Amplified Reception

I MITNITZKY & P AHLSTRÖM, TELEFONAKTIEBOLAGET LM ERICSSON, STOCKHOLM

U.D.C. 621.395.721:621.375.4

Telefonaktiebolaget L M Ericsson has introduced a telephone set with transistor amplifier for reception, which possesses greatly improved properties compared with earlier designs incorporating a vacuum tube amplifier.

The earlier telephone set type DBH 921 has been modernized by the introduction of a transistor type amplifier, which has made the telephone simpler to handle and simpler to install. It is anticipated that the new set will require no more maintenance than an ordinary dial telephone. Thus, there is every reason to expect very much improved performance in the new telephone *DBH 923*.

The goals set before the designers were as follows:

1. The voltages required by the transistor amplifier shall be supplied via the subscriber's line from the public exchange batteries.
2. The current consumption of the amplifier shall be so low that sending efficiency is affected as little as possible.
3. The ordinary receiver shall be used, and in such a way that successive improvements of the receiver can be put to full use in the new design.
4. As many complete components as possible from the standard set shall be used in *DBH 923*.
5. In order to avoid embarrassment to persons with impaired hearing, *DBH 923* should resemble an ordinary telephone in outer appearance as far as possible.

Fig. 1 X 8103

DBH 923 looks like the ordinary dial set DBH 15

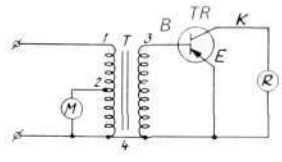


Fig. 2 X 2336

The transistor used as amplifier (with D.C. bias omitted)

B base
E emitter
K collector
M transmitter
R receiver
T induction coil
TR transistor

The diagrams in figs. 2, 3 and 4 show how the design has developed from idea to finished product.

The secondary side of the induction coil is connected between the base and the emitter, and the receiver between the collector and the emitter. In order that the transistor shall function as amplifier, there must be a D.C. source so that base and collector receive specific bias voltages in relation to the emitter. This is shown in fig. 3.

The transistor is of pnp-type, and both collector and base must be negative in relation to the emitter. The collector is connected to the negative side of the line via the receiver R and the choke L, and a negative potential is supplied to the base through the resistor R_2 between base and collector. The receiver is connected to the emitter across capacitor C_3, and the base to the induction coil across capacitor C_4.

The complete circuit diagram of the telephone under speaking conditions is shown in fig. 4.

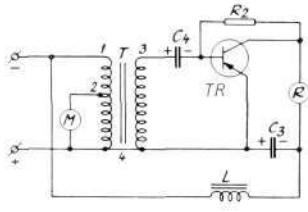


Fig. 3 X 2337

The amplifier with correct bias voltages from the telephone line

C_3, C_4 capacitors
L choke
R_2 resistor

Rect. 2 is a diode bridge which renders the amplifier independent of line polarity. The resistors R_3 and R_4 provide negative feedback. With R_3 and R_4 in the circuit the feedback is strong enough to eliminate amplification, the reception level being the same as in an ordinary telephone. When the handset key is depressed, R_4 is short-circuited and a gain of 12 db is obtained. The key also acts upon *Rect. 1*, which is coupled as a varistor (shock absorber). *Rect. 1* fulfils two purposes: it protects the transistor and the electrolytic capacitors against voltage surges, and prevents strong signals from being amplified to a level at which the sound pressure in the ear attains the threshold of feeling, i. e. produces a sensation of pain. This is accomplished irrespective of the transistor gain since, with the key depressed, the shock absorber sets in at a lower signal voltage. Depression of the key short-circuits half the shock absorber, while at the same time full amplification is obtained through the short-circuiting of R_4. Signals which would cause no discomfort at an ordinary level of reception, but would do so at 12 db, are therefore limited by the fact that half the shock absorber is short-circuited at the input of the amplifier. The capacitor C_5 prevents high frequency signals from being detected by the transistor, and R_1, stabilizes and lowers the input impedance of the amplifier, so that the load on the induction coil is roughly the same as in an ordinary telephone.

The transmission characteristics of *DBH 923* in different feed systems are tabulated below.

	System	SRE/0	MRE/0	
			without gain	with gain
		db	db	db
DBH 92301	24 V; 2 × 400 ohm	+ 6	— 4	— 16
DBH 92351	48 V; 2 × 400 »	+ 4.5	— 4	— 16
DBH 92371	48 V; 2 × 250 »	+ 3	— 4	— 16

SRE = sending reference equivalent relative to SFERT
MRE = receiving reference equivalent relative to SFERT

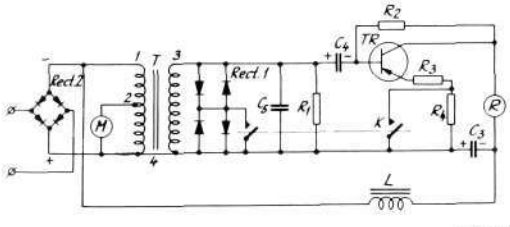


Fig. 4 X 2338

The complete circuit diagram

Rect. 1 shock absorber
Rect. 2 diode bridge
K key

Figs. 5 and 6 show the frequency response without gain and with gain.

The transmitter and receiver insets used in *DBH 923* are L M Ericsson's standard insets, which are described in Ericsson Review No. 4, 1956.

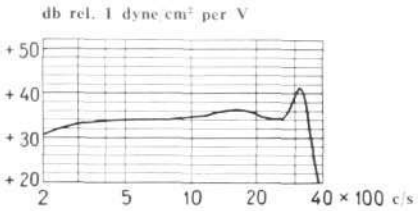


Fig. 5 X 2339

Frequency response at zero gain

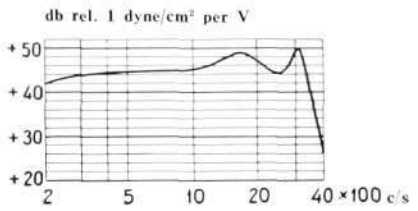


Fig. 6 X 2340

Frequency response with key depressed (12 db gain)

Fig. 7 X 8104

DBH 923 with cover removed

Fig. 8 X 8105

The key is conveniently placed and requires little pressure

The aim has been that the change in impedance shall be as little as possible, whether or not the gain is switched on, and is, on an average, only about 10 % at different frequencies. The set is matched to the international standard of 600 ohms.

In external appearance *DBH 923* resembles the ordinary dial set DBH 15, as is seen from fig. 1. The mounting of the amplifier in the telephone set is shown in fig. 7.

Thanks to the diode bridge there is no need to observe the line polarity, and *DBH 923* can therefore be connected to a telephone line just like any other telephone.

The transistor amplifier, being fed from the line, has no need of either plate or heater batteries.

The importance of all these factors will be apparent to administrations and subscribers alike.

