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CONTENTS

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CONTENTS

On cover: DIRIVOX—master set for L M Ericsson's loudspeaking communication system.

DIRIVOX — L M Ericsson's Loudspeaking Communication System with Natural Speech Control

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UDC 621.395.24
LME 8372

Advanced electronics for automatic speech control, numerous standard traffic facilities and individual name calls are some of the advantages offered by L M Ericsson's new DIRIVOX loudspeaking communication system.

DIRIVOX is the outcome of an intense development project aimed at a flexible loudspeaking system with at least as good voice reproduction as in a non-loudspeaking system, but much more convenient to use. The goal has been to offer loudspeaking communication of so high a class that it constitutes a real alternative to natural conversation.

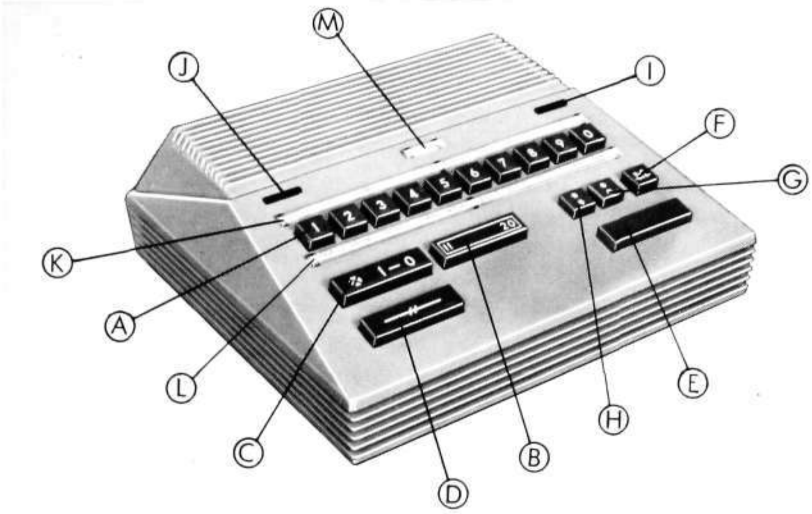
Natural Speech Control

In an ordinary loudspeaking system the direction of speech is controlled manually. This makes "natural" conversation difficult as one party must have one hand occupied throughout the conversation. This method is best adapted for orders, brief questions and quick replies.

One method of avoiding manual speech control would be to have both channels open at the same time. But as the overall loop gain (ratio between loss and gain) must not exceed 1 if singing is not to take place, the level and fidelity of sound would be unsatisfactory.

Fig. 1
Considerable care has been devoted to the design of the DIRIVOX

Fig. 2
DIRIVOX master set
A Call buttons
B Preselection bar for name calls
C Answering bar and preselection of digit calls
D Clearing bar
E Talk-listen bar
F Microphone cut-off button
G Secretary transfer switch
H Privacy switch
I Busy lamp
J Privacy lamp
K Name labels (1—10)
L Name labels (11—20)
M Extension number



In practice, however, a person does not speak and listen at the same time. Only one channel, therefore, need be open at a time. Through the introduction of sensitive control circuits, which all the time "listen" and quickly switch the direction of speech after each party has stopped speaking, adequate gain can be used. There is no danger of singing, since one channel is always cut-off when the other is transmitting sound.

For satisfactory operation the speech switching function should be unnoticed. It should permit either party to break into the conversation naturally without abnormal raising of the voice, e.g. for comments, corrections and confirmations such as "of course", "that's right", and the like. The speech control must also be as non-sensitive as possible to external noise; nor, of course, must it distort the speech.

After intense development work L M Ericsson has produced an electronic control equipment which fulfils these requirements. The DIRIVOX system is built up around this advanced electronics. Since DIRIVOX allows two parties to converse as though they were sitting in the same room, we speak of "natural speech control".

Traffic Facilities

In its standard form DIRIVOX has a number of traffic facilities which make the system simple and convenient to use. Fully dependable privacy, individual name calls, secretary transfer and "courteous" priority are some of these facilities.

The alphabetical symbols on the various keys referred to below relate to fig. 2, which shows the master set in the DIRIVOX system.

Incoming Calls

When switch H is moved upwards, all calls come in automatically (hands-free-accepted calls). A brief tone is heard in the master set and connection is immediately established.

When switch H is moved downwards, a call is notified by repeated tones corresponding to the ringing signals of an ordinary telephone. The same tone

1*—618131

is heard at the calling extension and shows that the called extension is switched for privacy. The called extension accepts the call by brief pressure on the answering bar C.

Outgoing Calls

Name calls are made by pressing one of the ten buttons A. Access to a further ten extensions can be obtained by first pressing the preselection bar B followed by the desired button in row A. The names of the persons having these 20 extensions are marked on the labels above and below the digit buttons.

In the larger systems the combinations of extensions to be called "by name" can be "tailored" for most requirements to allow quick contact with members of a working group or with common servicing departments. Every extension can choose two out of up to 32 combinations of ten extensions most suitable for his needs in the 90 line exchange. The extensions to be included in each combination can be chosen at will, as well as the order of sequence between them.

The remaining extensions in large organizations are contacted on ordinary extension numbers. One first presses the digit-call preselection bar C until the yellow lamp J lights and dial tone is returned. The desired number is then keyed with the digit buttons.

Busy Tone

If the called extension is engaged a busy signal is returned, consisting of repeated short tones.

"Courteous" Priority

The type of priority offered by the DIRIVOX system is called "courteous" priority, i.e. if a priority extension calls an engaged number he can warn the conversing parties by means of a discreet tone. To do this he presses his talk-listen bar E. When the parties have finished their conversation the priority caller is automatically connected to the desired extension.

Clearing

Bar D is used to clear a connection. After a hands-free-accepted call the caller alone need clear the connection. After a call to a privacy-connected extension, both extensions must clear the line.

Secretary Transfer

A certain number of extensions can have calls automatically transferred to another number, e.g. a secretary. This is done by operating switch G. Outgoing calls can be made whether the switch is operated or not. In some systems the extension to which calls are transferred can bypass the transfer connection and call the transferring extension.

Manual Speech Control

If the called extension is in a room with high noise level (machine-room or the like), the automatic speech control may in rare cases not operate satisfactorily. In such case the direction of speech can be controlled manually by either party by pressing bar E to talk and releasing it to listen.

If the noise ceases during conversation, automatic control can be restored by the other party momentarily pressing his talk-listen bar E.

Privacy

The yellow lamp J indicates that the extension is switched to the line. During conversation the lamp lights on both extensions. In conjunction with the tones for establishment of the connection, this precludes all risk of eavesdropping.

Temporary Privacy

The extension microphone circuit can be cut-off with button F. A conversation with another person in the room can then not be overheard by the other extension.

Non-loudspeaking Conversation

Handset telephones or Ericofons can be connected to the DIRIVOX system if non-loudspeaking conversation is required. When using the handset or Ericofon, the microphone and loudspeaker of the DIRIVOX master are disconnected.

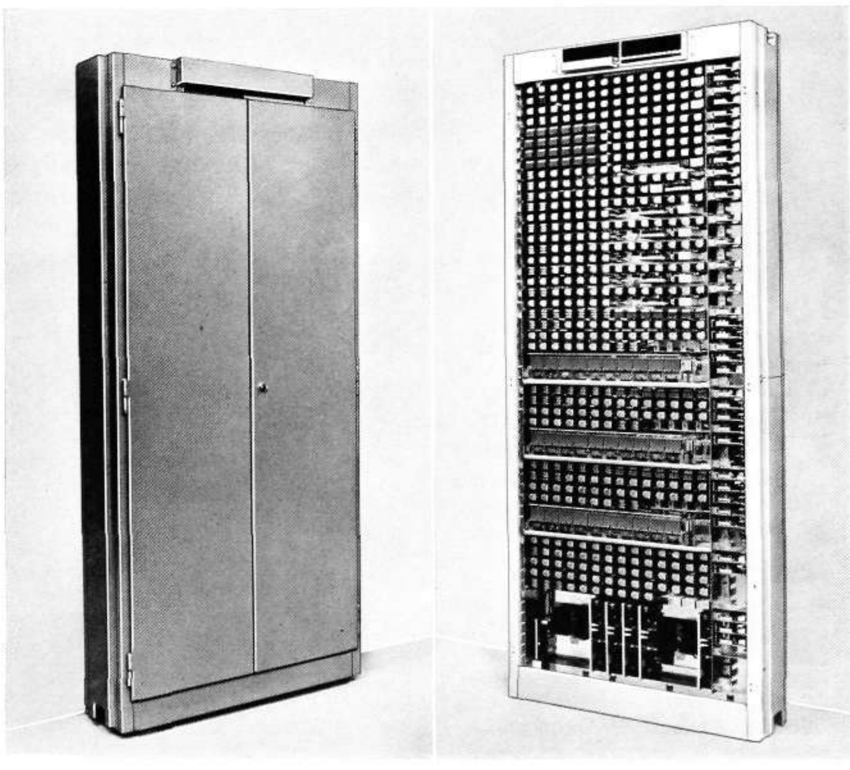


Fig. 3
Exchange AKD 847 with and without doors

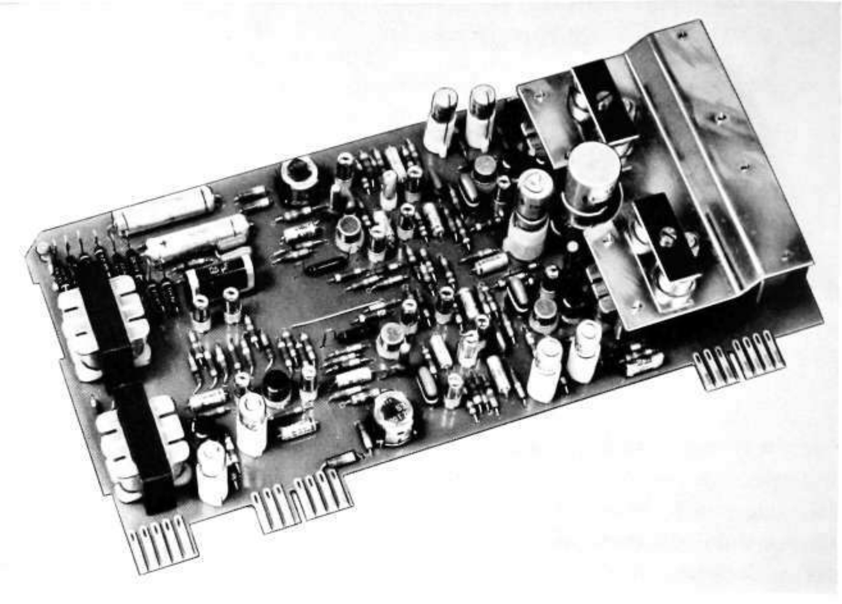


Fig. 4
Connecting-circuit amplifier

Busy Lamp

In a DIRIVOX system one need not wait for busy tone. If all connecting circuits are engaged the red lamp I lights.

Extra Traffic Facilities

An auxiliary equipment enables the DIRIVOX system to be used for paging. Ordinary conversations on the system are not disturbed by paging calls. Special loudspeakers can be used for paging in large rooms, for example, or out-of-doors. Visual and radio paging equipment can also be connected.

Under certain circumstances tie lines can be arranged between different DIRIVOX exchanges.

Exchanges and Systems

The DIRIVOX systems consist of exchanges with built-in amplifiers and speech control circuits, and units for tone signals etc., extension sets and cabling.

Fig. 5
Parts of DIRIVOX

1 Microphone (with casing)
2 Loudspeaker
3 Upper part
4 Lower part
5 Keyset with microphone amplifier
6 Gasket

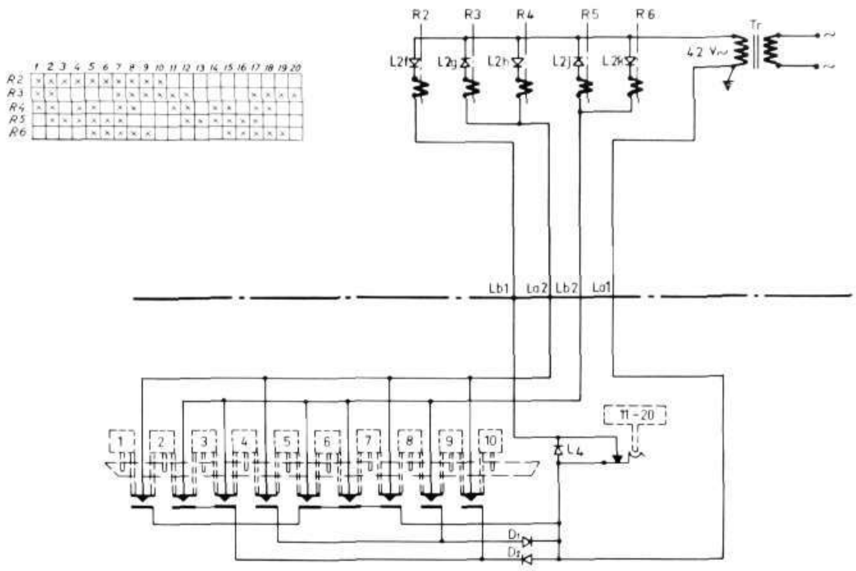


Fig. 6
Circuit diagram of digit receiving relays

Exchanges can be supplied for max. 20, 60 or 90 extensions. As the exchanges operate fairly silently and are of attractive appearance (fig. 3), they can well be placed in office premises.

The electronic equipment consists of a connecting-circuit amplifier (fig. 4), tone generator and voltage stabilizer. The equipment has printed circuits and is fully transistorized.

Extension sets are connected to the exchange on four-wire cables. Sets with secretary transfer facility require a fifth conductor. Ordinary plastic-insulated telephone cable can be used. The maximum length of line with 0.5 mm copper wire is 1000 metres and with 0.7 mm copper wire 2000 metres.

In view of the few moving parts in the extension sets, the simple cabling, and the fact that all automatic equipment is placed centrally in the exchange, the system requires a minimum of maintenance.

Master Set

The master set has a robust, light grey thermoplastic casing. It contains a row of 10 buttons, two loudspeakers and a microphone in a special compartment (fig. 5). A master set connected to a large exchange also has a transistorized microphone amplifier. One model is made without call buttons —for use as subset for incoming calls alone.

Push-button-dialling takes place on a relay-diode circuit. The operating voltage is 42 V AC. During keying this voltage is connected to the line wires and passes via rectifiers to the digit receiving relays (fig. 6). The relays operate in different combinations depending on whether the positive, negative or both half-cycles of the alternating current are used.

