## ERICSSON Revica



## ERICSSON REVIEW

Vol. XXXIX

No. 2
1962

RESPONSIBLE PUBLISHER: HUGO LINDBERG EDITOR: SIGVARD EKLUND, DHS EDITOR'S OFFICE: STOCKHOLM 32

SUBSCRIPTIONS: ONE YEAR $\$ 1.50$; ONE COPY $\$ 0.50$

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On cover: Rack-mounted telephone relay sets, viewed from the wiring side.

# Transistorized Group Translating Equipment for Carrier Terminals 

P-A HALLBERG \& H SCHILLING, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

UDC 621.395.44
LME 8421
This article is associated with the description of the channel translating equipment for carrier terminals given in Ericsson Review No. 2, 1961. In addition to the group translating equipment the description covers the pilotcontrolled level regulation of the basic group and also an equipment for signalling blocking when there is a break in the transmission path.

The line frequency allocations of multi-circuit carrier systems for 60 to 2,700 circuits are founded on the use of supergroups whose basic frequency range is $312-552 \mathrm{kc} / \mathrm{s}$; by means of further modulations these are translated to form the line frequency band or can be through connected at basic supergroup frequencies between different systems. In accordance with the recommendations of the CCITT the basic supergroup is formed from five groups; the basic group B lies in the frequency band $60-108 \mathrm{kc} / \mathrm{s}$. These groups are inverted in the process of modulation, whereby all the channels come to have an erect attitude. Alternatively, the group lying at the top end of the basic supergroup band can have inverted channels: this is used in certain 60 -circuit systems.

## I. Modulation Plan

The main duty of the group translating equipment is to modulate five basic groups to form a basic supergroup in accordance with the modulation plan, fig. 1. An inversion is obtained due to extraction of the lower sideband after modulation and channels having an erect attitude in the basic supergroup are obtained from channels with inverted attitude in the basic group. To enable Administrations who wish to do so to have the possibility of keeping the channels inverted in the basic group transposed to the frequency band 504-552 $\mathrm{kc} / \mathrm{s}$, there is a different type of modulator which uses a carrier frequency of $444 \mathrm{kc} / \mathrm{s}$.

The levels at the terminal strips can be adjusted between certain limits as the outgoing supergroups and incoming groups pass through coaxial plugs with built-in pads. In addition it is possible to have 135 or 150 ohms balanced instead of the nominal impedance of 75 ohms balanced on the basic group side.

The $411.92 \mathrm{kc} / \mathrm{s}$ supergroup reference pilot is added to the basic supergroup immediately after its formation. It is also possible to introduce the $84.08 \mathrm{kc} / \mathrm{s}$ group reference pilot in the basic groups if this has not been done previously.


Fig. 1
X 8362
Modulation plans for formation of alternative supergroups


Fig. 2
Mechanical construction of group translating equipment

The level of the basic groups on the receiving side can be regulated manually or automatically, the basic group level in this case being controlled by the group reference pilot level. Alarm can be sent out if tolerable deviations from nominal level are exceeded.

In the case of carrier systems using continuous signalling of the tone idle type, an interruption in the line causes a loss of tone and produces the same effect as a call on every free circuit. To prevent a mass call to the exchange which can have deleterious consequences, the signalling receivers in the channel translating equipment are blocked by means of a rapid acting pilot receiver responding to $411.92 \mathrm{kc} / \mathrm{s}$.

Special attention has been devoted to maintenance facilities in the development of this equipment. The inputs and outputs on the group and supergroup sides are provided with protected test points where measurements can be made irrespective of the impedance of the equipment connected and the transmission circuit is not affected by a short circuit in the test point.

When fault-finding, different parts of the system can be isolated by means of U-links. Fault localization is made very much easier by using the faultfinding test points provided on the units. Each unit meets very stringent performance limits so that it can be replaced by a similar unit without involving any subsequent adjustments.

The group translating equipment also fulfils the requirements for transmission of carrier programs (sound broadeasting).

The group translating equipment is built in accordance with the same modern design principles used in the channel translating equipment. New components and materials such as transistors and ferrites mounted on cards with etched wiring and contained in protecting cases give compact, stable and well-screened units. A detailed description of L M Ericsson's new method of construction and components is given in Ericsson Review no. 4, 1960 and no. 1, 1961, "A New Method of Construction for Transmission Equipment". The appearance of the group translating equipment mounted in a bay is seen in fig. 2.