Switching on and off the gain is done very simply with a key in the handset (fig. 8). When depressed, the key provides the two makes as seen in fig. 4. This arrangement provides a simple means of enabling the same telephone to be used by persons with impaired and with normal hearing. A gain of 12 db has been found to represent a practical compromise. The use of a key prevents acoustical feedback when the handset is occasionally put aside during conversation.

Apart from its obvious uses for the hard of hearing, *DBH 923* will naturally be of advantage on long lines in local networks, on insufficiently amplified trunk lines, on telephone lines for power supply undertakings, railway companies, and so on.

Another important field of use is in moderately noisy premises such as hotel reception offices, restaurants, airport waiting rooms, bus and railway stations, workshop offices, and department stores.

Fig. 7

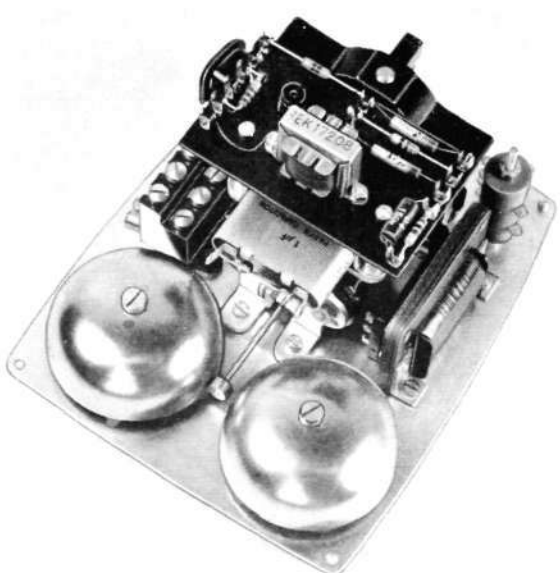


Fig. 8

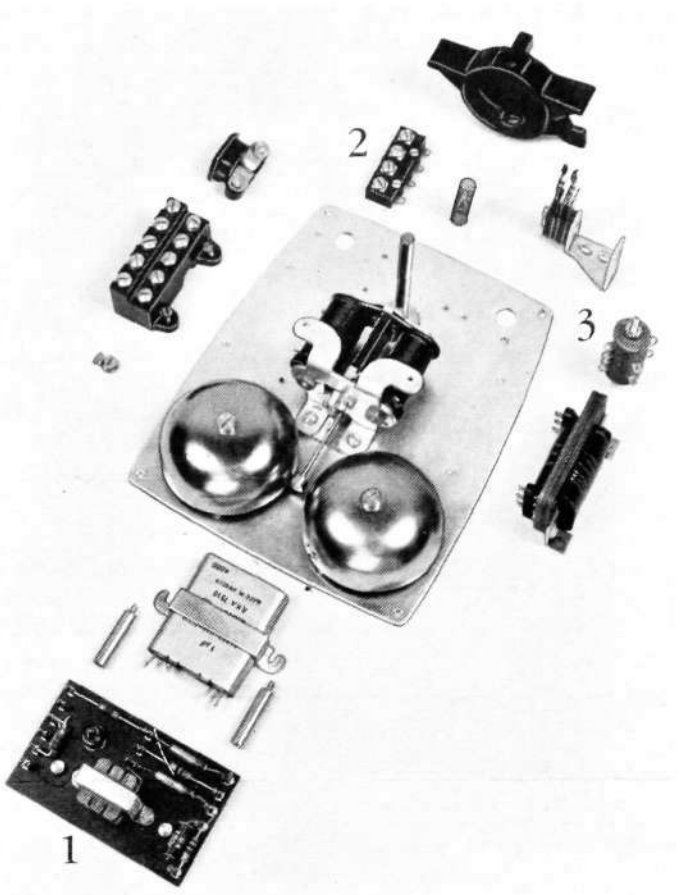


Fig. 9 X 8106

The components of DBH 923

The numbered parts alone are peculiar to the DBH 923 set

The components of *DBH 923* are shown in fig. 9. The new units, not used in DBH 15, are:

1. Transistor amplifier 360975

This unit contains the necessary amplifier components such as the transistor, the resistors R_1—R_4, the capacitors C_3—C_5, and the choke L. C_3 and C_4 are electrolytic capacitors of tantalum type, which give the amplifier a higher degree of reliability and longer life than the ordinary electrolytic capacitors of aluminium type.

2. Terminal block NEM 1111

3. Rectifier pile-up RKT 15401 containing diode bridge and shock absorber.

One model of the telephone *DBH 923* adapted for the Swedish telephone system has been approved by the Royal Board of Telecommunications.

New Electron Tubes for Wide-band Amplifiers

S EDSMAN, AB SVENSKA ELEKTRONRÖR, STOCKHOLM

U.D.C. 621.385:621.375.121

The greater quantities of information that are now required to be transmitted on coaxial cables or radio links have placed higher demands on the ability of electron tubes to amplify wide ranges of frequencies. To fulfil such requirements tubes must have higher transconductance and at the same time lower capacitances.

The following description of the pentode 5847/404A, the triode 5842/417A and the tetrode 7150 embraces all the properties which make these tubes especially suitable in wide-band amplifiers.

With a view to increasing the transconductance of electron tubes while keeping the capacitances low, use has been made of increasingly small diameters of grid lateral wire. The three tubes *5847/404A*, *5842/417A* and *7150* all have frame grids with a lateral wire of only 6.5 μ diameter. *5847/404A* is a pentode for both low and intermediate frequencies. *7150* is a tetrode for the same applications, but can also be coupled as a triode for use as a low noise tube in input circuits. *5842/417A* is a low noise triode for grounded grid input stages at intermediate frequencies.

Figure of Merit

The wide-band properties of an amplifier may be expressed as the product of gain and band width. This product is determined by the figure of merit (G) of the amplifier tube. At low frequencies (*LF*), at which impedance transformation between the amplifier stages is impossible, the figure of merit may be expressed as

$$G_{LF} = \frac{g_m}{C_I + C_O}$$

where g_m = transconductance of the tube in mA/V, and C_I and C_o are the total working capacitances in the input and output circuits in pF. At intermediate frequencies (*IF*) the figure of merit will be

$$G_{IF} = \frac{g_m}{\sqrt{C_I \cdot C_O}}$$

provided that optimum impedance transformation can be achieved between the input and output circuits.

From these two formulae the desirability of increasing g_m, or reducing C_I and C_o, is clearly apparent. At *IF* the main effort should be to reduce C_o. In *7150* the output capacitance C_{out} of the tube itself has been reduced to only 2 pF.

The data of the three types of tube are given in Table I.