Natural Speech Control in the DIRIVOX System

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If a loudspeaking telephone conversation is to be equivalent to a natural conversation, the voice control must be so well designed that the conversing parties normally do not notice the switching of the direction of speech. No effort should be needed to interrupt the speaker, and the system must not distort the spoken word. It is important, too, that the voice control is as insensitive as possible to room acoustics and to noise from fans, typewriters and the like.

After intense development work Telefonaktiebolaget L M Ericsson has produced the advanced electronic equipment required for natural speech control. This article deals with the speech control circuits and with some of the ideas which lie behind them.

The requirements in respect of speech control may be summarized under the following points:

- ☐ Switching from one to the other channel must be extremely rapid and unnoticed by the conversing parties.
- ☐ The turn-on time must be very short. The interval between the moment when the voice reaches the microphone and the moment when one channel of the amplifier works at full gain must be extremely short. Otherwise the first syllable, perhaps a whole word, will be lost.
- ☐ The turn-off time must exceed the reverberation time for the called party's room. Sound reflected from furniture, walls etc. must not switch the direction of speech. The speaker must not hear the echo of his own voice.
- ☐ Switching to the other channel must not occur between syllables or between words in a sentence. On the other hand the turn-off time must not be so long that a quickly alternating conversation is rendered impossible.
- ☐ Either party must be able to interrupt the other quickly and effortlessly.

The DIRIVOX speaking circuits, which use more than 60 transistors and other semiconductors on every conversation, fulfil these requirements. When a DIRIVOX connection has been established, the parties can carry on a hands-free conversation. They need not worry about reversing the direction of speech, this is done by the DIRIVOX electronics.

Speaking Circuits

Every conversation makes use of two separate amplifier channels for the two directions of speech, and of control circuits which keep one channel open and the other closed, dependent on the direction of speech.

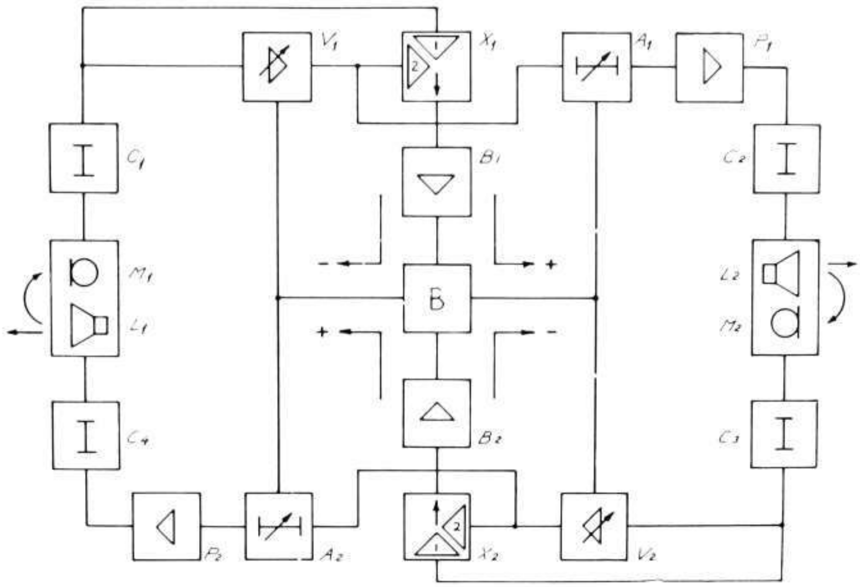

Fig. 1

Block schematic of speech circuits of DIRI-VOX system

V_1, V_2 Variable gain amplifiers
A_1, A_2 Variable attenuators
C_1, C_4 Line attenuators
X_1, X_2 Mixers
P_1, P_2 Power amplifiers
B Control bridge
B_1, B_2 Channel control amplifiers
M_1, M_2 Microphones
L_1, L_2 Loudspeakers

Fig. 1 shows a block schematic of the speech circuits. Each of the two identical speech channels consists of microphone, line attenuator, variable gain amplifier, variable attenuator, power amplifier and loudspeaker.

The controlling circuits consist of mixers *X1–X2,* channel control amplifiers *B1–B2* and the control bridge *B*. The latter controls the various amplifiers and attenuators in the speech channels.

Microphone and loudspeaker are placed in the extension set. The line attenuator *C* is placed on the line between the extension set and the exchange. The other units in fig. 1 are placed in the connecting circuit unit in the exchange.

In order to avoid singing, the ratio between attenuation and gain in the closed loop must not exceed 1. This is achieved through the fact that there is a reciprocal relationship between gain on one channel and attenuation on the other.

A strong coupling can thereby be accepted between loudspeaker and microphone, on an average –60 dB, the maximum in unfavourable cases being –40 dB. This means that the extension set is very insensitive to location.

Since all increases and decreases of the signal level in the entire speech chain are known, the signal in the active channel can be compared in control bridge *B* with that on the suppressed channel. If the control bridge receives from the suppressed channel only the signal deriving from the coupling between loudspeaker and microphone in the receiving extension, it keeps the channel open. A very small additional signal in the suppressed channel, however, through the listener entering the conversation, causes the bridge to switch the direction.

Since the control voltage is extracted both directly from the microphone and after the variable gain amplifier *V*, a low supplementary signal can be made to change the direction of speech. When the speech control has started to function fully, the amplifier *V* in the previously suppressed channel has its gain increased so that the signal to the control bridge increases further. Thus, once the signal has started, it increases with avalanche-like velocity.

The change of gain is achieved through change of impedance in the respective stages. The change of impedance is controlled by the bridge B and reduces the attenuation in the sending channel and the gain in the other channel.

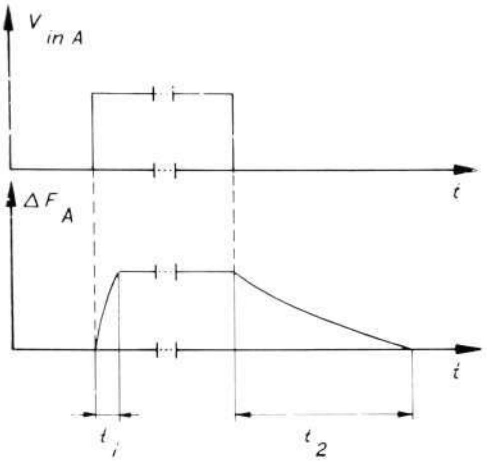

Fig. 2

Change of gain in channel A (ΔF_A) resulting from an input signal ($V_{in\ A}$) as function of time

t_1 Turn-on time

t_2 Turn-off time

Switching Times

The automatic voice switching does not take place instantaneously but with some delay. The choice of time constants for turn-on, turn-off and channel switching has great significance for the smoothness of speech control.

Figs. 2 and 3 show the signal amplitudes on the speech channel inputs and outputs as function of time. For comparison with the switching times mentioned below, some durations for ordinary human sounds may be indicated. These vary greatly, of course, but, on an average, it may be said that the consonants lie chiefly between 22 and 75 ms and the vowels between 44 and 120 ms. The shortest consonants are *k* (22 ms), *r* (35 ms) and *n* (68 ms). Among the vowels a short *i* has a duration of 50 ms and a long *a* 120 ms.

In the idle condition the gain in both speech channels is so low that no singing can occur.

If a signal enters channel A, the gain is increased in that channel as shown in fig. 2. The time t_1 is the turn-on time. It should be short in order that no syllable shall be lost at the beginning of a word. In the DIRIVOX it is around 8 ms. The time t_2 is the turn-off time which, in the DIRIVOX, is around 150 ms. It should be long enough to preclude any variation in gain in the middle of a word owing to pauses between syllables. The turn-off time should also be so long that the speaker does not hear the echo of his own voice.

Fig. 3 shows what happens if a signal enters channel B at the same moment as the signal ceases in channel A. The time t_3 is the switch-over time. In the DIRIVOX it is about 20 ms, so considerably less than the total turn-off and turn-on time, which permits rapid and natural reversal of the direction of speech without loss of syllables at the beginning of words.

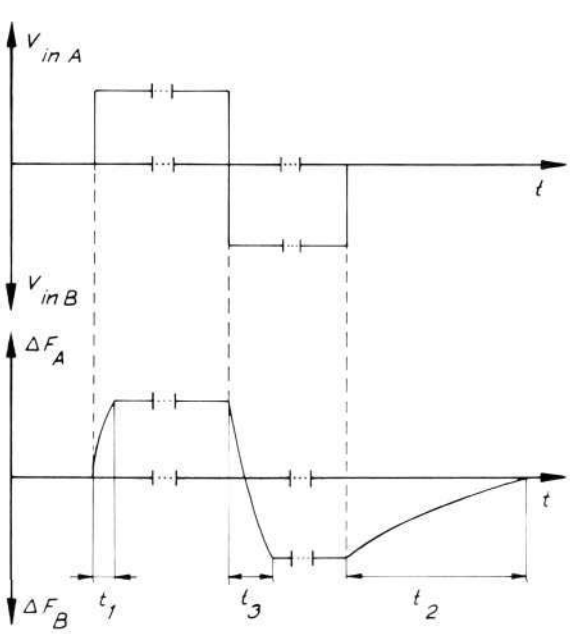

Fig. 3

Changes of gain in channels A and B (ΔF_A and ΔF_B) as a result of two consecutive signals on the two channels, as function of time

t_3 Switch-over time

The switching times are dependent on the sound level and increase with decreasing level. The turn-off and switch-over times are affected by the coupling between loudspeaker and microphone. This can be individually adjusted to the room acoustics and reverberation time by means of a potentiometer built into the extension set.

Frequency Range and Sound Level

The DIRIVOX amplifier has a very sharp low-frequency roll-off. This is aided by the microphone, which has a steeply falling sensitivity below 400–450 Hz. The room echo, which may cause speech to sound as if it came out of a barrel, is thereby avoided. Room echo increases heavily at frequencies below 400 Hz.

The upper cut-off frequency is 5000 Hz. This is not a critical value; a higher cut-off frequency does not appreciably add to intelligibility. By avoiding frequencies above 5000 Hz, however, one avoids interference from fans and the like.

A DIRIVOX circuit transmits the frequency band 400–5000 Hz, which provides very good intelligibility of speech.

The intelligibility for a given frequency range is favourably influenced by an increase of sound level. The DIRIVOX system therefore utilizes a slightly elevated sound level. The channel gain is 80–85 dB, which gives an acoustic gain of 10 dB. The maximum power is 3 W, which ensures satisfactory dynamics.

Insignificant Noise Sensitivity

The variable gain amplifiers *B1* and *B2* (fig. 1) are frequency-corrected. This ensures that the entire system is very little sensitive to room noise, which as a rule lies in the lower frequency range.

The switching of the channels is influenced by the wave fronts caused by speech and is therefore insensitive to continuous noise, even if at a higher level than the speech.

DIRIVOX — Flexible Loudspeaking Communication System with Many Traffic Facilities

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LME 8372

The DIRIVOX systems are built up around exchanges of different types and capacities. This article deals with the exchanges ARD 631 for max. 20 lines and AKD 847 for max. 60 or 90 lines. The same extension instrument is used with both types of exchange. Since the large exchange operates at a higher microphone level, the extension instruments for this exchange are supplied with built-in microphone amplifier. The latter is in the form of a printed circuit card which is easily fitted into the instrument.

Traffic Facilities

The traffic facilities of the two exchanges are listed in the table on page 14.

Common Name Call

Speedy connection with frequently called extensions can be obtained by means of "name calls", by pressing one of ten call buttons. A further ten extensions can be called in this way by pressing first a preselection bar followed by one of the ten individual buttons.

Individual Name Call

Large exchanges can be equipped with relay sets which allow a larger number of name-call groups. This is an advantage in organizations in which there are groups among the staff who work in close cooperation. Each extension has the choice of two combinations of 10 names out of 32 possible in a 90-line exchange.

Digit Calls

Digit calls are used in large exchanges for calling extensions outside the caller's name-call groups. A digit-call preselection bar is pressed, dial tone is returned and the caller keys a two-digit number (10–99). Experience shows that, thanks to the individual name-call groups, only 10 % of all calls need usually be made as digit calls.

Number of Simultaneous Conversations

The number of possible simultaneous conversations depends on the number of connecting circuits. Loudspeaking conversations take a very much shorter time than other kinds of telephone calls. A limited number of connecting circuits, therefore, suffices for a large volume of traffic. If all connecting circuits are engaged, this is marked by the lighting of the red lamp on all unengaged extensions.

Priority with Camp-on-busy Feature

When a priority extension calls an engaged number, busy tone is returned. Momentary depression of the talk-listen button sends a tone signal to the conversing parties. This signal indicates that someone wishes to communicate with one of them. As soon as they have cleared the line, a new connection is established automatically between the priority extension and the called party.

Priority for any given extension is arranged through strapping in the exchange.

Secretary Transfer

Incoming calls can be transferred to another extension, e.g. a secretary, by operating a switch on the extension instrument. The transfer takes place irrespective of whether the call is made as name call or digit call.

If desired, calls to several extensions can be transferred to a single number, e.g. when several persons have the same secretary.

The operation of the transfer switch does not prevent the use of the extension for outgoing calls.

By-passing of Transfer

The extension to which calls are transferred can by-pass the transfer connection, i.e. a secretary can communicate with her boss even if his extension is switched to her line.

Paging

The system can be used for audible, visual or radio paging. A paging call can be made from any extension. The audible signal is sent to selected free extensions without disturbance of engaged extensions. Separate loudspeakers or a separate public address system can be connected if desired. In large exchanges the extensions can be divided into groups to which paging calls can be made in any desired combination.

Tie Lines

DIRIVOX exchanges can be interconnected by means of tie lines. This requires a special unit (*FUR-X*) in one of the exchanges. In the other exchange the tie line terminates on an ordinary extension line. In this way an extension of the exchange which is equipped with *FUR-X* can make calls direct to any of the extensions in the other exchange. No connecting circuit is used in the exchange from which the call is made.

If two lines are used, they may be connected to the same exchange or to two exchanges.

If a two-way circuit is desired, both exchanges must be equipped with *FUR-X*.

Exchange *AKD 847* can be expanded in stages since the components are connected by plug and jack. Each switching unit serves a group of 30 lines. The connecting circuit units, register for digit calls, and name call groups can be installed according to requirements.