Fig. 3
X 7842
Block schematic of group translating equipment

## II. Modulation Equipment

The principle of the group translating equipment will be seen in the block schematic, fig. 3.

## Sending direction

The basic group at a nominal level of -26 dbr enters the translating equipment via a U-link. For input levels in the range -26 dbr to -37 dbr , the levels at different points in the sending equipment are correspondingly lower. The nominal impedance on the basic group side is 75 ohms unbalanced. A matching transformer is introduced before the U-link if it is desired to obtain an impedance of 135 ohms or 150 ohms balanced.

A test point for measuring purposes is provided at the input to the group modulator to permit checking of the level of the basic group.

The basic group frequency band is translated in the group modulator to its position in the basic supergroup using one of the five group carriers. If the group lying in the frequency band $504-552 \mathrm{kc} / \mathrm{s}$ is required to be inverted, a carrier of $444 \mathrm{kc} / \mathrm{s}$ is used instead of $612 \mathrm{kc} / \mathrm{s}$ and the upper sideband is selected. This is obtained by plugging into the bay a different modulator unit which, since its carrier input uses different contacts, automatically receives the correct carrier frequency.


Fig. 4
Circuit diagram of modulator and filter


Fig. 5
X 2641
Group modulator and filter


Fig. 6
X 2638
Attenuation graph for group modulator filter

The modulator is of double balanced type of a special design which has been patented by L M Ericsson, see fig. 4. With this circuit the conducting diodes do not reduce the carrier voltage to the non-conducting diodes thus giving the same sideband power with lower carrier power. An even greater advantage is that good total harmonic ratios are obtained. The modulators therefore give a negligible contribution to intermodulation noise.

In order to obtain optimum results using as few elements as possible, the filters have been calculated using a modern electronic computer. A very low attenuation distortion has been obtained by compensating the filters for dissipation, thus avoiding the need for correcting networks. By compensating for dissipation the filter impedance rapidly becomes high in the stop bands, thus leading to negligible mutual interference. The design is shown in fig. 4, and the attenuation characteristic in the stop bands is shown in fig. 6.

The five group filters belonging to a supergroup are connected together alternately on either side of a symmetrical differential primary winding of a hybrid transformer. This is also provided with a differential secondary winding which is unsymmetrical so as to permit injection of the $411.92 \mathrm{kc} / \mathrm{s}$ supergroup reference pilot. The injection is independent of the impedance of the filters connected together. The level of this pilot lies 20 db below the level of the channel test tone. A pad can be connected into the pilot path so as to retain this ratio even when a lower speech path level is used in the sending direction.

The whole supergroup band is amplified in a supergroup amplifier using two transistors. The secondary side of the output transformer is formed of differential windings where the maintenance test point is branched off. It is therefore possible to carry out correct measurement even if the equipment connected to the test point is not correctly matched. An incorrect manipulation in the test point does not disturb the transmission in the main circuit.

Some Telephone Administrations use a supergroup sending level of -47 dbr or less. In this case the amplifier need not be used and may be replaced by a dummy unit which is provided with a branching network to feed the maintenance test point.

The supergroup passes out from the equipment via a U-link which contains a pad for matching purposes. The nominal supergroup sending level is -35 dbr and the impedance is 75 ohms unbalanced.

## Receiving direction

The incoming supergroup at a level of -30 dbr passes via a U -link to the receiving equipment. The U-link is provided with a built-in pad if the incoming level is higher.

A maintenance test point which is protected from interference and an outlet for the $411.92 \mathrm{kc} / \mathrm{s}$ reference pilot frequency to a signalling blocking equipment described below in section IV are obtained from a hybrid transformer provided with differential windings on the primary and secondary sides.

The supergroup frequency band passes through a hybrid transformer where it is split up and distributed to the group filters.

The demodulator and filter unit are of the same type as on the sending side which is an advantage from the spares point of view.