Tube Capacitances

Data sheets usually give the tube capacitances in cold state only. Nor do the values include sockets or pins; nor, of course, coupling and circuit capacitances. It is seen from fig. 1 that the input capacitance C_{in} increases very considerably with the cathode current. When the cathode is heated, C_{in} increases even when the plate current is cut off by a large grid bias. When the bias is reduced the current increases, but at the same time the input capacitance increases still further due to changes in the space charge. The output capacitance

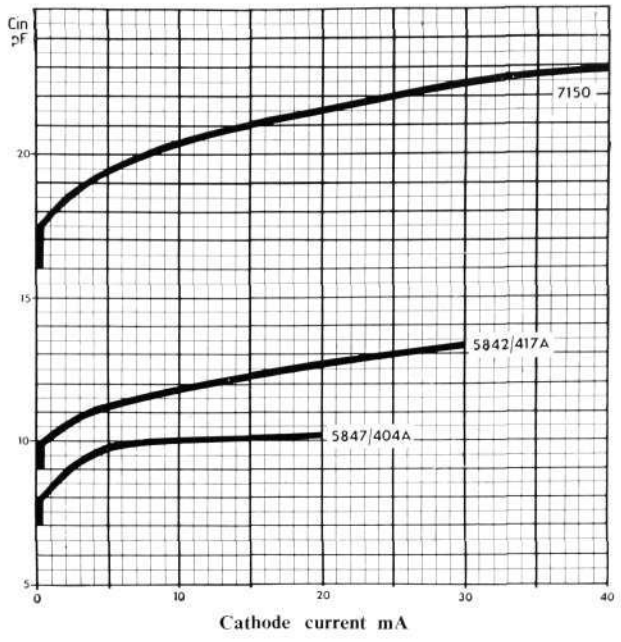


Fig. 1 X 8081

The input capacitance C_{in} of tubes 5847/404A, 5842/417A and 7150 increases from 7, 9 and 16 pF respectively in cold state to 10.2, 13 and 22.8 pF at normal cathode current

C_{out}, on the other hand, is not affected to any great extent by heating of the tube or increase in the cathode current. C_{out} does increase, however, if an external shield is used, whereas the other capacitances remain virtually unaffected.

The input capacitance is also increased as a result of the coupling between the input and output circuits caused by the control grid—plate capacitance C_{gp}. The increase will be equal to $F \cdot C_{gp}$, where F is the amplification of the tube. At *LF* this product will usually be insignificant compared with C_{in}. At *IF*, on the other hand, the coupling between the input and output circuits of the tube may cause a difference in amplification at the lower and upper band limits, leading in severe cases even to instability. For grounded grid stages the cathode—plate capacitance C_{kp} is the unwanted coupling between the input and output circuits.

Power Output and Distortion

In low frequency systems the relation between the fundamental frequency and the second and third harmonics (A_{k2}, A_{k3}) represents the magnitudes which determine what negative feedback is required, for the generated crosstalk must not exceed given values. Figs. 2a and 2b show A_{k2} and A_{k3} as function of the plate impedance R_a at different outputs for tubes *5847/404A* and *7150*. The pentode and tetrode data alone are given; negative feedback cannot be introduced in triodes owing to problems of phase shift. It is not usually possible to achieve greater plate impedances than 1000—2000 ohms. To obtain higher outputs, therefore, it is necessary to use two or more tubes *5847/404A* in parallel, or to use *7150*.

At intermediate frequencies a higher circuit impedance is generally attainable. The plate impedance, however, is limited owing to loading of the input conductance (g_{in}) of the subsequent tube. Since g_{in} increases with the square of the frequency, there will be considerable damping of the circuits at high frequencies. Since g_{in} also increases with increasing cathode lead inductance, triple cathode leads have been provided for *7150*.

Noise

An extremely important characteristic is the tube noise, since it determines the lowest level which the transmitted signal may assume on the input side of the following amplifier. This affects, for example, the distance between the

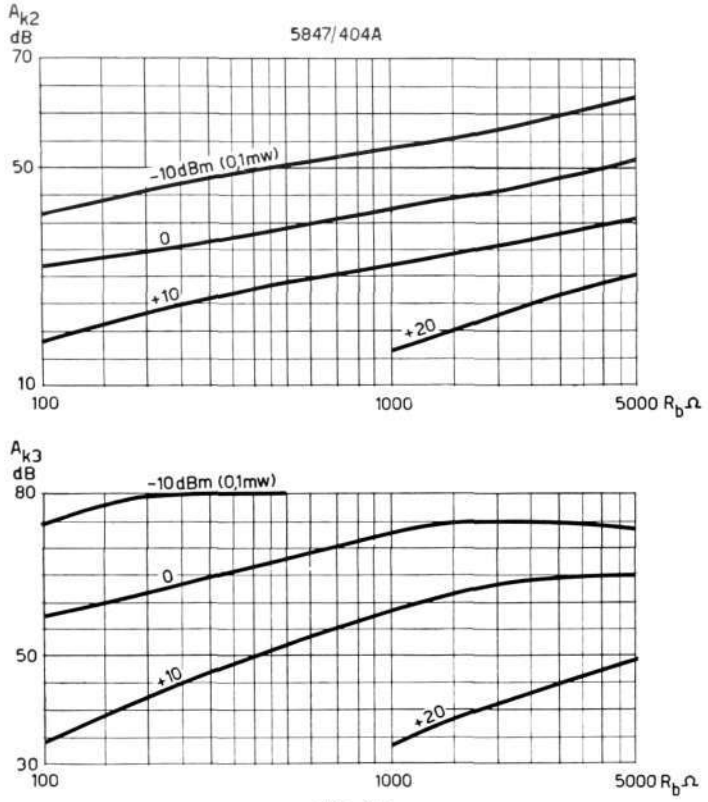


Fig. 2 a

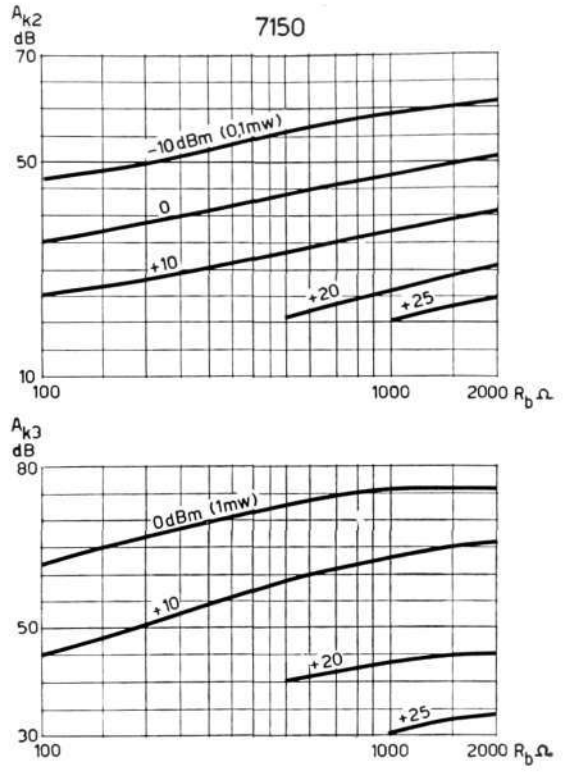


Fig. 2 b

Fig. 2 a X 7734

Relation between fundamental frequency and second and third harmonics A_{k2} and A_{k3} as function of the load impedance R_b at different outputs for tube 5847/404A under typical conditions of operation

Fig. 2 b

The same data as in fig. 2 a, but for tetrode 7150

line amplifiers. The calculated equivalent noise resistances (R_{noise}) are given in Table I. At low frequencies, however, considerable additions of noise may occur due to "flicker effect". In particular, the occurrence of interface resistance between the oxide coating and cathode sleeve must be prevented. At high frequencies this resistance is bypassed by the capacitance between the oxide coating and cathode sleeve, but at low frequencies the reactance is no longer negligible. Apart from lower amplification at low frequencies, this resistance, owing to its high operating temperature, adds a considerable amount to the noise. In the tubes described in this article, however, the cathode material is such that the interface resistance is minimal even after several years of operation.