Facility	Exchange ARD 631 max. 20 lines	Exchange AKD 847 max. 60 lines	max. 90 lines
Common name calls	For all 20 extensions	For extension nos 10—29	
Individual name calls		8 individual combinations of 10 names each for each 30-line group plus 8 individual groups per exchange	
Digit calls	—	10—69	10—99
Connecting circuits	2	Max. 4*	Max. 5*
Priority	Optional number of extensions	Max. 28 extensions	Max. 42 extensions
Secretary transfer	Standard for 1 extension; extra for additional extensions	Standard for 6 extensions	Standard for 9 extensions
By-passing of transfer		Standard	
Paging (extra relay set)	To all or selected unengaged extensions	To any of 9 selected groups of extensions	
Tie line (extra relay set)	Max. 1	Max. 2**	Max. 2**

* Need not be initially installed to full capacity but can be added as desired.

** Max. 1 if exchange equipped for paging.

Privacy and Tones

The various DIRIVOX exchanges have the same system for privacy and tone signalling.

Privacy

A call is announced by repeated tone signals. The called party takes the call by briefly depressing an answer button. The yellow lamp remains alight during the conversation as a reminder that the microphone is connected. A connection is cleared by briefly depressing the release button.

A simpler method of taking a call is to set the privacy switch on the extension instrument for direct through-connection. A call is then announced by a distinct tone, after which it is put through automatically. The yellow lamp remains alight during the conversation. The connection is cleared by the caller without any action on the part of the called party.

Through these privacy measures an extension user is completely safeguarded against eavesdropping.

Tones

The DIRIVOX exchange is equipped with a generator which delivers the call and busy tones. The generator is fully transistorized and has a volume

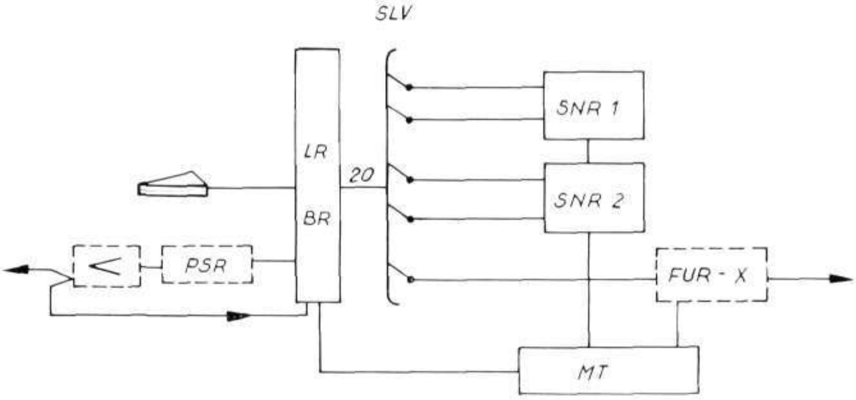


Fig. 1
Trunking diagram for ARD 631

LR	Line relay
BR	Cut-off relay
SLV	Crossbar switch
SNR	Connecting circuit
MT	Marker
FUR-X	Tie line equipment
PSR	Paging relay set

control for adjustment of the signal volume. The frequency of the signals is about 600 Hz. The character of the busy tone is 0.4 second on, 0.4 second off. The calling tone is sent at intervals of 1 second on, 1 second off.

Operation of Exchanges

Exchange ARD 631

This exchange is designed for 20 extensions. Its trunking diagram is shown in fig. 1.

The switching unit is a 6-horizontal crossbar switch with 5 verticals, four of which are used for switching between extension lines and the connecting circuits. The fifth vertical is used for tie lines to other exchanges.

In the following the calling side will be referred to as the *A*-side and the receiving side as the *B*-side.

When an extension makes a call, its line relay (*LR*) operates to identify the *A*-extension and the marker (*MT*) is seized. The line relay connects the extension's line to the marker, which immediately analyses the keyed code. The marker hunts for a free connecting circuit (*SNR*) and connects the *A*-side of the connecting circuit via the crossbar switch to the *A*-extension's line. The cut-off relay (*BR*) then operates and the line relay releases.

The code information stored in the marker causes the *B*-extension's line relay to operate. The *B*-extension has now been identified and the marker can connect the *B*-side of the switch to the *B*-extension's line. The marker then tests to see whether the *B*-extension is free. If so, the connection is set up. If the *B*-extension is engaged, the connecting circuit unit returns busy tone to the *A*-extension. In both cases the marker releases immediately thereafter.

If a priority extension calls an engaged number, the connecting circuit unit returns busy tone. If the *A*-extension then presses his talk-listen button, the connecting circuit unit induces a discreet tone signal via the crossbar switch on the connection.

The *A*-extension can now wait on the camp-on-busy circuit: a test relay in the connecting circuit unit senses when the *B*-extension becomes free and then puts through the new call.

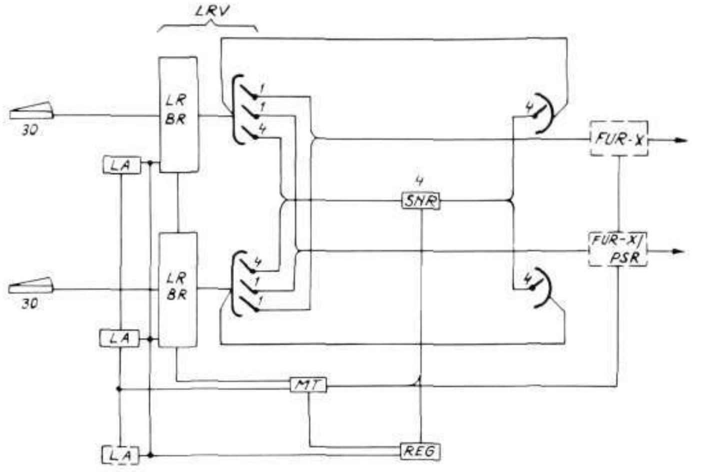


Fig. 2
Trunking diagram for AKD 847, 60 lines

LRV	Code switch unit
LR	Line relay
BR	Cut-off relay
LA	Relay set for name-call groups
SNR	Connecting circuit
MT	Marker
REG	Register
FUR-X	Tie line equipment
PSR	Paging relay set

Exchange AKD 847

This exchange can be supplied for maximum capacities of 60 and 90 extensions divided into groups of 30. The trunking diagrams for the two exchanges are shown in fig. 2 and 3.

Each 30-line group has a complete switching unit (*LRV*) containing line and cut-off relays (*LR*, *BR*) and code switch with ten verticals (*V1–V10*). Every vertical has 30 multipled outlets.

A connecting circuit (*SNR*) normally has access to two code switch verticals in each 30-line group, one on the *A*- and one on the *B*-side. Five connecting circuits therefore utilize all 30 verticals in the three code switches in order to be accessible to all extensions on the *A*-side and to reach all extensions on the *B*-side.

When a 90-line exchange has a tie line (*FUR-X*) or paging (*PSR*) unit, two code switch verticals in each 30-line group are used for this purpose. They are obtained by grading the verticals of the first three connecting circuits on the *A*-side. The first connecting circuit thus becomes accessible to extensions in the first 30-line group, the second connecting circuit to the second, and the third to the third group. The two remaining connecting circuits are accessible

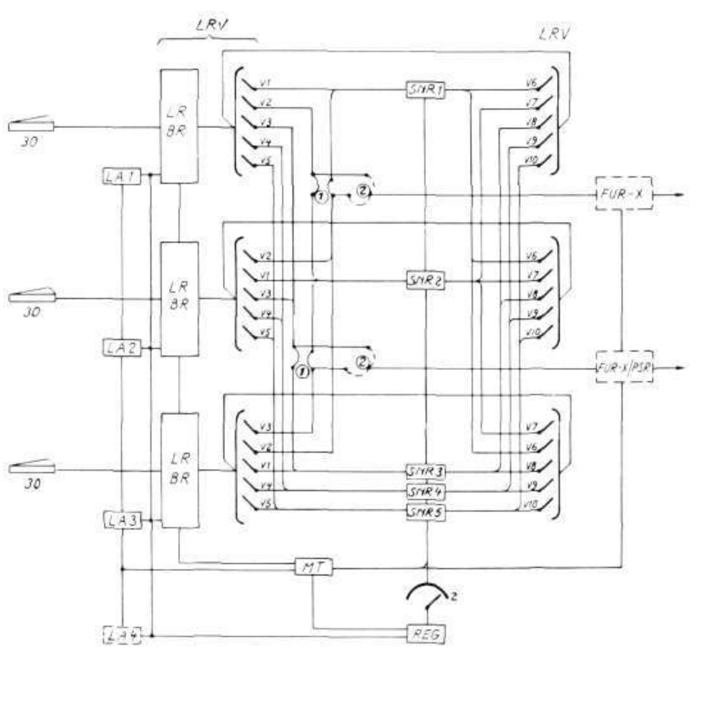


Fig. 3
Trunking diagram for AKD 847, 90 lines

LRV	Code switch unit
LR	Line relay
BR	Cut-off relay
LA	Relay set for name-call groups
SNR	Connecting circuit
MT	Marker
REG	Register
FUR-X	Tie line equipment
PSR	Paging relay set
①	Strap, to be removed if FUR-X or PSR installed
②	Strap, to be inserted if FUR-X or PSR installed

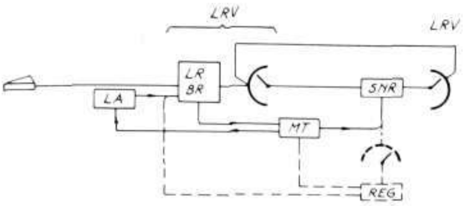


Fig. 4
Simplified trunking diagram for AKD 847, name calls

LRV	Code switch unit
LR	Line relay
BR	Cut-off relay
LA	Relay set for name-call groups
SNR	Connecting circuit
MT	Marker
REG	Register

to all groups. Since the marker (*MT*) is in this case arranged so that the fourth and fifth connecting circuits are allotted a call only when the connecting circuit of the caller's 30-line group is engaged, this grading does not materially affect the traffic capacity of the exchange.

There are two ways of making calls, i.e. name calls or digit (register) calls.

Name calls do not make use of the register (*REG*). The operation of the exchange will be seen from the simplified diagram in fig. 4.

When the button of the wanted extension is pressed, the line relay (*LR*) operates to identify the *A*-extension and the marker (*MT*) is seized. At the same time the relays for the two name-call groups allocated to the *A*-extension operate in the respective *LA* unit. The line relay connects the extension line to the marker, which immediately analyses the keyed code. The information is transmitted to the relay sets for the name-call group in 1 out of 20 possible codes.

The marker selects a free connecting circuit and connects the *A*-side of the code switch to the *A*-extension. The cut-off relay (*BR*) then operates and the line relay releases.

The code information stored in the marker and the *LA* unit, together with the information from one of the two operated group relays in the name-call unit (*LA*), now controls the operation of the wanted *B*-extension's line relay. The *B*-extension is thereby identified and the marker can cause the associated vertical on the *B*-side to operate. The marker ascertains whether the *B*-extension is free and, if so, the connection is completed. If the *B*-extension is engaged, the connecting circuit unit returns busy tone to the *A*-extension. In both cases the marker releases immediately after the busy test.

A register call does not engage any relay set for name-call groups (*LA*). Fig. 5 shows a simplified diagram of the method of operation of the exchange on register calls.

When the *A*-extension makes a register call, he presses the digit-call preselection bar, whereupon line relay and marker operate as described above. In this case the marker does not receive a name-call code but selects a free register (*REG*) and free connecting circuit. The *A*-side of the code switch is connected to the extension line and the register sends dial tone to the extension via the connecting circuit. The marker releases.

The *A*-extension now presses the two buttons representing the *B*-extension's number. When the register has received two digits, it calls and seizes the marker. The register now actuates the line relay of the called extension, whereupon the marker operates the code switch and tests whether the *B*-extension is engaged, in the same way as before. Register and marker then release.

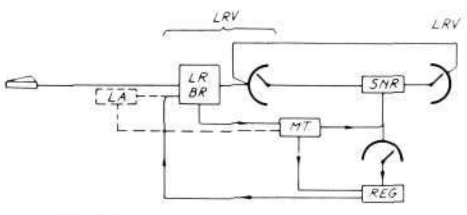


Fig. 5
Simplified trunking for AKD 847, digit calls

LRV	Code switch unit
LR	Line relay
BR	Cut-off relay
LA	Relay set for name-call groups
SNR	Connecting circuit
MT	Marker
REG	Register

Priority calls are made in the same way as described above, whether name calls or register calls. When the *A*-extension's line relay operates, a class-of-service indication is sent from the line relay via the marker to the connecting circuit. A relay in the connecting circuit stores this information until the busy test has been completed. If the *B*-extension is engaged, the connecting circuit unit returns busy tone.

If the *A*-extension presses the talk-listen button, the connecting circuit unit sends a discreet tone via the line relay to the called party's line. The *A*-extension can now remain on the line. A relay in the connecting circuit unit senses when the called *B*-extension becomes free and then immediately sets up the connection.

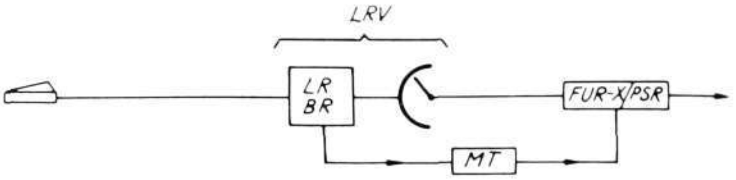


Fig. 6
Simplified trunking diagram for AKD 847, call to special service equipment

LRV	Code switch unit
LR	Line relay
BR	Cut-off relay
MT	Marker
FUR-X	Tie line equipment
PSR	Paging relay set

Tie line (*FUR-X*) and paging (*PSR*) calls are initiated as name calls, but no *LA* relay set, connecting circuit or register is used. The trunking diagram is shown in fig. 6.

On depression of the appropriate button for a tie line or paging call, the line relay operates and the marker is seized. The marker analyses the code and selects a tie line or paging unit. If free, the unit's vertical which has access to the called extension is switched to the line. The marker releases and the connection is put through.

A call on a tie line to another exchange seizes an extension line in the latter. The call is thereafter completed in the same way as a call within the calling exchange.

Fig. 7
Wall terminal with compensation resistor

Installation

Every extension is connected to the exchange on 4 wires. Extensions with secretary transfer facility require an extra conductor. Ordinary unscreened, plastic-insulated telephone cable with twisted pairs can be used. The line resistance may be up to 170 Ω, i.e. 85 Ω per conductor. With 0.5 mm copper wire, therefore, the maximal length of line is 1000 m and with 0.7 mm copper wire 2000 m.

The extension set is connected through a flexible plastic cable and 5-point plug to a wall terminal.

A compensation resistor to compensate the line resistance is soldered into the wall terminal (fig. 7), the compensation thereby being fixed to the line and not to the instrument.

The incoming lines terminate on screw terminal blocks in the exchange.