At intermediate frequencies, owing to the absence of negative feedback, use can be made of triodes, which have the advantage of causing less noise. *5842/417A* is specially designed for such applications. In narrow band amplifiers operating at 150 Mc/s a noise factor of 2.5 db has been measured. At larger band widths, and the frequency of 70 Mc/s usual in such cases, the noise factor is about 5 db in circuits optimized for minimum noise factor.

Special Characteristics

Since, in *5847/404A* and *7150*, some internal shields have been connected to one end of the heater-pins 3 and 5 respectively, this end should be grounded. In *7150* there is a direct flow of electrons from the cathode to the shield when the latter is positive in relation to the cathode. The voltage drop across the cathode resistor, however, stops the flow of electrons if the right heater-pin is grounded.

The mechanical stability of these tubes can perhaps best be illustrated by the test performance of *5847/404A* when vibrated with a sinusoidal amplitude of ± 1 mm at 25 c/s. This corresponds to a peak acceleration of 2.5 g. The alternating voltage measured across a plate impedance of 2000 ohms was only about 5 mV, as against the 500 mV allowed by international standards.

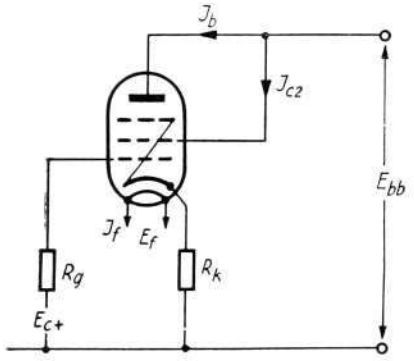


Fig. 3 X 2329

Table 1

	Tube type						
	5847/404A		5842/417A		7150		
Dimensions							
Base (EIA)	E—1		E9—1		9-pin special		
Bulb	T6 1/2		T6 1/2		T9		
Diameter, max.	7/8″		7/8″		13/16″		
Maximum Ratings							
Grid resistance	0.1		0.05		0.05		Megohm
Grid current	0		0		0		mA
Cathode current	35		35		50		mA
Control grid dissipation	0		0		0		W
Screen grid dissipation	0.75		—		1.5		W
Plate dissipation	3.0		4.0		4.0		W
Bulb temperature	120		120		130		°C
Typical Operation (Abbreviations will be understood from fig. 3)	PENTODE		TRIODE		TETRODE	TRIODE	
E_f	6.3		6.3		6.3	6.3	V
I_f	0.3		0.3		0.45	0.45	A
E_{bb}	150	160	130	150	125 135	125	V
R_k	110	600	360	60	45 260	33	ohm
E_{c+}	0	8.5	9	0	0 8	0	V
I_b	13.5	13.5	27	25	25 26	34	mA
I_{c2}	4.0	4.0	—	—	10 10	—	mA
g_m	13.0	13.0	27	25	34 34	47	mA/V
r_p	200	200	1.6	1.7	40 40	0.85	kohm
μ	—	—	44	43		40	
R_{noise}	500	500	110	120	180 180	60	ohm
Capacitances							
C_{in} (tube cold)	7		9		16	18	pF
C_{in} (typical operation)	10.2		13		22.8	24.8	pF
C_{out} (without extern. shield)	2.5		1.8		2	7	pF
C_{out} (with external shield)	2.9		2.6		3.6	8.6	pF
C_{gp}	0.03		—		0.03	—	pF
C_{kp}	—		0.5		—	0.6	pF
Figure of Merit							
G_{oLF} (tube cold)	1.37		—		1.9	—	
G_{LF} (typical operation)*	0.73		—		1.0	—	
G_{oIF} (tube cold)	3.1		6.2		6.0	4.2	
G_{IF} (typical operation)*							
without external shield	1.7		3.2		2.9	2.7	
with external shield	1.6		2.9		2.5	2.5	
Input Conductance							
g_{in} at 100 Mc/s	2000		4000		2200		μA/V

* The additions tabulated below for tube holders and coupling capacitances have been made for the various tubes to get total circuit capacitances in typical operation. To obtain the optimum figure of merit, the external shield should be excluded since in most cases it is not required.

	5847/404A	5842/417A	7150	
At low frequency	5		8	pF
At intermediate frequency				
Input circuit	3	3	5	pF
Output circuit	2	2	3	pF

Life

The life of the tubes depends largely on the design of the plate, since this determines the working pressure in the tube. Triodes, with their more closed systems, usually have a far inferior life to the more open tetrode and pentode systems. Low screen grid and plate voltages are also favourable in view of the low electrode dissipations, and consequently low working temperatures, but under these conditions it is more difficult to attain high figures of merit and an adequate grid swing without grid current loading.

For *7150* it may be predicted that the mean life in service will approach or exceed 50000 hours, a figure which is also attained by *5847/404A*. As regards *5842/417A* with its more closed structure and high cathode currents, and in certain cases critical applications (e.g. low noise stipulations), the mean life is usually approximately 10000 hours. Consequently, it is an advantage to use a triode-coupled tetrode or pentode instead of a triode. *7150* is well adapted for use in triode coupling (see table I). *5847/404A*, on the other hand, cannot be used as triode in grounded grid stages since the capacitance between the plate and the suppressor grid, which is internally connected to the cathode, is about 1.5 pF, so that C_{kp} would be too high.

Up to now *5847/404A* and *5842/417A* have been used together in the same amplifier. The new type, *7150*, however, can be used in all amplifier stages both at intermediate and low frequencies.

LM Ericsson NEWS *from All Quarters of the World*

(Above) Dr. Fusesi, Professor of Telecommunications (fourth from left), Brigadier General Hugo Afonso de Carvalho, Principal, Col. Heitor Bonapace, Professor of Electronics, flanked by (from left) Messrs. P. Madsen, D. Lundström and M. Kischner, and (right) Mr. V. Muniz of Ericsson do Brasil. Behind them is seen part of the presented equipment.

LM Ericsson Tribute to World Champions: Ericofon to Each Member of Team

The World Football Championships in Stockholm were a triumph for Brazil, whose magnificent team beat Sweden by 5–2 in the final at the Råsunda Stadium. The World Champions were applauded by King Gustaf Adolf and Queen Louise, backed by 50000 cheering spectators.

The Brazilians' joy over their victory was a moving spectacle. The Swedish King was very popular with the winning team when he came down onto the ground to congratulate them after the match (photo above). The man holding the trophy is the Brazilian manager, Paulo Carvalho.

As a mark of esteem and admiration for the world champions' brilliant play and fine sportsmanship, L M Ericsson presented each member of the team with an Ericofon. In the photo below are seen four of the virtuosi of the noble art of football, (from left) Garincha, Pelé, Gylmar and Didi, who seem to enjoy L M Ericsson's new one-piece telephone.

L M Ericsson Presents Models of Switchboards to Brazilian Army Technical School

At a ceremony on June 20 at the Brazilian Army Technical School at Rio de Janeiro, L M Ericsson presented to the school three working models of the company's different automatic telephone systems. The presentation was made by representatives of its affiliated company, Ericsson do Brasil Comércio e Indústria S.A. The equipment is intended for use in practical demonstrations in courses in telecommunications.

New Automatic Exchange in Panama

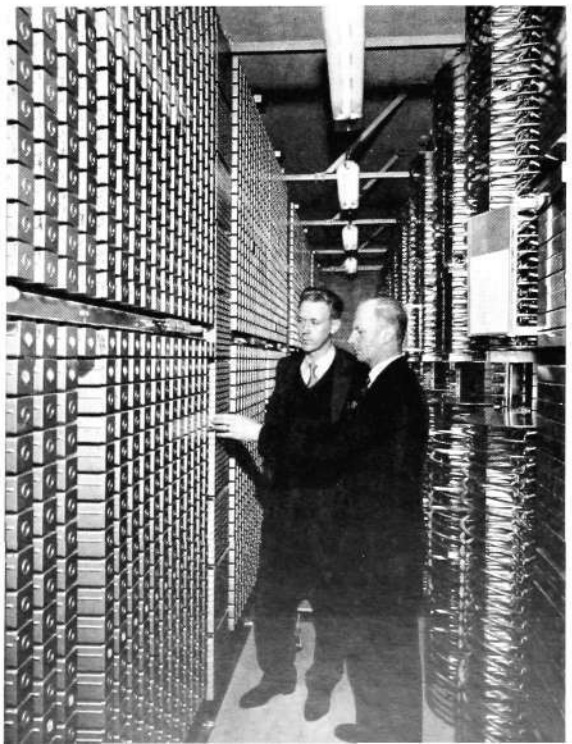
A new automatic telephone exchange, the fourth in Panama C., was opened on July 14. This exchange, of L M Ericsson 500-switch type, has an initial capacity of 1000 lines, of which 500 P.B.X., bringing the total Panama network up to 15740 lines. Including party lines, the number of subscribers is now above 18000. The installation work was done, as earlier, by Cía Panameña de Fuerza y Luz.

Among those present at the inauguration were the Minister of Public Works, Mr. Roberto López Fábrega, the Archbishop, Monseñor Francisco Beckmann, the President of Cía Panameña de Fuerza y Luz, Mr. Thomas Oglesby, and the Head of the Telephone Department, Mr. Walter A. Daniels.

Following the Archbishop's blessing of the new exchange, an opening call was made between the President of Panama, Ernesto de la Guardia, and the Minister, López Fábrega.

(Above) The Minister of Public Works, Mr. Roberto López Fábrega, used an Ericofon to make the first call to the President of Panama through the new telephone exchange. Behind him (from the left) are Messrs. Luis E. Kjorstad, T. V. Oglesby, W. A. Daniels, Rune Gustafsson (L M Ericsson's representative) and Salcedo Levy.

Mr. Evert Stålhagen of the Swedish Telecommunications Administration inspects the Biskopsgarden automatic exchange (below) in company with Mr. Gunnar Fredholm who is in sole charge of maintenance of the exchange.



New 500-switch Exchange in Gothenburg

A new automatic exchange was recently opened at Biskopsgården, Gothenburg. It is equipped with L M Ericsson 500-line switches and, when installed to full capacity, will serve 10000 subscribers. In the first stage the exchange has been equipped for 4000 lines, but by the autumn it will be possible to connect another 2000 subscribers.

The installation work is in the hands of L M Ericsson's installation group in Gothenburg.

C.T.C. on Carrier for Formosa

The Formosan State Railway system covers some 1000 kilometres of track. The network consists chiefly of a west coast line from north to south of the country, and of a shorter east coast line. At present the two lines are not interlinked. The gauge is 1067 mm, which is narrower than the standard international gauge. Formosa also has a privately owned railway network extending over some 3000 kilometres and operated mainly by sugar refineries.

The railways are a very important means of communication in Formosa, and in recent years the capacity has proved altogether inadequate. As a first step, C.T.C. is to be introduced on the west coast line between Tainan and Changhua, but it is intended that the system shall be extended to Chunan.

In January this year tenders were called for, comprising signalling and C.T.C. equipment for the Tainan-Changhua line. The order, issued in May, went to L M Ericssons Signalaktiebolag and comprised deliveries of equipment, including supervision of installation work, for US $ 1,900,000. The equipment is to be delivered within 12 months.

The Tainan–Changhua line is single-track, about 150 kilometres in length with 26 stations. The C.T.C. office is to be at Changhua. An overhead line will be used for transmission of the C.T.C. information between the C.T.C. office and field stations, and, in view of the length of the railway and the large volume of traffic, will be divided into two sections, of which the northern section, nearest the C.T.C. office, will be controlled direct and the southern section will be controlled via carrier circuits in the northern section.

In the map above, the heavy continuous line marks the Tainan-Changhua section for which C.T.C. has been ordered. The heavy dotted line marks the planned extension to Chunan. The light dotted lines represent the remaining railway system.

L M Ericsson Builds New Auto-Exchanges in Indonesien

L M Ericsson has recently delivered a further automatic exchange to Indonesia, for the town of Magelang in Central Java. This crossbar exchange, at present equipped for 1000 lines, is the second delivered to Indonesia within a short period; an exchange of the same type for 3000 lines was opened at the end of last year at Solo, the latter being the first of its kind not only in Indonesia but in the whole of Asia. A large number of distinguished personages from State, Municipal and Military bodies were present at the official opening.

Large orders have been placed with L M Ericsson for additional exchanges in Palembang, Padang, Pakan Baru, Bukkit Tinggi, Djambi and Tandjong Kerang, all in Sumatra: also for transmission equipment for two 12-circuit systems on overhead lines between Padang, Bukkit Tinggi and Pakan Baru.