The larger exchanges (*AKD 847*) have an M.D.F., which on its line side has terminals for 110 lines (fig. 8). By alteration of the jumpering on the M.D.F. an extension user can be moved from one room to another without changing his number or name-call facility. The allocation of special facilities is done in the larger exchanges by means of single-wire straps in the switches and relay sets for name calls.

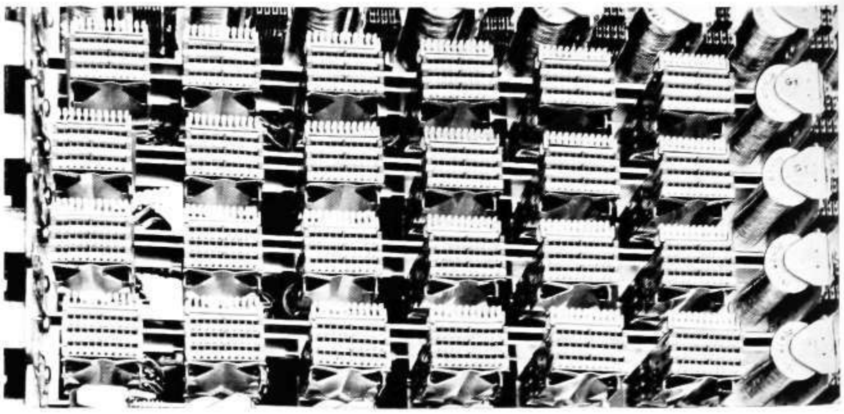


Fig. 8
M.D.F. for name-call jumpering, AKD 847

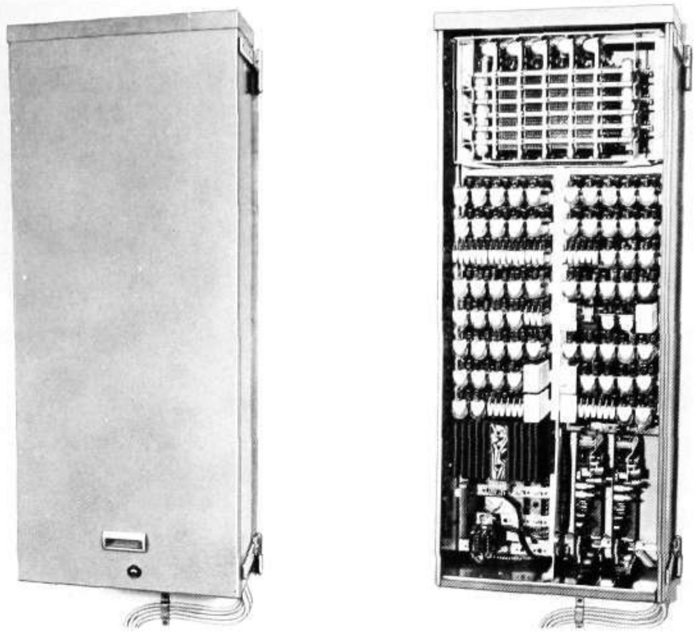


Fig. 9
Exchange ARD 631 with and without front panel

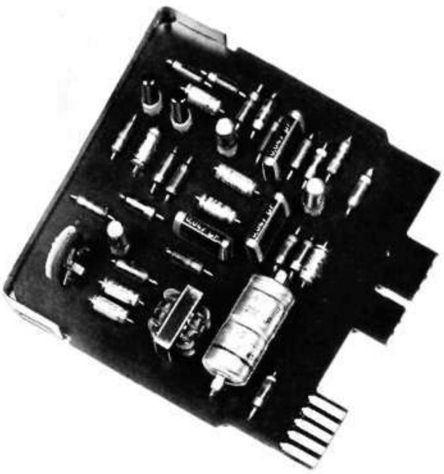


Fig. 10
Tone generator for ARD 631

Design of Exchanges

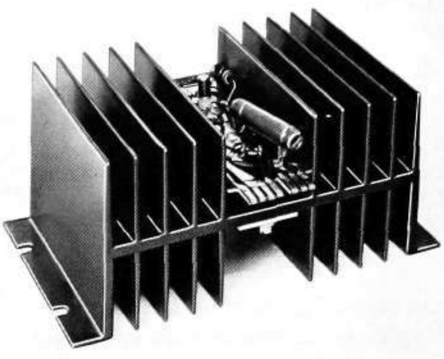
ARD 631 for 20 extensions is enclosed in a wall cabinet (fig. 9). For purposes of installation and maintenance the entire exchange can be swung out so as to provide access to all components both at front and rear.

The electronic equipment consists of tone generator, voltage stabilizer and two connecting circuit amplifiers with speech control circuits (fig. 10, 11 and 12). The connecting circuit amplifiers and tone generator connect to the exchange cabling by plug and jack.

The switching equipment consists of crossbar switches and ordinary telephone relays.

A metal cover protects the exchange against dust and mechanical damage. The cover and bottom frame are enamelled light grey.

Fig. 11
Voltage stabilizer



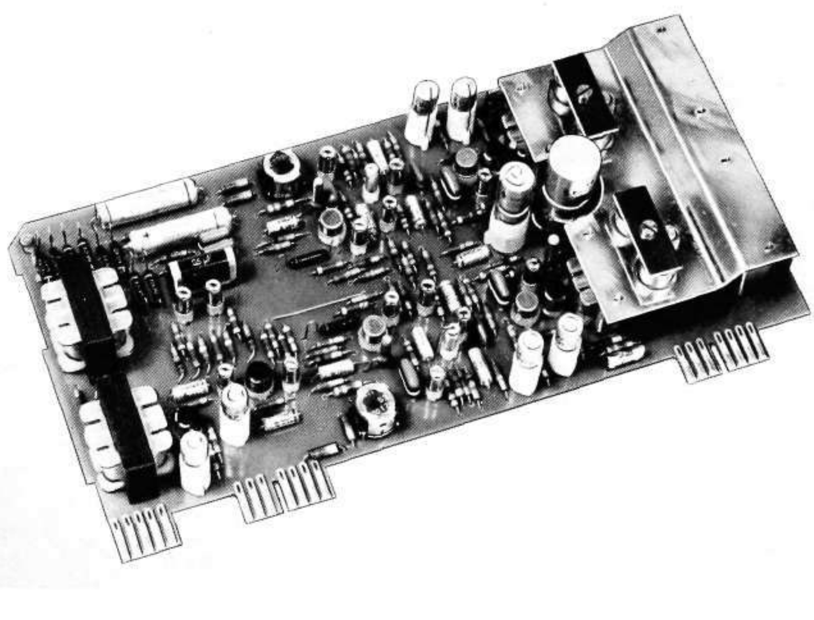


Fig. 12
Connecting circuit amplifier

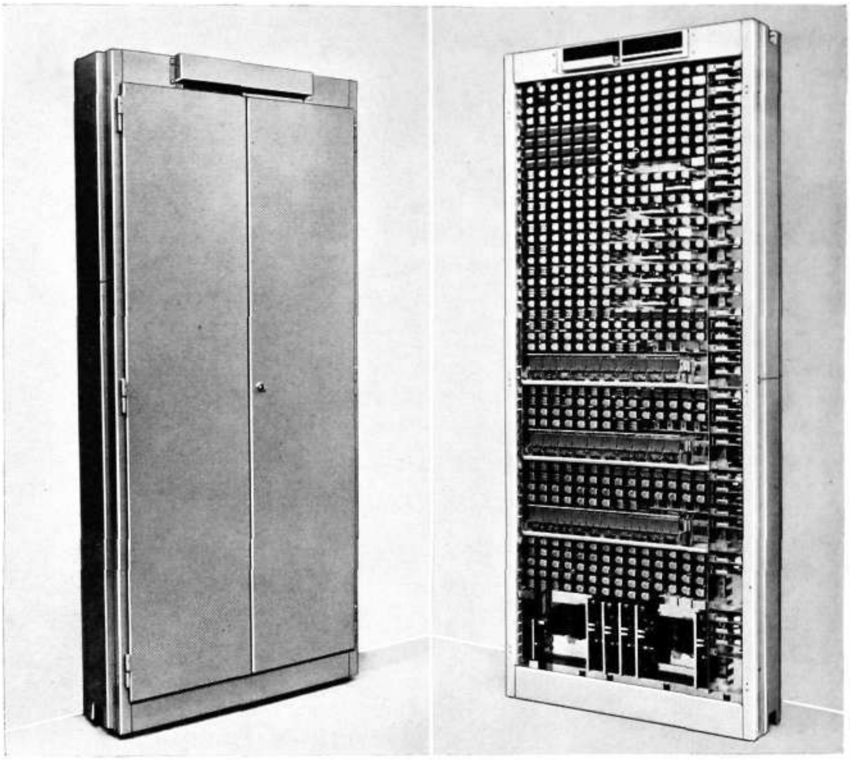


Fig. 13
Exchange AKD 847
(Right) with doors removed

Exchange *AKD 847* is supplied in two sizes, for 60 and 90 lines (fig. 13). The racks are supplied ready cabled for maximum capacity. The switching equipments connect by plug and jack. Installation can thus be completed quickly and testing is very simple. The plug-and-jack arrangement also implies that the exchanges can be easily modified and extended without interruption of service.

Each switch and relay set in the exchange has its individual dust cover.

If the exchange is set up in an office or in a room used for other purposes, it can be supplied with a lockable door. It then has the appearance of a sheet-metal filing cabinet. The doors also provide extra dust protection.

Racks, relay covers etc. are antirust-treated and grey-enamelled. They can therefore be used also in tropical climates.

The electronic equipment is made up roughly of the same units as in the 20-line exchange (fig. 11 and 12). The difference is that the tone generator in *AKD 847* has its own power amplifier (fig. 14).

Fig. 14
Tone generator with power amplifier for AKD 847

The relay equipments, on the other hand, are of entirely different type. *AKD 847* is register-controlled. The switching stage consists of code switches operating on the bypath principle.

The dimensions of the exchanges are tabulated below:

Exchange type	Height	Width	Depth
	mm	mm	mm
ARD 631	1000	425	220
AKD 847, 60 lines	1940	1025	250
AKD 847, 90 lines	2400	1025	250

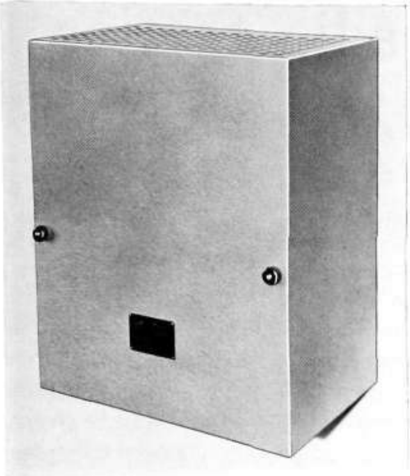


Fig. 15
Battery eliminator

Power Supply

The exchanges are supplied from the commercial network via battery eliminators, *BMN 2430* for the 20-line exchange and *BMN 2431* for the larger exchanges. Both units have the same dimensions: height 360, width 280 and depth 200 mm (fig. 15).

The battery eliminators have tappings for 100 to 240 V (in steps of 10 V), 50–60 Hz. The exchange equipment will tolerate mains voltage variations of up to ± 10 %.

The output voltages are:

	BMN 2430	*BMN 2431*
for relays and switches	48 V DC 3 A	48 V DC 5 A
for electronic equipment	20 V DC 2 A	20 V DC 4.2 A
for pushbutton-dialling	42 V AC 0.5 A	42 V AC 1 A

SRA-TRANSPORT—Mobile Radio Station

H. NORRBY, SVENSKA RADIOAKTIEBOLAGET, STOCKHOLM

UDC 621.396.721
LME 8525

Svenska Radio AB (SRA) has manufactured radio stations for mobile use and their associated stationary equipments for more than 20 years. In this field—as in all other electronics applications—developments in the last few years have been extremely rapid, due to a large extent to the transistor. Transistors have enabled the power consumption of radio stations to be greatly reduced. The increased radio traffic has rendered certain accessory apparatus necessary in some cases. With its Series 300, SRA has sought to meet the demands made by modern developments. The stations in this series have been given the name SRA-TRANSPORT.

SRA-TRANSPORT is used for directing vehicles of different kinds—police, fire brigade, hauliers' and road maintenance vehicles, etc. This type of station is made for a maximum of six radio channels in three frequency bands, 30—41, 70—87.5 and 100—108 MHz, and in all three cases in two models, one for 25 and one for 50 kHz channel spacing. Owing to the serious shortage of frequencies the Swedish Board of Telecommunications has ruled that, after a transitional period, radio traffic of this kind on the aforementioned frequency bands may be effected only with apparatus for the smaller channel spacing, and specifications have been issued for such equipments. SRA-TRANSPORT naturally fulfils the specifications, and the 80 MHz model for 25 kHz channel spacing has been put through type tests by the Radio Division of the Board of Telecommunications. It has also been type-tested according to the standards of the Swedish Army for shock stability (50 g acceleration).

The designations of the three models in the aforementioned frequency ranges and of narrow-band type are *CN-301*, *CN-302* and *CN-303*. In the broad-band type the letter *N* (narrow band) is replaced by *B* (broad band).

The normal method of operation is simplex, i.e. two communicating stations must transmit alternately. A duplex model (simultaneous transmission) is also available. This is designated by a *D*, e.g. *CN-302 D*. The station can be transferred from one vehicle to another with different battery voltages—6, 12 or 24 V—without any circuit modification.

A complete standard radio station consists of

- main unit containing transmitter, receiver and DC converter
- control unit with built-in loudspeaker
- microphone or handset with holder
- aerial for roof- or side-mounting
- fuse box and standby relay, cables and terminals

An entire system of accessories has been developed for SRA-TRANSPORT, providing for widely varying requirements and permitting the station to be used in the most efficient possible manner. The station can, for instance, be supplied with an automatic *channel changer* for simultaneous watch on two radio channels, a *squelch relay unit* and a *tone transmitter* and *tone receiver*

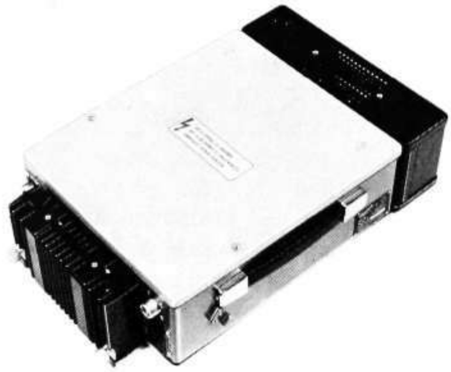


Fig. 1
Main unit

for selective calling. It can also be used as fixed station if equipped with a *mains power unit*. For the latter case there are two systems of operation, one for extended local control via a multiwire cable and one for remote control over a distance up to ten kilometres on a two-wire telephone line. The local control station is designated *F/CN(B)-300* and the remote-control station *F/CN(B)-300 R*, *F* signifying "fixed" and *R* "remote control".