Indonesia has been an important L M Ericsson market during the past fifty years: a large number of public and private telephone exchanges have been delivered, and also selective calling telephone systems for the Indonesian Railways.

(Top left) Mr. Samdjoen, Director-General of the Indonesian P.T.T., making a speech at the opening of the Solo exchange, a view of which is seen in the photo top right. In the lower photo the Governor of Central Java, Mr. Mangunnagoro, is seen making the first trunk call from Solo to the Governor of Western Java, then on a visit to Bandung.

Carrier System Santos —São Paulo

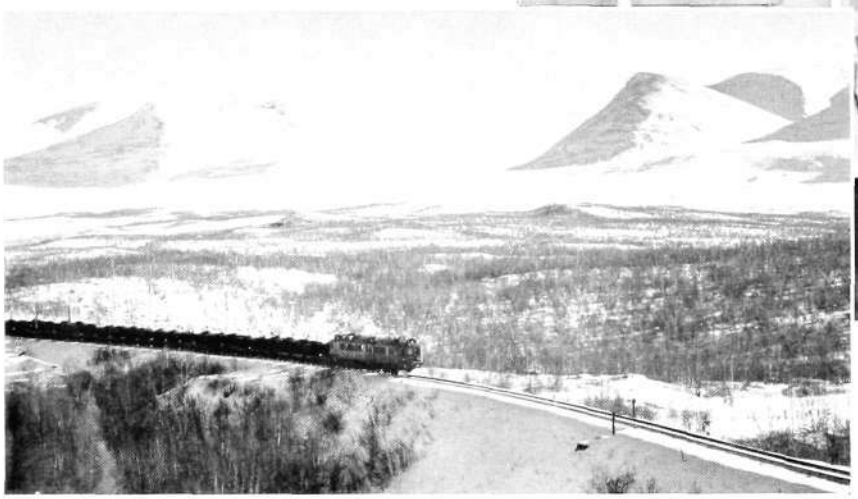
On June 7 the new Companhia Telefônica Brasileira carrier system linking Santos and São Paulo was opened to traffic. The main part of the equipment, including 70 kilometres of coaxial cable and 7 intermediate repeater stations, was supplied by L M Ericsson's affiliated company, Ericsson do Brasil Comércio e Indústria S.A.

The carrier equipment, type ZAX 960/2, will initially provide for 360 simultaneous calls between São Paulo and Santos, and when fully extended will have a capacity of 2000 calls.

This plant forms part of the enormous programme of C.T.B. and the Brazilian government for increasing the telephone facilities in the State of São Paulo. As reported in Ericsson Review No. 2, 1958, carrier systems have previously been installed between São Paulo and Campinas and between Rio de Janeiro and São Paulo.

A cocktail party was arranged by Ericsson do Brasil in conjunction with the opening ceremony. The gentlemen in the photograph are (from left to right) Dr. J. A. Wiltgen, Cia. Telefônica Brasileira, Mr. Adrian van Winkel, Ericsson do Brasil, Dr. Alvaro de Souza Lima, head of the São Paulo State Water & Electricity Board, and Dr. Carlos Reis Filho, Cia. Telefônica Brasileira.

L M Ericsson C.T.C. in Operation North of Arctic Circle



(Above) The C.T.C. office in Kiruna. The C.T.C. controller establishes train routes by operation of a keyset.

(Left) The ore line with the Lapporten pass in the background.

A new C.T.C. installation was completed by the Swedish State Railways in May and officially opened for service on June 1. The C.T.C. office is in Kiruna, from which the signalling system of the more than 80-mile line between Kiruna and the Norwegian frontier is controlled. This is the world's most northerly C.T.C. installation, the whole line running north of the Arctic Circle.

The installation comprises 12 remote-controlled stations, each having three or more tracks. The line is chiefly used for iron ore freights between the Lapland ore fields and the Norwegian port of Narvik, but also carries some passenger traffic. No road communications exist at all. The region is very sparsely populated, and very little passenger traffic occurs at the intermediate stations. For this reason it has been difficult to find personnel to man certain stations. The introduction of the C.T.C. system has made it possible to withdraw all train dispatching personnel from the stations and so reduce the Railways' operating costs. The chief advantage of the C.T.C. installation, however, is the improvement in railroad operation and the consequent increase in the transport capacity of the line.

The signalling and C.T.C. equipment was supplied by L M Ericssons Signalaktiebolag, while the installation work was carried out by the Swedish State Railways. The wiring of the relay bays for the C.T.C. equipment was done at the workshops of L M Ericssons Signalaktiebolag in Stockholm.

L M Ericsson's 1958 Conference on Maintenance Questions

This year's conference on maintenance of automatic telephone exchanges, the third of its kind, was held at the end of May and beginning of June. On this occasion the administrations invited were those of Latin America, and the majority of our South and Central American customers were represented at the green baize table at Midsommargården, opposite the head factory at Stockholm, around which the discussions took place. The Swedish Telecommunications Administration (Televerket) was also kind enough to send two delegates.

The discussions at the conference were mainly concerned with the economic aspects of maintenance, and with methods and possibilities of reducing the cost and improving the efficiency of maintenance routines in telephone networks in general and at telephone exchanges in particular. In a tour of the Scandinavian countries after the conference the delegates were given the opportunity of seeing how L M Ericsson equipment functions. The trip started in Åland, in the Finnish archipelago, where the small, reliable rural exchanges aroused considerable interest. Thereafter, in Örebro, the delegates saw how a Swedish engineering section at Televerket operates. At Aalborg and Aarhus in Denmark experience was gained of L M Ericsson's city exchange systems of crossbar type operated by the Jutland Telephone Administration. In particular, the new exchange at Aalborg with its advanced maintenance technique attracted considerable attention. The last visit was to the large trunk exchange of the Copenhagen Administration at Borups Allé.

During their time in Stockholm the conference visited plants in the Stockholm Telephone District. In the photo Mr. S. A. Moberg, Sectional Engineer of Televerket, is seen (left) describing the features of the Handen telephone exchange to a group consisting of (from right) Messrs. R. Novakowski, USA, R. C. Sussekind, Brazil, P. Tancred, Brazil, A. Soltero Gonzales, Mexico, H. S. Andersson, L M Ericsson, and C. B. Muros, Brazil.

U.D.C. 621.395.25

BJÖRK, H & HAGLUND, A: *Facilities Offered by Modern Private Automatic Exchanges.* Ericsson Rev. *35*(1958): No. 3, pp. 78—82.

Some of the new facilities developed by Telefonaktiebolaget L M Ericsson are described in this article, which deals principally with a private automatic exchange for up to 800 extensions, type *ARD 231*.

U.D.C. 621.395.23

ADENSTEDT, W: *P.M.B.X. Type ADF 162 for C.B. Systems.* Ericsson Rev. *35*(1958): No. 3, pp. 83–86.

L M Ericsson has always striven to offer its customers manual telephone switchboards of the most modern and efficient design. To this end a new single position P.M.B.X. has been designed, typed *ADF 162,* which possesses a number of technical and practical finesses.

U.D.C. 621.317.785.025.1

LINDBERG, S E: *Wide Range Single-Phase Meter.* Ericsson Rev. *35* (1958): No. 3, pp. 87—93.

In this article a single-phase meter is described, typed *VEN 23,* which will measure loads of up to 360 % of its rating within an error of not more than 2.5 %. It is designed to measure single-phase energy with great accuracy even if the line voltage and ambient temperature vary within wide limits.

U.D.C. 621.395.721:621.375.4

MITNITZKY, I & AHLSTRÖM, P: *Telephone Set with Amplified Reception.* Ericsson Rev. *35*(1958): No. 3, pp. 94—97.

Telefonaktiebolaget L M Ericsson has introduced a new type of loud sounding telephone set, *DBH 923*. The use of transistors has given the telephone greatly improved properties compared with the earlier design incorporating a vacuum tube amplifier.

U.D.C. 621.385:621.375.121

EDSMAN, S: *New Electron Tubes for Wide-band Amplifiers.* Ericsson Rev. *35*(1958): No. 3, pp. 98—102.

To fulfil the higher demands on the ability of electron tubes to amplify wide ranges of frequencies, tubes must have higher transconductance and at the same time lower capacitances. This description of the pentode *5847/404A*, the triode *5842/417A*, and the tetrode *7150* embraces all the properties which make these tubes especially suitable in wide-band amplifiers.

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A/S Norsk Kabelfabrik *Drammen*, P. B. 205, tel: 1285, tgm: kabel

A/S Norsk Signalindustri *Oslo*, P. B. Mj 2214, tel: Centralbord 56 53 54, tgm: signalindustri

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O/Y L M Ericsson A/B *Helsinki*, Fabianinkatu 6, tel: A 8282, tgm: ericssons

Sverige

Telefonaktiebolaget L M Ericsson *Stockholm 32*, tel: 19 00 00, tgm: telefonbolaget

AB Alpha *Sundbyberg*, tel: 282600, tgm: aktiealpha-stockholm

AB Ermex *Solna*, tel: 82 01 00, tgm: elock-stockholm

AB Ermi *Ulvsunda 1*, tel: 262600, tgm: ermibolag-stockholm

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

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

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

L M Ericssons Signalaktiebolag *Stockholm 9*, tel: 68 07 00, tgm: signalbolaget

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

Mexikanska Telefonaktiebolaget Ericsson *Stockholm 32*, tel: 190000, tgm: mexikan

Sieverts Kabelverk AB *Sundbyberg*, tel 282860, tgm: sievertsfabrik-stockholm

Svenska Radioaktiebolaget *Stockholm*, Alströmergatan 12, tel: 22 31 40, tgm: svenskradio

• ASIA •

India

Ericsson Telephone Sales Corporation AB *New Delhi 1*, P.O.B., 669, reg. mail: 1/3 Asaf Ali Road (Delhi Estate Building), tel: 44490, tgm: inderic

Bombay, c/o Manu Maison, 16, Old Custom House, tgm: inderic

Calcutta, P. O. B. 2324, tel: 45-4494, tgm: inderic

Indonesia

Ericsson Telephone Sales Corporation AB *Bandung*, Djalan Dago 151, tel: 2135, tgm: javeric

Djakarta, Djalan Gunung Sahari 26, tel: Gambir 50, tgm: javeric

Liban

Telefonaktiebolaget L M Ericsson, Technical Office *Beyrouth*, Rue du Parlement, Immeuble Bisharat, tel: 33555, tgm: ellem

Türkiye

Ericsson Türk Ltd. Şirketi *Ankara*, Âdil Han, Zafer Meydani, Yenişehir, tel: 23170, tgm: ellem *Istanbul*, Istanbul Bürosu, Liman Han, Kat 5, No. 75, Bahçekapi, tel: 228102, tgm: ellemist

• AFRICA •

Union of South Africa

L M Ericsson Telephone Co. Pty. Ltd. *Johannesburg*, 70, Loveday Street, tel: 33-2742, tgm: ericofon

• AMERICA •

Argentina

Cía Sudamericana de Teléfonos L M Ericsson S. A. *Buenos Aires*, Belgrano 894, tel: 332071, tgm: ericsson

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

Cía Argentina de Teléfonos S. A. *Buenos Aires*, Perú 263, tel: 305011, tgm: cecea

Cía Entrerriana de Teléfonos S. A. *Buenos Aires*, Perú 263, tel: 305011, tgm: cecea

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

Industrias Eléctricas de Quilmes S. A. *Quilmes FCNGR*, 12 de Octubre 1090, tel: 203-2775, tgm: indelqui-buenosaires

Brasil

Ericsson do Brasil Comércio e Indústria S. A. *Rio de Janeiro*, C. P. 3601, tel: 43-0990, tgm: ericsson

São Paulo C. P. 5677, tel: 36-6951, tgm: ericsson

Canada

Ericsson Telephone Sales of Canada Ltd. *Montreal 8, Que.*, 130 Bates Road, tel: RE 1-6428, tgm: caneric

Toronto 18, Ont., 34 Advance Road, tel: BE 1-1306

Cía Ericsson de Chile S. A. *Santiago*, Casilla 10143, tel: 82555, tgm: ericsson-santiago-dechile

Colombia

Cía Ericsson Ltda. *Bogotá*, Apartado Aéreo 4052, tel: 11-100, tgm: ericsson

México

Cía Comercial Ericsson S. A. *México D. F.*, Apartado 9958, tel: 46-46-40, tgm: coeric-mexico

Perú

Cía Ericsson S. A. *Lima*, Apartado 2982, tel: 34941, tgm: ericsson Soc. Telefónica del Perú, S. A. *Arequipa*, Casilla de Correo 112, tgm: telefonica

Uruguay

Cía Ericsson S. A. *Montevideo*, Casilla de Correo 575, tel: 84433, tgm: ericsson

USA

The Ericsson Corporation *New York 17, N. Y.*, 100 Park Avenue, tel: Murray Hill 5-4030, tgm: erictel

North Electric Co. *Galion, Ohio*, P. O. B. 417, tel: 24201, tgm: northphone-galionohio

Venezuela

Cía Anónima Ericsson *Caracas*, Apartado 3548, tel: 543121, tgm: ericsson

Teléfonos Ericsson C. A. *Caracas*, Apartado 3548, tel: 543121, tgm: tevela

• AUSTRALIA & OCEANIA •

Australia

L M Ericsson Telephone Co. Pty. Ltd. *Melbourne C 1 (Victoria)*, Kelvin Hall, 55 Collins Place, tel: MF 5646, tgm: ericmel