For remote control a panel containing line relays is placed in the mains power unit. This *line terminal panel* can also contain a *voice-operated T/R switching unit* which permits connection of the station for simplex operation as well to the telephone network.

The control unit for the mains-connected stations is used also for SRA's larger radio stations, types *F-40* and *F-100*.

Main Unit

The main unit (fig. 1 and 2) consists of two sections. One comprises the transmitter driver and output stages ; these contain the only two valves in the station. The other section contains the transistorized units. The two sections are joined into a unit separated by a thermally insulating air gap. The life of the transistors and other components is thereby increased. The transistorized section is in turn divided into four subunits: transmitter modulator and low-power stages, receiver RF and oscillator stages, receiver IF and AF stages, and the DC converter. The latter has effective aluminium heat sinks in which the transistors are mounted. The three former subunits are mounted on printed circuit cards in low frames. The latter are secured by captive screws on bars running along the inner sides of the main frame and can be easily removed for inspection. The main unit is mounted on a baseplate screwed to the vehicle and fixed to it by two snap-on catches.

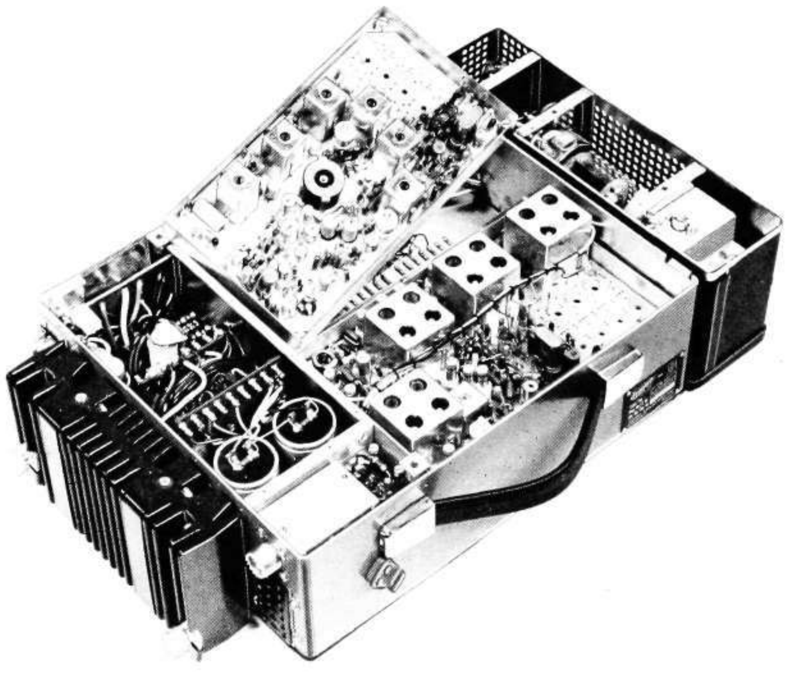


Fig. 2
Main unit with cover removed. (From left) DC converter, modulator and low-power stages of transmitter (raised), RF amplifier and first oscillator of receiver. (Far right) Transmitter power unit with driver and output stage

The operation of the transmitter and receiver will be seen in broad outline from the block schematics in fig. 3 and 4.

Transmitter

On the printed circuit card carrying the modulator and low-power stages there is first the oscillator. This is switchable between six crystals. Switching is done with diodes instead of relays, which for this purpose are rather unreliable. The voltage from the oscillator is amplified in one stage and then taken to the phase modulator, which is of diode type. As appears from the block schematic, in the narrow-band case only one modulator is used and in the broad-band case two modulators in cascade. After the modulation there follow a number of frequency- and deviation-multiplier stages. The crystal frequency is multiplied only twelve times, which means that spurious radiation from the transmitter is kept to a very low level.

The circuit card delivers 10—15 mW at the transmitter frequency and this power is taken to the power amplifier.

The AF amplifier of the transmitter includes a speech clipper for prevention of overmodulation and a low-pass filter which cuts-off speech frequencies above 3000 Hz.

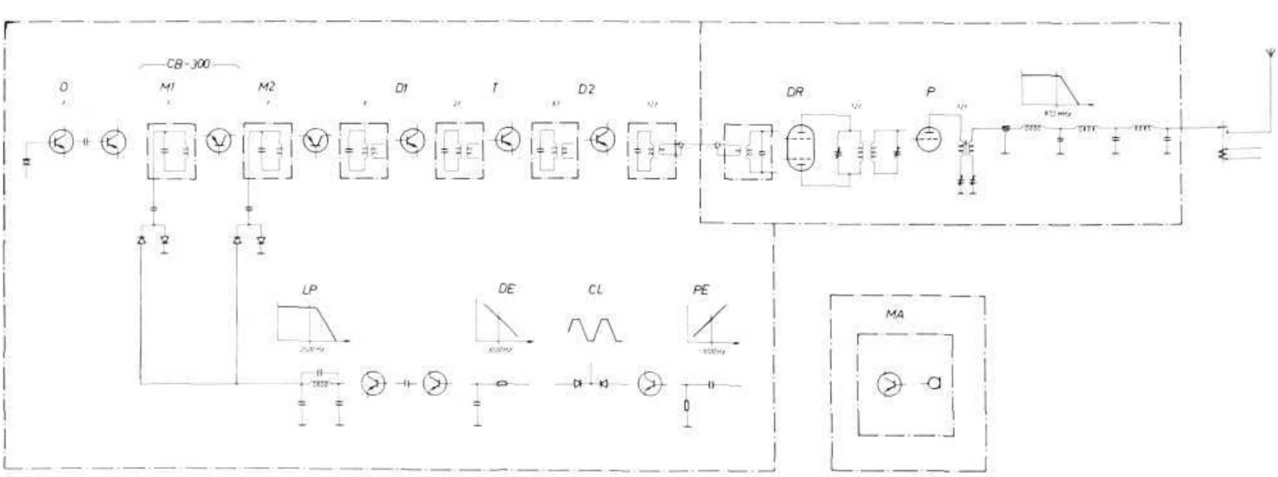
Receiver

The receiver is a fully transistorized double superheterodyne. Its RF unit contains two stages with six tuned circuits, the crystal-controlled first oscillator with doubler stage and the first mixer. Switching of the crystals is done as in the transmitter with diodes. The subsequent IF unit comprises, first, four circuits tuned to 8.8 MHz. This first intermediate frequency and the signal from the second oscillator are taken to the second mixer, which is followed by 5+5 circuits with an intermediate amplifier stage. These circuits are tuned to the second intermediate frequency of 455 kHz. Thereafter follow a number of limiter stages and the discriminator which, via an emitter-follower, feeds the AF unit. This contains two amplifier stages and a push-pull output stage which delivers about 2 W at 1000 Hz and max. frequency deviation.

The AF unit also contains a squelch circuit. It consists of two amplifier stages and a noise detector, the output voltage from which controls a keying stage which cuts off the AF amplifier in the absence of a carrier signal.

Fig. 3
Block schematic of transmitter

O	Oscillator
M1, M2	Modulators
D1, D2	Doubler stages
T	Tripler stage
DR	Driver stage
P	Output stage
PE	Pre-emphasis network
DE	De-emphasis network
CL	Speech-clipper
LP	Low-pass filter
MA	Microphone with built-in amplifier



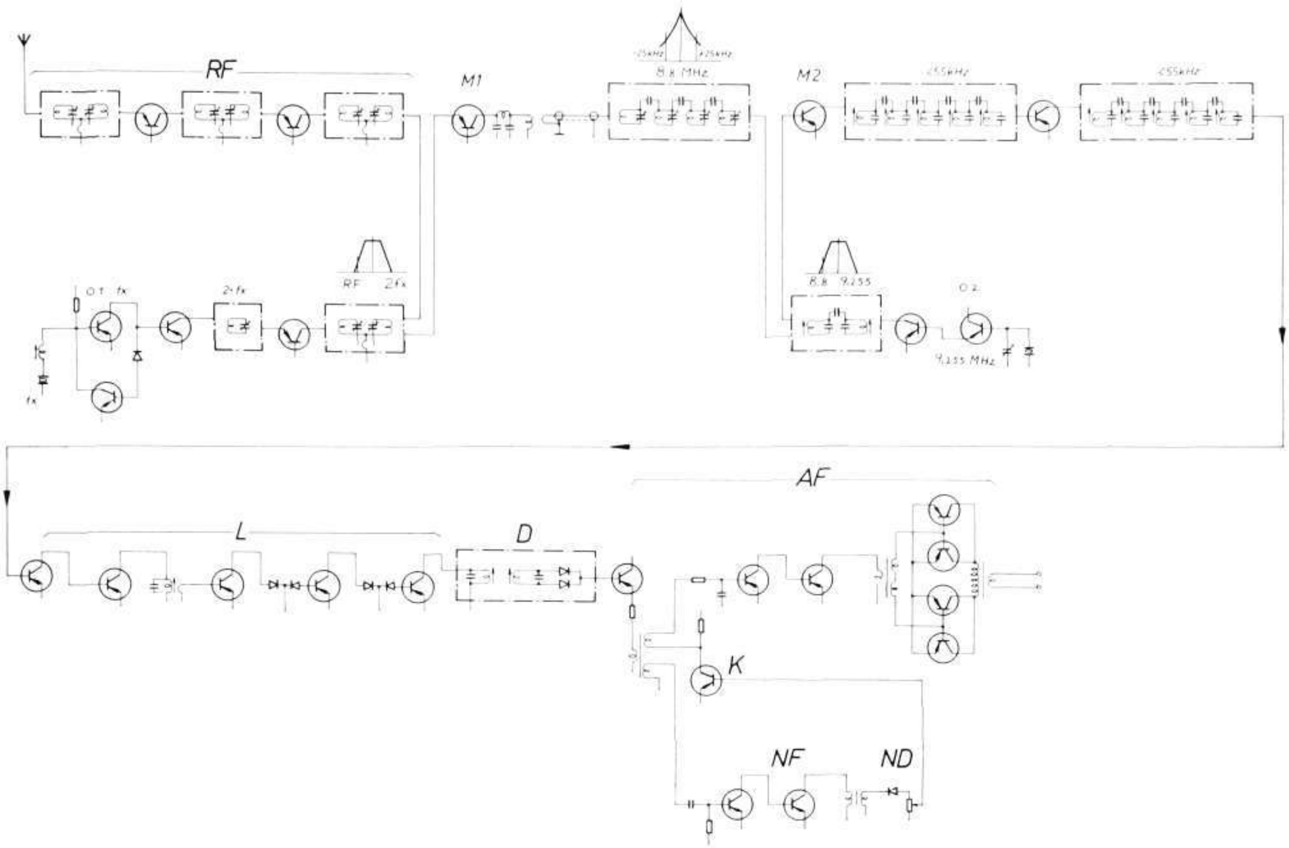


Fig. 4
Block schematic of receiver

RF	RF amplifer
M1, M2	First and second mixers
O1, O2	First and second oscillators
L	Limiter
D	Discriminator
AF	AF amplifier
NF	Noise amplifier
ND	Noise detector
K	Keying stage

DC Converter

The converter contains two push-pull oscillators with the windings on a common transformer core. The oscillators are thereby very rigidly coupled to one another, the output voltage being in phase. The connections for 6 V and 12 V differ in the number of turns in the collector circuits and in the difference of bias point (the change being made in the battery plug). At 24 V battery voltage the two oscillators work from a DC point of view in series but from an AC point of view in parallel. The oscillator frequency is 3000—5000 Hz depending on the load. At this high frequency the transformer core could be made small despite the relatively large power output. In this case the core consists of a ferrite toroid. The AC voltage arising in the primary winding of the transformer is transformed to the desired values on the secondary side, rectified and smoothed. The DC converter delivers the following voltages:

- + 450 V and + 225 V to the transmitter output stage,
- – 18 V, stabilized, to the transmitter modulator and low-power stages and to the receiver,
- – 15 V to the receiver output stage and
- 6.3 V to the filaments of the transmitter valves. This voltage is obtained from a separate winding of the transformer.

The relays station are fed from – 15 V and from the rectifier prior to the – 18 V stabilizer.

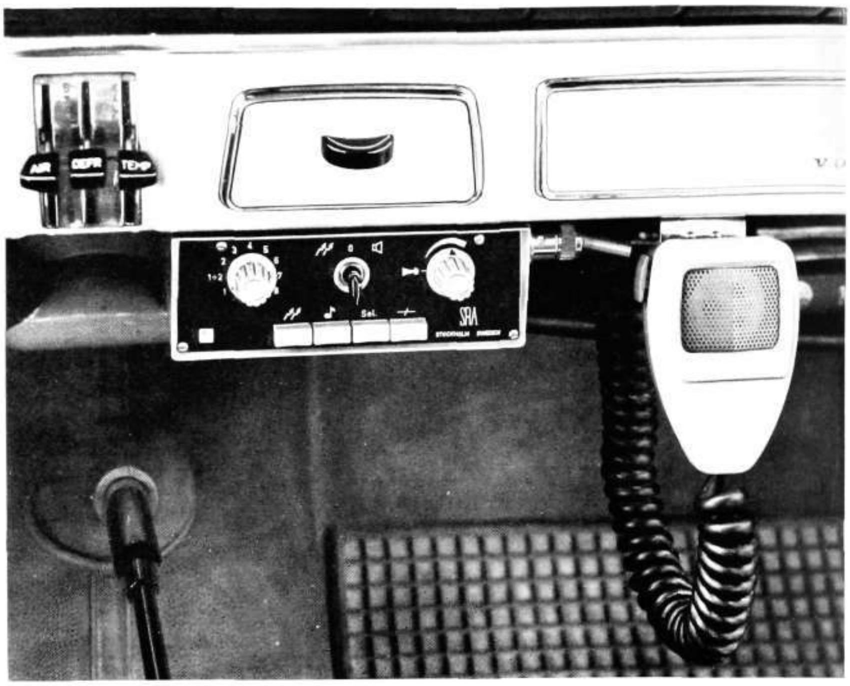


Fig. 5
Control unit with microphone mounted in passenger car

Control Unit

The control unit (fig. 5) is built in a frame of grey impact-resistant plastic with top and bottom sections of sheet steel pressings. The loudspeaker is mounted on one of them. Top and bottom can be interchanged, so that the loudspeaker can be directed in the most favourable manner according to the position of the control unit.

The control unit has space for a tone transmitter and tone receiver for selective calling (see below). The front panel carries the following controls:

- Main switch. This has three positions. In the centre position, marked 0, the station is shut-down; in the right hand position, marked ◁ , only the receiver is in operation. This position is used when an especially low current consumption is important, e.g. when no charge goes to the battery. In the third position, marked ///, heater voltage is supplied to the transmitter valves, i.e. standby operation of transmitter.
- Channel selector
- Stepwise volume control
- Switch on right: squelch "on" and "off"
- Switch on left: setting of tone code
- Green lamp, indicates station "on"
- Red lamp, indicates that a selective call has been received
- Row of keys with following functions:

  /// = sending key

  ♪ = tone transmission

  Sel. = connection of tone receiver for selective call

  -/- = restoring after selective call

As already mentioned, the station can be supplied either with a microphone (fig. 5) or a handset, in both cases with dynamic microphone inset and built-in transistor amplifier. The transmitter is operated with the microphone key.

Accessories

Automatic Channel Changer

As switching of the crystals is done purely electronically with diodes, automatic watching on two channels simultaneously is possible. The switching is achieved through the fact that an astable multivibrator earths the leads to the crystal-switching diodes in the receiver alternately and so shifts between two channels. When a carrier signal arrives on one of the channels, the multivibrator is locked in the position corresponding to that channel. This takes place through the fact that the voltage from the squelch circuit, which in the presence of a carrier signal deblocks the low-frequency amplifier, controls the multivibrator as well.

The automatic channel changer is made up on a small printed wiring unit mounted on the RF and oscillator card of the receiver. If the station has an automatic channel changer, therefore, it can only be equipped with crystals for four channels.

The channel selector on the control unit must be set to position 1+2 for simultaneous watch on two channels. When the call is to be answered, however, i.e. for operation of the transmitter, the channel selector must always be set to the desired position.

Squelch Relay Unit

The squelch circuit of the receiver opens and blocks the AF unit electronically in the presence and absence, respectively, of a carrier signal. Often, however, it is desirable to extend the function of the squelch circuit to provide at the same time a contact closure, e.g. for starting an alarm device, lighting of lamps etc. The squelch relay unit provides precisely this extended function and, like the channel changer, is controlled by the detected voltage from the noise amplifier.

The unit contains three transistors and one relay and is placed in the main frame near the socket for the control cable.

Mains Power Unit

This is carried on a base of pressed sheet steel similar to the bottom section of the main unit and, apart from its height, has the same dimensions as the transistorized part of the main unit.

The unit delivers −24 V DC, which is fed to the station via the battery plug, connected for 24 V. The DC converter thus operates when the station is connected to the mains. This has the practical advantage that, without special arrangements, any vehicle station whatsoever can be used as stationary equipment, an important point from the servicing point of view. The power unit contains a mains transformer, rectifier, choke and smoothing capacitor. The choke is of "swinging choke" type to maintain the output voltage as far as possible constant despite the large difference between sending and receiving current output.

Control Unit and Operation of Mains-Connected Station

Extended local control takes place, in the same way as when the station is installed in a vehicle, on a multiwire cable (max. 75 m), but the control unit is of different design. It naturally has the same facilities, but in this case is equipped entirely with push-buttons instead of knobs.

The control unit is enclosed in a plastic casing of console type. The tone transmitter and tone receiver can be built into the control unit. Fig. 6 shows the model with rows of buttons for sending of tone code (see Selective Calling page 30). The other buttons have the following functions:

ON = switching-on of control unit

= volume control (two buttons)

SEL = connection of selective call receiver

1+2 = simultaneous watch on two channels

f_1—f_4 = channels 1—4

= transmission

= restore after selective call

Yellow lamp indicating that the control unit is switched on

Red lamp indicating receipt of a selective call

The control unit has a built-in dynamic microphone and a microphone amplifier. For checking of uniform modulation when speaking, a level instrument of the same type as used in most tape recorders is fitted on the panel between the two lamps.

In some cases, however, for example in noisy premises, it may be inadvisable to use the built-in microphone. In such case an Ericofon can be connected to the control unit. The Ericofon has a dynamic microphone and a sending key and its bottom terminal is used in such a way that, when the Ericofon is raised, the built-in microphone is disconnected.

The *remote control unit* is of exactly the same appearance and has the same controls as the local control unit but contains, in addition, a line transformer and a line amplifier both for microphone and loudspeaker; also a rectifier unit which supplies the various amplifiers and relays. The control unit is connected to the mains via a transformer which delivers 2×17 V AC to the rectifier. The transformer is placed in a ventilated casing for wall mounting.

Fig. 6
Control unit for mains-connected station

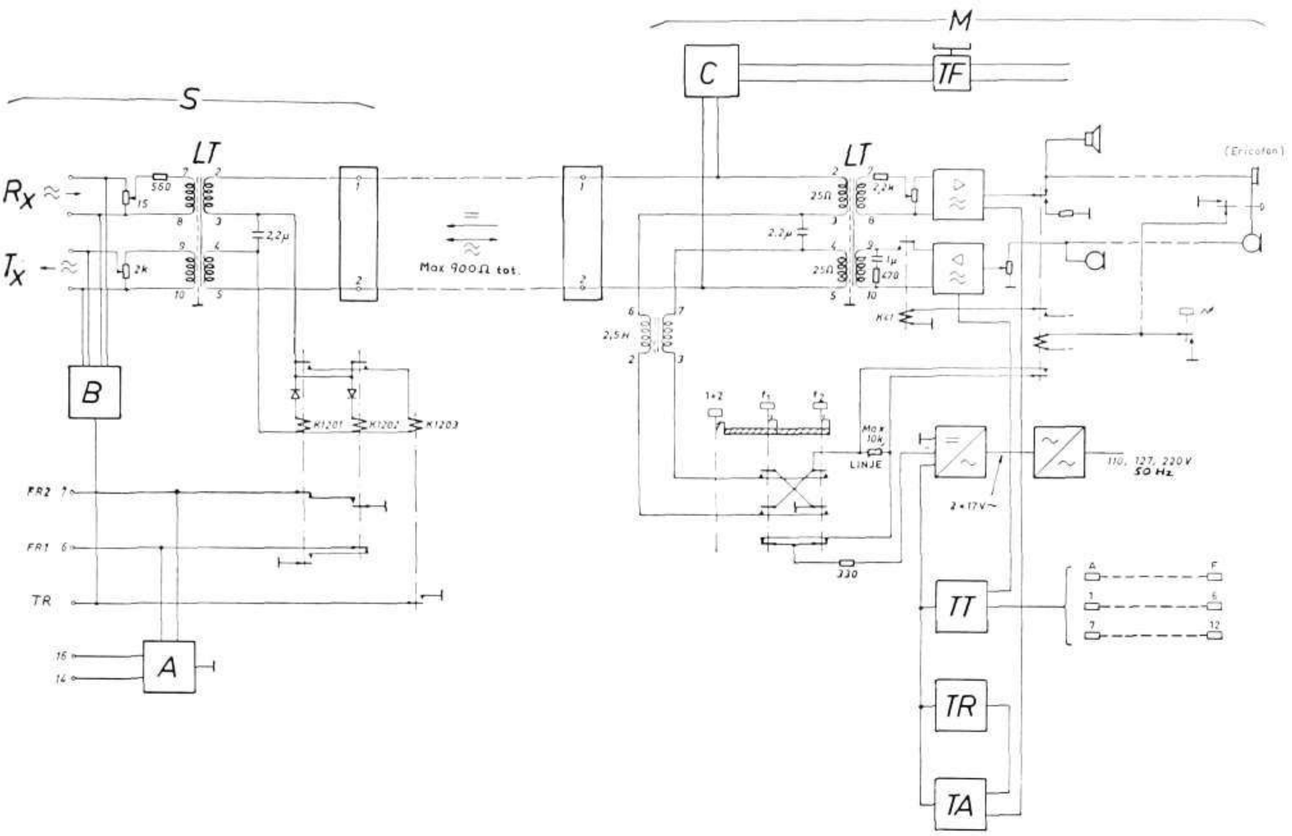


Fig. 7
The remote control system. ***S*** **indicates the apparatus at the station position and** ***M*** **at the control position**

LT	Line transformer
K1201-K1203	Control relays
$1+2, f_1, f_2$	Channel keys
↗	Transmission key
A	Automatic channel selector
B	Voice-operated T/R switching unit
C	Line terminal box
TF	Intermediate telephone set
TT	Tone transmitter
TR	Tone receiver
TA	Tone amplifier
R_x	Receiver output
T_x	Transmitter output

The part of the remote control equipment belonging to the station position, the *line terminal panel*, is, as already mentioned, placed in the mains power unit. The panel contains three telephone relays, two of which connect the desired radio channel and the third controls the transmitter ; also a line transformer, level setting device, microphone socket and traffic switch. For remote control the latter must be set to "TRAFIK" position. In "TEL" position telephone communication is possible with the control unit via the line, which may be of value for servicing purposes. In the other two positions of the switch, *FR1* and *FR2*, the station is entirely controlled from the line terminal panel.

In the standard equipment the remote control system allows two radio channels. The principle is shown in fig. 7. When the remote control unit is switched on, DC is fed to the line via the potentiometer, *LINJE*, which is accessible on the underside of the control unit. The polarity depends on which of the buttons, f_1 or f_2, is pressed. The potentiometer must be set so that *K 1201* or *K 1202* (depending on the polarity) operates with some margin to spare. The setting will of course depend on the line resistance. *K 1201* connects channel 1 and *K 1202* channel 2. When the sending key is pressed, the potentiometer is short-circuited and the full line voltage, 36 V, is supplied. *K 1203* then operates and starts the transmitter.

If key 1+2 is pressed, no direct current flows on the line; for the station with automatic channel changer this means that simultaneous watch is obtained on channels 1 and 2. In this position transmission is prevented.

Zero level on the line, i.e. about 0.8 V AF, is set from the radio receiver at the station position and from the microphone amplifier on the control unit. The modulation of the transmitter and the volume of the loudspeaker will depend on the length of line and must be set accordingly.

Voice-operated T/R Switching Unit

The line terminal panel can be equipped with a unit for voice operation of the transmitter. This, as noted, is used especially when the radio station in simplex operation is to be connected to a telephone network. The voice-operated unit has two inputs. The speech voltages from the line enter one input and, after amplification and rectification, start the transmitter via a relay circuit. The other input is connected to the radio receiver output and, if speech power comes from the latter, the relay set becomes inoperative and the transmitter cannot be started. On the control side the line is connected to the telephone network via an intermediate telephone set and line terminal box.

Selective Calling

As the name indicates, selective calling implies that calls are picked up only by a specific station. The method is becoming increasingly common and is adopted for several reasons, in most cases to reduce the irritation sometimes felt when personnel have to listen to a number of calls and conversations which do not concern them. SRA's selective calling system works with audio frequencies in the speech band. The 18 frequencies are divided into two groups, six with the alphabetical notations *A—F* and 12 with digits *0—11*. Each tone code consists of two audio frequencies, an alphabetical frequency and a numerical frequency, and these are sent simultaneously. The method provides a great safeguard against false calls and allows a total of 72 combinations.

Apart from the controls referred to in conjunction with the control units, the apparatus consists of a two-tone transmitter and a two-tone receiver (fig. 8). These are transistorized and made up on printed circuit cards for placing in the control units, whether stationary or mobile.

A tone transmitter contains two *LC* oscillators, one for the alphabetical frequency and one for the numerical. The various audio frequencies are obtained from different tappings on the coil. The selection of tapping is done in the stationary control unit with keys *A—F* and *0—11*. The alphabetical keys release one another, while the numerical keys are non-locking. Code *B9*, for example, is sent by pressing first key *B*, which remains locked when the pressure is released, and then key *9*, whereupon a carrier signal modulated with tones *B* and *9* is transmitted as long as key *9* is held depressed.

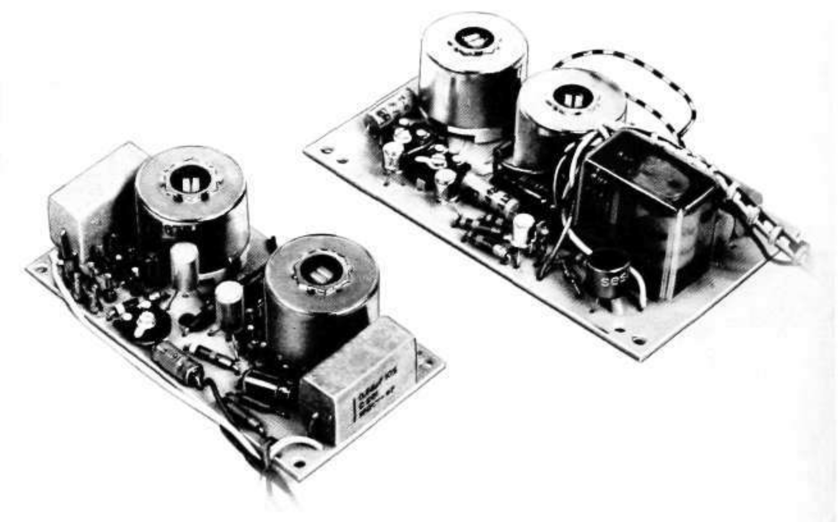


Fig. 8
Printed circuit card with tone transmitter (left) and tone receiver

In the vehicle control unit the alphabetical frequency is preset and can be changed only by resoldering. Thus in this case only a numerical frequency can be selected, i.e. one can have 12 combinations. The digit is selected with the switch on the left and is visible in the small square window at the bottom left of the panel. The carrier signal and the desired tone code are sent with the key marked ♪.

The tone receiver contains two series tuned-circuits in parallel, and the desired combination of tones is obtained by connecting the tuning capacitors to certain terminals on the coils. The audio frequencies from the two circuits are rectified and control their respective transistors. These transistors are in series and, only when there is a control current on both, do they actuate a relay via a thyristor. If key SEL on the control unit is depressed, the loudspeaker is bypassed. It is connected by the relay in the tone receiver only after reception of the correct combination of tones. This is indicated also by the lighting of the red lamp. At the end of conversation the restore key is pressed, whereupon the lamp goes out and the loudspeaker is disconnected again.

The mobile control unit has a position on the volume control marked with the symbol . This implies that an external alarm device such as a hooter can be connected. Alarm is issued as long as the numerical key on the sending control unit is kept depressed.