Agencies

• EUROPE •

Belgique

Electricité et Mécanique Suédoises *Bruxelles*, 56 Rue de Stassart, tel: 11 14 16, tgm: electrosuede

Greece

»ETEP», S. A. Commerciale & Technique *Athens*, 41, Stadiou Street, tel: 31211, tgm: aeter-athinai

Ireland

Teletec Ltd. 4446 South Dock St., Ringsend, tel: 680707

Island

Johan Rönning H/F *Reykjavik*, P. O. B. 45, tel: 14320, tgm: rönning

Yougoslavie

Merkantile Inozemna Zastupstva *Zagreb*, P.O.B. 23, tel: 25-222, tgm: merkantile

Österreich

Inglomark, Industrie-Belieferungs-Gesellschaft Markowitsch & Co. *Wien XV*, Maria Hilferstrasse 133, tel: R 32-0-11, tgm: inglomark

• ASIA •

Burma

Vulcan Trading Co. Ltd. *Rangoon*, P. O. B. 581, tel: S. 878, tgm: suecia

Ceylon

Vulcan Trading Co. (Private) Ltd. *Colombo 1*, 19, York Street, tel: 36-36, tgm: vultra

China

The Ekman Foreign Agencies Ltd. *Shanghai*, P. O. B. 855, tel: 16242-3, tgm: ekmans

Hongkong

The Swedish Trading Co. Ltd. *Hongkong*, Prince's Building, Ice House Street, tel: 20171, tgm: swedetrade

Iran

Irano Swedish Company AB *Teheran*, Khiaban Sevom Esfand 201-203, tel: 36761, tgm: irano-swede

Iraq

Koopman & Co. T.H.M., N.V., c/o *Messrs. Dwyer & Co. (Iraq) Ltd. Baghdad*, P. O. B. 22, tel: 86860, tgm: havede

Israel

Jos. Muller, A. & M. Engineer (Representations & Import) Ltd. *Haifa*, P.O.B. 243, tel: 3160, tgm: mullerson

Japan

Gadelius & Co. Ltd. *Tokyo*, Shiba Park No. 7, Minato-ku, tel: (43)-8251/6, tgm: goticus

Jordan

H. L. Larsson & Sons Ltd. Levant *Amman*, P. O. B. 647, tgm: larsonhus

Kuwait

Latiff Supplies Ltd. *Kuwait*, P.O.B. 67, tgm: latisup

Liban

Swedish Levant Trading Co. *Beyrouth*, P. O. B. 931, tel: 31624, tgm: skefko

Pakistan

Vulcan Trading Co. (Pakistan) Ltd. *Karachi City*, P. O. B. 4776, tel: 32506, tgm: vulcan

Philippines

Koppel (Philippines) Inc. *Manila P. R.*, P. O. B. 125, tel: 3-37-53, tgm: koppelrail

Saudi Arabia

Mohamed Fazil Abdulla Arab *Jeddah*, P. O. B. 39, tel: 2690, tgm: arab

Syrie

Georgiades, Moussa & Cie *Damas*, Rue Ghassan, Harika, tel: 1-02-89, tgm: georgiades

Thailand

Vichien Radio & Television Co., Ltd. *Bangkok*, 299-301, Suriwongse Road, tel: 31 364, tgm: vision

Viêtnam

Vo Tuyen Dien-Thoai Viet-Nam, Matériel Radio & Téléphonique du Viêtnam *Saigon*, 17, Cong Truong Lam-Son, tel: 20805, tgm: telerad

• AFRICA •

British East Africa

Transcandia Ltd. *Nairobi, Kenya*, P. O. B. 5933, tel. 3312, tgm: transcanda

Congo Belge

Société Anonyme Internationale de Télégraphie sans Fil (SAIT) *Bruxelles (Belgique)*, 25, Boulevard du Régent, tel: 125070, tgm: wireless

Egypt

The Pharaonic Engineering & Industrial Co. Cairo, 33, Orabi Street, tel: 4-36-84, tgm: radiation

Ethiopia

Swedish Ethiopian Company *Addis Ababa*, P. O. B. 264, tel: 1447, tgm: etiocomp

Ghana

The Standard Electric Company *Accra*, P.O.B. 17, tel: 2785, tgm: standard

Marruecos

Elcor S. A. *Tangier*, Francisco Vitoria, 4, tel: 2220, tgm: elcor

Moçambique

J. Martins Marques *Lourenço Marques*, P. O. B. 456, tel: 5953, tgm: tinsmarques

Nigeria

Scan African Trading Co. *Yaba-Lagos 32*, P. O. B. 1, tgm: swed-africa

Rhodesia & Nyasaland

Reunert & Lenz, (Rhodesia) Ltd. *Salisbury (Southern Rhodesia)* P.O. B. 2071, tel: 27001, tgm: rockdrill

• AMERICA •

Bolivia

Johansson & Cía, S. A. *La Paz*, Casilla 678, tel: 2700, tgm: johansson

Costa Rica

Tropical Commission Co. Ltd. *San José*, Apartado 661, tel: 3432, tgm: troco

Cuba

Mc Avoy y Cía *Habana*, Apartado 2379, tel: U-2527, tgm: macavoy

Curaçao N. W. I.

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

República Dominicana

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

Ecuador

Sociedad Radiotécnica Ecuatoriana *Quito*, Casilla de Correo 414, tel: 12140, tgm: rota

Guatemala

Nils Pira *Ciudad de Guatemala*, Apartado 36, tel: 3311, tgm: nilspira-guatemala

Haïti

F. Georges Naudé *Port au Prince*, P. O. B. A 147, tel: 3075, tgm: nodeco

Honduras

Cía de Comisiones Inter-Americana, S. A. *Tegucigalpa D. C.*, P. O. B. 114, tel: 15-63, tgm: inter

Jamaica and Brit. Honduras

Morris E. Parkin *Kingston*, P.O.B. 354, tel: 4077, tgm: morrispark

Nicaragua

J. R. E. Tefel & Co. Ltd. *Managua*, Apartado 24, tel: 387-1169, tgm: tefelto

Panama

Productos Mundiales, S. A. *Panama, R. P.*, P. O. B. 4349, tel: 3-0476, tgm: mundi

Paraguay

S. A. Comercial e Industrial H. Petersen *Asunción* Casilla 592, tel: 9868, tgm: pargtrade

El Salvador

Dada-Dada & Co. *San Salvador*, Apartado 274, tel: 4860, tgm: dada

Surinam

C. Kersten & Co. N. V. *Paramaribo*, P. O. B. 216, tel: 2541, tgm: kersten

USA

State Labs. Inc., *New York 12, N.Y.*, 649 Broadway, tel: Oregon 7-8400, tgm: statelabs. Only for electron tubes

• AUSTRALIA & OCEANIA •

New Zealand

ASEA Electric (N Z) Ltd. *Wellington C.1.*, Huddart Parker Building, Post Office Square, tel: 70-614, tgm: aseaburd

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