Technical Data

The data below relate to the 80 MHz model. The same data, however, apply to the 40 and 100 MHz models with the exception of the maximum frequency spacing between channels, which in the 40 MHz band is 400 kHz and in the 100 MHz band 600 kHz. The output on the 100 MHz band, moreover, is maximized in Sweden to 3 W, but the Board of Telecommunications often allows 15 W.

Type of station	CN-302, CB-302
Frequency range	70—87.5 MHz
Number of channels	1—6
Max. channel spacing	550 kHz
Min. channel spacing	25 kHz (50 kHz for CB-302)
Frequency stability (ambient temperature $-25°$ to $+45°$ C)	Better than $\pm 20 \times 10^{-6}$ ($\pm$ 0.002 %)
Modulation	FM (phase)
Transmitter	
Power output	25 W $\pm$ 1 dB*
Frequency multiplication	12 times
Max. deviation	$\pm$ 5 kHz ($\pm$ 15 kHz for CB-302) at the 1000 Hz modulating frequency
AF characteristic	300—2500 Hz rising by 6 dB per octave
Spurious radiation	-85 dB

* At 6.3 V battery voltage 20 W $\pm$ 1 dB.

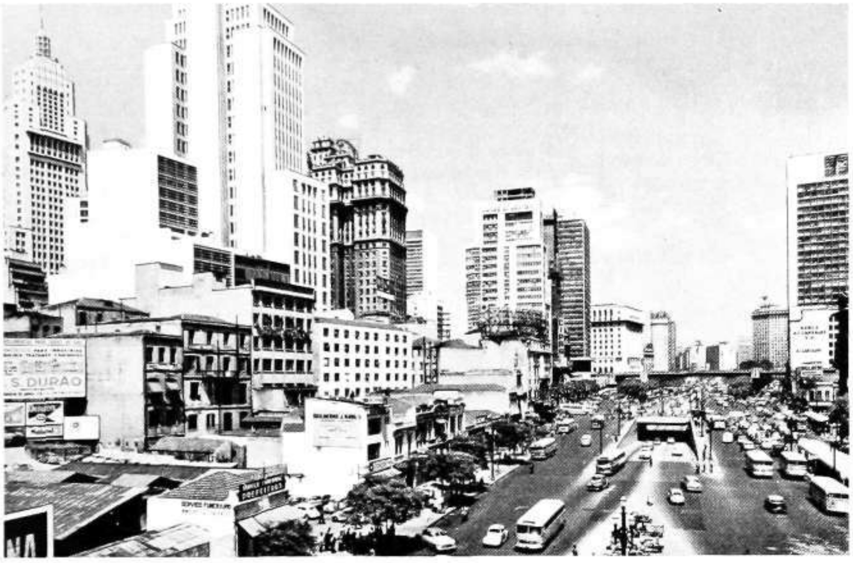
Receiver	
Sensitivity (measured by EIA method)	Better than 0.5 μV
Selectivity	
Two-signal	Better than 80 dB
Three-signal	Better than 70 dB
AF output ± 1 dB	2 W at ± 5 kHz (± 15 kHz for CB-302) deviation and 1000 Hz modulating frequency
AF characteristic	300—3000 Hz falling by 6 dB/octave
Sensitivity to spurious signals	− 80 dB
Transistors	
Transmitter	3-AC126, 2-AF118, 5-AF124, 1-QQE 03/12 (valve), 1-6146 (valve)
Receiver	4-AF102, 7-AF125, 7-AC126, 2-AF118, 2-AF124, 4-AC128
DC converter	4-2N277
Power supply	6, 12 or 24 V DC 110—240 V, 50 Hz with mains power unit

Power consumption	Receiving	Standby	Transmit
6.3 V DC	1.5 A	4.3 A	18.8 A
12.6 V DC	0.8 A	2.2 A	9.3 A
25.2 V DC	0.4 A	1.1 A	4.8 A
Mains connection 220 V	0.3 A	0.4 A	0.9 A

Dimensions and weights	Width	Height	Depth	Weight
	mm	mm	mm	mm
Main unit + base plate	250	100	400	10.7
Control unit with loudspeaker ..	170	60	179	1.3
Mains power unit	250	140	300	14.2

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

Multimillion Order from Brazil



Anhangabau Avenue, São Paulo

L M Ericsson's Brazilian subsidiary, Ericsson do Brasil (EDB), has received a very large order for telephone equipment for the city of São Paulo. The contract was gained in hard competition with American, British and German manufacturers and exceeds 100 millon kronor in value.

The contract comprises 13 automatic telephone exchanges of crossbar type for altogether 85,500 lines. It was signed with Companhia Telefônica Brasileira, Brazil's largest telephone operating company, which has nearly one million subscribers in the most important industrial and commercial parts of the country.

The project covers the first stage in a plan for expansion of the São Paulo telephone network, where telephones are in very great demand. The bulk of the equipment will be manufactured at L M Ericsson's factory at São José dos Campos in Brazil.

L M Ericsson has been established in Brazil through subsidiaries since 1934 and has had a factory there since 1955. The factory was designed by the internationally known architect, Oscar Niemeyer, among whose other creations are the Presidential Palace and public buildings in the new capital, Brasilia. L M Ericsson has supplied and has on order from Brazil automatic exchanges and other telephone equipment for 380,000 lines in more than 300 localities from Belém on the Amazon in the north to Pelotas near the Uruguay frontier in the south.

São Paulo is one of the most rapidly growing cities in the world. It is the largest industrial centre in Latin America and, with its roughly 6 million inhabitants, is South America's largest city.

From the signing of the São Paulo contract. (Sitting from left) Sr. Geraldo Nóbrega, EDB, Mr. Ragnar Hellberg, EDB, Sr. Carlos Reis Filho, Companhia Telefônica Brasileira, and Sr. José Meiches, Secretary of Public Works in São Paulo.

Continued Automatization of Norwegian Railways

The first ARD 331 exchange was delivered at the end of last year to the Norwegian State Railways (NSB). It was installed at Oslo East and at the cut-over 1200 local lines from the earlier OS exchange and from a manual exchange used for Oslo West were transferred to the new exchange. The new exchange is connected to the public telephone network via 40 two-way exchange line circuits. Via trunk circuits it is also connected to NSB's exchanges at Trondheim, Bergen, Drammen and several other stations throughout Norway. The exchange has some 20 selective calling circuits and also a number of code ringing lines. There are five manual operators.

The installation was excellently carried out by L M Ericsson's Norwegian subsidiary, A/S Elektrisk Bureau.

Director General Håkan Sterky (left) receives a gift from Dr. Marcus Wallenberg, Chairman of the Board of L M Ericsson, and Mr. Sven T. Åberg, its former President.

Last autumn L M Ericsson was visited by Sr. Alberto Mamán, head of the Planning Department OPD (Oficina de Planificación y Desarrollo de Telecommunicaciones) of CANTV (Compañía Anónima Nacional de Teléfonos de Venezuela) in connection with an earlier contract for 29 ARM exchanges.

(Standing, from left) Messrs. R. Rinnan and G. Vikberg, LME, Sr. S. Grimaldi, CEV, Mr. T. Lindstedt, LME, Mr. van der Dys, CEV, and Mr. T. Andersson, LME, (Sitting) Srs. R. Diaz, J. Pagez, and A. Mamán, CANTV, Mr. A. Stein, LME, Mr. N. Kauser, CANTV, and Mr. G. Fernstedt, LME.

Retirement of Director General Håkan Sterky

On his retirement from the Director Generalship of the Swedish Telecommunications Administration at the end of last year, Mr. Håkan Sterky received many tokens of respect at a farewell ceremony arranged in his honour. Some thirty representatives from a number of companies and from the management and officials of the Board of Telecommunications were in attendance.

Dr. Marcus Wallenberg, Chairman of the Board of L M Ericsson, presented 25,000 kronor to the fund for scholarships granted to members of the staff of the Administration, which had been founded by Director General Sterky. From the Board of Telecommunications Mr. Sterky received, among other gifts, a transistor radio which is remarkable insofar as it can receive two programmes on the same wavelength. The Administration had published a book surveying the activities of the Administration during the last 25 years, a de luxe edition of which was presented to Mr. Sterky.

32 ARF Exchanges to El Salvador

In 1964 a contract was signed between L M Ericsson and Administración Nacional de Telecomunicaciones of El Salvador in Central America, representing the first stage in the reorganization of the country's telephone system. It comprised 26,000 lines, with ARF exchanges at the capital, San Salvador, and at Santa Ana and San Miguel, all of which are now under installation.

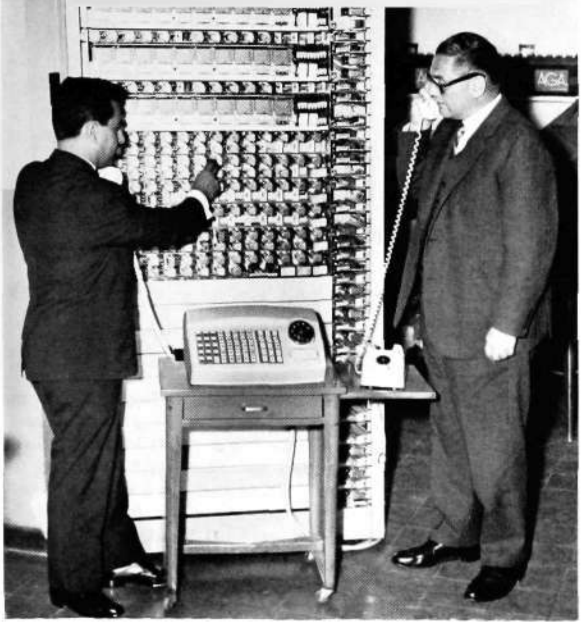
On December 10, 1965, a new contract was signed for the installation of a further 32 ARF exchanges totalling 7,600 lines in rural areas. Since these exchanges will be connected to the automatic trunk network on modern radio links, the contract also includes the delivery and enlargement of a number of ARM exchanges. El Salvador will then have an extremely modern telephone network. The contract is worth about 8½ million kronor and is being financed by the World Bank.

New Credit Agreement with Ecuador

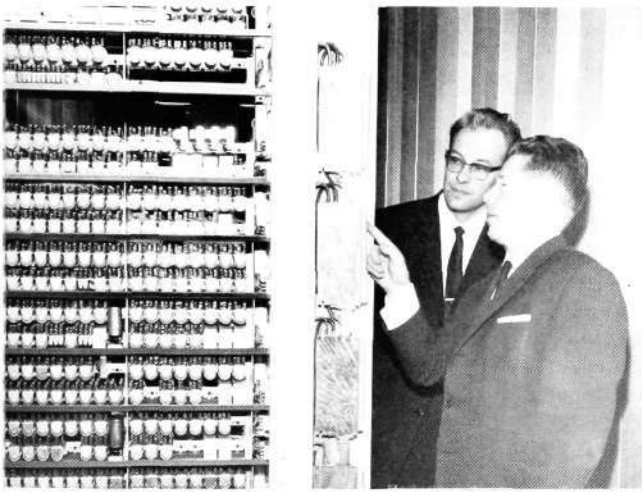
Through its subsidiary in Ecuador, L M Ericsson has signed two new credit agreements with the Telephone Administrations of Quito and Guayaquil. The contracts amount to 10 million dollars and cover the total requirements of telephone equipment of the administrations up to 1974. The credit agreements extend those signed in 1962, which totalled 6.8 million dollars.

The new credit agreements are guaranteed by the state of Ecuador and will form part of the 10-year financing plan for Ecuador. This plan was drawn up in cooperation with the Interamerican Development Bank, and comprises some forty projects, among which the construction of the telephone systems at Quito and Guayaquil.

From the signing of the El Salvador contract. (From left) Dr. Margarito Gonzales Guerrero, Head of the State Telephone Administration, Col. Mario Guerrero, Mr. Ragnar Ling, L M Ericsson, and Dr. Alvaro Gonzales Lara.



L M Ericsson's new P.A.B.X. type AKD 741, based on the code switch, has now been introduced in Colombia, the first installation being at the main offices of the Royal Bank of Canada at Bogotá. The picture above shows the President of the Bank, Mr. Winston Kendall Moyle, and (left) the Technical Director of L M Ericsson's subsidiary company in Colombia, Sr. Alvaro Cifuentes, who recently held a special course at Lima, Peru, on this type of P.A.B.X. for Ericsson technicians in South America.



Finland's first code switch exchange was opened at the end of last year when the Tampere Telephone Administration put into operation 2000 of the contracted initial capacity of 4000 lines. This exchange, of system AKF 10, is an extension of the Tampere local exchange and is housed in a separate bunker. In his opening address the chairman of the board, Bank Director T. Hietala, emphasized the excellent commercial relations with L M Ericsson extending back to the twenties. The Managing Director of the Tampere Administration, K.V. Onnela, spoke of the rapid subscriber growth, which in the last nine months had amounted to 7 per cent. Mr. Onnela (right) is seen discussing a detail with his chief engineer, Mr. Rainer Letho.

During a recent trip to Venezuela Mr. Björn Lundvall, President of L M Ericsson, was received in audience by the Venezuelan President, Raúl Leoni. (From left) Mr. Nils Kjellander, President of Compañia Anónima Ericsson, Caracas, Mr. Lundvall and President Leoni.

November 10, 1965, was the tenth anniversary of the inauguration of the Ericsson do Brasil (EDB) factory at São José dos Campos. To celebrate the occasion a number of prominent visitors had been invited to view the plant. Among the 40 or so persons who arrived direct from Rio in a plane chartered by EDB were General Dirceu Coutinho, head of Emprêsa Brasileira de Telecomunicações (EMBRATEL), and Captain Euclides Quandt de Oliveira, head of Conselho Nacional de Telecomunicações (CONTEL). Also General Elysio Dale Coutinho from the Communications Department of the Ministry of Defence and several representatives of Companhia Telefônica Brasileira (CTB) of Rio and São Paulo, headed by its director, General Landry Salles. The EDB Works Manager, Mr. Robert Brunn, demonstrated the firm's products and mentioned that the present production capacity is 80,000 telephones and 60,000 crossbar lines per annum.

In the picture above from the tour of the factory are seen, in the centre, the Director of CTB, General Landry Salles, the chairman of EDB, Marshal Nelson de Mello, and Captain Euclides Quandt de Oliveira.

Several papers were read by Ericsson engineers at the Second International Telecommunication Congress at Madrid in November in 1965. An exhibition had been arranged in conjunction with the congress and was visited by the Minister of Industry, Sr. López Bravo (photograph above, right). He is seen greeting Dr. Christian Jacobæus, Technical Director of L M Ericsson. Between them (from right) General Rafael Mª Cavanillas Prósper, chairman of Cia Española Ericsson, and Mr. Sven Oscar Englund, president of the same company. (Below) An interior from L M Ericsson's section of the exhibition.

(Above) Some photographs from visits to the exhibition room and factory at Midsommarkransen. (From left to right) Mr. Kwee Swan Tie, Research and Planning Director of the Indonesian PTT, is studying a crossbar switch demonstrated by Mr. Ernst Bergholm, L M Ericsson. Visitors from Madagascar are shown old and new telephones; (from left) M. Henri Rasolondraibe, Commercial Attaché at the Embassy in London, M.Eugène Lechat, Minister of Communications, his Permanent Secretary, M. Jean Ralaivas, M. Georg Ramparany, Commercial Counsellora t the Paris Embassy, and Mr. Erik Lundqvist, L M Ericsson. A group from the UN course on Trade Promotion were shown round the factory. Here they are seen inspecting the soldering of relay sets.

The flagship of the Nigerian Navy, the frigate N.N.S. Nigeria, was delivered a few months ago from a yard in Holland. This 2000-ton frigate, which is designed for use against submarines and air attack, has a P.A.B.X. for 40 internal and 5 external lines. The telephone equipment was supplied from L M Ericsson's factory at Rijen, Holland.

Ericsson Technics

Ericsson Technics No. 2, 1965, was issued at the year end, so completing the 21st annual volume of the journal. No. 1, 1965, was reported in Ericsson Review No. 1, 1965. No. 2 contains three papers.

The first is "Planning of Junction Network in a Multi-exchange Area. II. Extensions of the Principles and Applications" by Y. Rapp. This is a continuation of the paper published in No. 2, 1964, on the general plan for a multi-exchange area. This new paper develops the principle of simultaneous optimization of the number of junctions and of the transmission plan.

The second paper, by A. Törby, is entitled "Detectability of Signal in Noise when Using Range Gated MTI Radar". The author studies two alternatives for a coherent NTI system with range gating. In one system the signal-to-noise ratio in a range channel is determined principally by the limitation of bandwidth prior to the non-linear detection. In the other system the signal-to-noise ratio in a range channel is dependent on the frequency of the doppler shift.

The last paper, "A Class of Stochastic Processes Applicable to the Control of Service Quality in Telephone Systems" is the thesis presented by G. Lind for the Filosofie Licentiat Degree in mathematical statistics at the University of Stockholm. The auther builds up a mathematical model in the form of a class of stochastic control processes designed to describe how technical faults arise, are supervised and repaired in telephone systems. The paper is intended to provide a basis for assessing how the statistical quality control of telephone plant should be organized.

FATME's new factory at Rome was opened recently, the ceremony being attended by a large group of representatives of government and industry. The opening address was held by Sr. Marchesi. Sr. Baggiani presented a brief retrospect and mentioned that the total floor area of the factory is close on 700,000 sq.ft., which allows space for some 3000 employees. The Minister of Industry, Sr. Lami Starnuti, and the Mayor of Rome, Sr. Petrucci, also spoke. Cardinal Dante blessed the factory in the customary manner, after which the visitors were shown round the premises. In the photograph below are seen in the front row (from right) Monsignor Pietro Galavotti, Mr. Arvid Olsson, Mr. Björn Lundvall, General Bucchi, Senator Latini, Senator Pennavaria, General Perrone and Cardinal Dante.

UDC 621.395.24
LME 8372

BERGQUIST, Å.: *DIRIVOX—L M Ericsson's Loudspeaking Communication System with Natural Speech Control.* Ericsson Rev. *43*(1966): 1, pp. 2—7.

Advanced electronics for automatic speech control, numerous standard traffic facilities and individual name calls are some of the advantages offered by L M Ericsson's new DIRIVOX loudspeaking communication system.

DIRIVOX is the outcome of an intense development project aimed at a flexible loudspeaking system with at least as good voice reproduction as in a lowspeaking system, but much more convenient to use. The goal has been to offer loudspeaking communication of so high a class that it constitutes a real alternative to natural conversation.

UDC 621.395.24
LME 8372

MELLQVIST, L.: *Natural Speech Control in the DIRIVOX System.* Ericsson Rev. *43*(1966): 1, pp. 8—11.

If a loudspeaking telephone conversation is to be equivalent to a natural conversation, the voice control must be so well designed that the conversing parties normally do not notice the switching of the direction of speech. No effort should be needed to interrupt the speaker, and the system must not distort the spoken word. It is important, too, that the voice control is as insensitive as possible to room acoustics and to noise from fans, typewriters and the like.

After intense development work Telefonaktiebolaget L M Ericsson has produced the advanced electronic equipment required for *natural speech control*. This article deals with the speech control circuits and with some of the ideas which lie behind them.

UDC 621.395.24
LME 8372

KÜHN, W.: *DIRIVOX—Flexible Loudspeaking Communication System with Many Traffic Facilities.* Ericsson Rev. *43*(1966): 1, pp. 12—21.

The DIRIVOX systems are built up around exchanges of different types and capacities. This article deals with the exchanges ARD 631 for max. 20 lines and AKD 847 for max. 60 or 90 lines. The same extension instrument is used with both types of exchange. Since the large exchange operates at a higher microphone level, the extension instruments for this exchange are supplied with built-in microphone amplifier. The latter is in the form of a printed circuit card which is easily fitted into the instrument.

UDC 621.396.721
LME 8525

NORRBY, H.: *SRA-TRANSPORT—Mobile Radio Station.* Ericsson Rev. *43*(1966): 1, pp. 22—32.

Svenska Radio AB (SRA) has manufactured radio stations for mobile use and their associated stationary equipments for more than 20 years. In this field—as in all other electronics applications—developments in the last few years have been extremely rapid, due to a large extent to the transistor. Transistors have enabled the power consumption of radio stations to be greatly reduced. The increased radio traffic has rendered certain accessory apparatus necessary in some cases. With its Series 300, SRA has sought to meet the demands made by modern developments. The stations in this series have been given the name SRA-TRANSPORT.

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Telefonaktiebolaget LM Ericsson, Technical office *San Salvador*, Apartado 188, tel: 4989, tgm: ericsson

Uruguay

Cia Ericsson S.A. *Montevideo*, Casilla de Correo 575, tel: 92611, tgm: ericsson

USA

The Ericsson Corporation *New York*, *N.Y.*, 10017, 100 Park Avenue, tel: MUrrayhill 5-4030 tgm: erictel, telex: etelsac 620149

North Electric Co, *Galion*, *Ohio*, P.O.B. 688, tel: (419) 468-24 20, tgm, northphone-galionohio, telex: 419-464-4860

Venezuela

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

· AUSTRALIA & OCEANIA ·

Australia

L M Ericsson Pty. Ltd. *Broadmeadows (Victoria)*, P.O.B. 41, tel: 307-2341, tgm: ericmel, telex: AA 30555

North Sydney (NSW), 182 Blue's Point Road, tel: 92 11 47, tgm: ericsyd

Teleric Pty. Ltd. *Broadmeadows (Victoria)*, P.O.B. 41, tel: 307-2341, tgm: teleric, telex: AA 30555

North Sydney (NSW), 182 Blue's Point Road, tel: 92 11 47, tgm: teleric

Representatives

· EUROPE ·

Austria

Telecom G. m. b. H. *Wien XI*, Geiereckstrasse 6, tel: 74 15 81, tgm: teleric, telex: electrodiesel wn 2436

Belgium

Electricité et Mécanique Suédoises *Bruxelles 5*, 56, rue de Stassart, tel: 11 14 16, tgm: electrosuede

Greece

"ETEP" S.A. Commerciale & Technique *Athens 143*, 57, Akadimias Street, tel: 62 99 71 tgm: aeter athinai, telex: 5708

Iceland

Johan Rönning H/F *Reykjavik*, P.O.B. 883, tel: 10632, tgm: rönning

Yugoslavia

Merkantile Inozemna zastupstva *Zagreb*, Pošt pretinac 23, tel: 36941, tgm: merkantile, telex: 21139

· ASIA ·

Burma

Myanma Export Import Corp. Import Agency Division *Rangoon*, P.O.B. 400, tel: 10999, tgm: myaceico

Cambodia

The East Asiatic Company Ltd. *Phnom-Penh* P.O.B. 625, tel: 3334, tgm: pyramide

Cyprus

Zeno D. Pierides *Larnaca*, P.O.B. 25, tel: 2033, tgm: pierides

Hong Kong & Macao

Swedish Trading Co Ltd. *Hongkong*, P.O.B. 108, tel: 23 10 91, tgm: swedetrade

Iran

Irano Swedish Company AB, *Teheran*, Khiabane Sevom Esfand 29, tel: 310 66, tgm: iranoswede

Iraq

Usam Sharif Company W.L.L. *Baghdad*, P.O.B. 493, tel: 870 31, tgm: alhamra

Japan

Gadelius & Co. Ltd. *Tokyo C*, P.O.B. 1284, tel: 403-2141, tgm: goticus, telex: 22-675

Jordan

The Arab Trading & Development Co., Ltd. *Amman*, P.O.B. 1, tel: 259 81, tgm: aradeve

Korea

Gadelius & Co. Ltd. *Seoul*, I.P.O. B. 1421, tel: 22—9866, tgm: gadeliusco

Kuwait

Morad Yousuf Behbehani *Kuwait*, *State of Kuwait*, P.O.B. 146, tel: 32251, tgm: barakat

Lebanon

Swedish Levant Trading (Elié B. Hélou) *Beyrouth*, P.O.B. 931, tel: 23 16 24, tgm: skefko

Malaysia and Brunei

Swedish Trading Co. Ltd. *Kuala Lumpur*, P.O.B. 2298, tel: 25316, tgm: swedetrade

Pakistan

TELEC Electronics & Machinery Ltd. *Karachi 2*, 14, Motan Building, Bunder Road, tel: 231723, tgm: elco

Philippines

U.S. Industries Philippines Inc. *Manila*, P.O.B. 125, tel: 88 93 51, tgm: usiphil, telex: 344

Saudi Arabia

Engineering Projects & Products Co. *Riyadh*, P.O.B. 987, tel: 271, tgm: eppcol

Singapore

Swedish Trading Co. Ltd. *Singapore 1*, 42 Chartered Bank Chambers, Battery Road, tel: 94362, tgm: swedetrade

Syria

Constantin Georgiades *Damas*, Rue Ghassan, Harika, tel: 1-02-89, tgm: georgiades

Vietnam

Vo Tuyen Dien-Thoai Viet-Nam, *Saigon*, P.O.B. 10 49, tel: 22 660, tgm: telerad

· AFRICA ·

Congo

I.P.T.C. (Congo) *Léopoldville 1*, P.O.B. 8922, tel: 5345, tgm: induexpan

Ethiopia

Mosvold Company (Ethiopia) Ltd. *Addis Abeba*, P.O.B. 1371, tel: 14567, tgm: mosvold

Ghana

The Standard Electric Company *Accra*, P.O.B. 17, tel: 646 15, tgm: standard

Kenya, Tanzania, Uganda

Transcandia Telecommunication Sales Ltd. *Nairobi*, *Kenya*, P.O.B. 7296, tel: 25941, tgm: trantel

Liberia

Post & Communications Telephone Exchange, *Monrovia*, Corner Ashmun & Lynch Street, tel: 22222, tgm: radiolibe

Libya

ADECO African Development & Engineering Co. *Tripoli*, P.O.B. 2390, tel: 33906, tgm: adeco

Mauritius

Mauritius Trading Co. Ltd. *Port Louis*, P.O.B. 201, tgm: agentou

Morocco (Tangier)

Elmar S. A.—SEYRE *Tetuan*, Apartado 440, tel: 3701, tgm: elmar

Mozambique

J. Martins Marques & Co Lda. *Lourenço Marques*, P.O.B. 2409, tel: 5953, tgm: marquesco

Nigeria

I.P.T.C. (West Africa) Ltd. *Lagos*, P.O.B. 2037, tel: 26531 tgm: consult, telex: shell pb 35

South Africa, South-West Africa

Dryden Communications (Pty.) Ltd. *Johannesburg*, P.O.B. 2440, tel: 838-5454, tgm: qualsteels

Sudan

TECOMA Technical Consulting and Machinery Co. Ltd. *Khartoum*, P.O.B. 866, tel: 72224, ext. 27, tgm: sutecoma

Tunisia

Ateliers Mécaniques du SAHEL, *Sousse*, Route de Monastir/Djemmal, tel: 21.011, tgm: amesa

· AMERICA ·

Bahama Islands

Anglo American Electrical Company Ltd., *Freeport*, *Grand Bahama*, P.O.B. 104

Bolivia

Johansson & Cía, S.A. *La Paz*, Casilla 678, tel: 25923, tgm: johansson

British Guiana

General Supplies Agency *Georgetown*, P.O.B. 375, tgm: benwlks

Costa Rica

Tropical Commission Co. Ltd. *San José*, Apartado 661, tel: 3432, tgm: troco, telex: CR-126

Dominican Republic

Carcia & Gautier, C. por A. *Santo Domingo*, Apartado 771, tel: 3645, tgm: gartier

Guatemala

Nils Pira *Ciudad de Guatemala*, Apartado 36, tel: 62258, tgm: nilspira

Honduras

Quinchón Leon y Cía *Tegucigalpa*,
tgm:

Jamaica and Brit. Honduras

Morris E. Parkin *Kingston*, P.O.B. 354, tel: 24077, tgm: morrispark

Netherlands Antilles

S.E.L. Maduro & Sons. Inc. *Willemstad*, *Curacao*, P.O.B. 304, tel: 11200, tgm: madurosons

Nicaragua

Sonitel Centroamerica S.A. *Managua*, Apartado 1271, tel: 4476, *tgm: sonitel*

Panama

Sonitel, S. A. *Panama*, *R. P.* Apartado 4349, tel: 5-3640, tgm: sonitel

Paraguay

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

Puerto Rico

Novae Electronics Inc. *San Juan*, F 17, Park Lane, Bayamón, tel: 782-1054, tgm: novaelec

El Salvador

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

Surinam

C. Kersten & Co. N. V. *Paramaribo*, P.O.B. 1808, tel: 4444, tgm: kersten

Trinidad, W. I.

Leon J. Aché Ltd. *Port-of-Spain*, 100 Frederick Street, tel: 32357, tgm: achegram

USA

State Labs. Inc. *New York*, *N.Y.*, *10003*, 215 Park Avenue South, tel: (212) 677-8400, tgm: statelabs, telex: (212) 867-6996 (For electron tubes)

· AUSTRALIA & OCEANIA ·

New Zealand

ASEA Electric (N Z) Ltd. *Wellington* ... P.O.B. 3239 tel: 70-614,