The demodulator is followed by a low-pass filter which ensures that carrier leak and the unwanted sideband are suppressed to such a low level that they do not load the subsequent amplifiers or make measurements difficult. The final suppression occurs in the channel translating equipment or in a through connexion filter.

The supergroup reference pilot must be stopped so as not to cause interference when through connecting groups or when receiving out-band signals. The pilot is stopped after demodulation, its frequency then being 104.08 $\mathrm{kc} / \mathrm{s}$. The pilot stop filter consists of three sections each of which is a bridge circuit with a crystal in the shunt arm. The filter attenuates the pilot by at least 40 db .

Each of the basic groups is amplified by two identical amplifiers connected on either side of a level regulating network.

A short-circuit-proof maintenance test point for determination of the level at the input to the level regulating network is branched off via a differential circuit from the output of the first amplifier.

The level regulating network consists of a d.c. controlled attenuator or an adjustable pad which can be set by a rotary switch. The two types permit compensation of a deviation of level of $\pm 4 \mathrm{db}$ from nominal. The first type of network consists of a bridged T-network with indirectly heated thermistors in the bridge and shunt arms. With this arrangement the attenuation is not affected by changes in ambient temperature or in the supply voltage. If the latter disappears completely, the attenuation reverts to the nominal value. The advantage of a thermistor attenuation network is that a change of the level setting occurs entirely without interference or sudden changes of level in the transmission path.

The direct current control is obtained from a manually adjustable potentiometer or from one which is automatically adjusted. In the latter case, this is controlled from a centralized pilot receiver, described in section III below. This pilot receiver, which is also used for sending out an automatic alarm, is connected in turn to each basic group.

The level at which the basic group leaves the second amplifier can be checked at a short-circuit proof maintenance test point. The differential winding which branches off this test point from the amplifier also feeds the centralized pilot receiver.

The basic group leaves the equipment via a U-link which is not normally provided with a pad.

As in the case of the sending direction, the nominal impedance of 135 or 150 ohms balanced can be obtained by using a matching transformer, instead of the usual impedance of 75 ohms.

## III. Automatic Regulating and Supervisory Equipment

By means of a centralized pilot receiver the level of the basic groups can be automatically regulated and supervised or alternatively only supervised. When regulating, the pilot receiver affects a memory element which in turn controls the attenuating network in the transmission path. When supervising, the central unit sends out an alarm if there are large deviations in the level of any group, and at the same time the particular group at fault is indicated by

Fig. 7
Block schematic of pilot receiver

X 2639

Fig. 8
Block schematic of automatic group regulation and supervision

Fig. 9
Different types of level supervision units
Left, automatic level adjuster with stepping motor; centre, manual setter with level supervision relay; right, manual level setter only


Fig. 7 shows a very simplified block schematic and a more detailed schematic is shown in fig. 8 .

The connexion of the groups in turn to the centralized pilot receiver is carried out by a chain of relays which steps automatically.

Each group is connected for about 10 seconds. When all incoming groups have been checked and before the chain of relays starts a new interrogation cycle, the group reference pilot generator of the station is connected. Alarm is given if the pilot level there deviates by more than 0.3 db from the nominal value. The station group reference pilot and the centralized pilot receiver are thus checked in this way.



Fig. 10
X 2640
Attenuation graph for $84.08 \mathrm{kc} / \mathrm{s}$ group reference pilot filter

The group whose turn it is to be checked is connected from the test output at the output of the second amplifier in the transmission path receiving direction, to the input of the pilot equipment via a reed relay. The signal is amplified in a normal type group amplifier and the $84.08 \mathrm{kc} / \mathrm{s}$ pilot frequency is selected in a crystal filter of ladder type using three crystals in the series arms. The attenuation of interfering speech and out-band signalling frequencies is shown in fig. 10. The pure pilot frequency is amplified in two amplifiers connected in cascade and is then passed to the electronic level sensing device. The pilot level can be measured at the input to the device and read off on a built-in meter.

The level sensing device consists of several electronic trigger circuits, each of which is set to operate at a different voltage. The voltages are chosen so that a level deviation of more than +0.3 or -0.3 db from nominal operates one of the regulation trigger circuits. A greater deviation which may be set to $\pm 4 \mathrm{db}, \pm 2 \mathrm{db}$ or $\pm 1 \mathrm{db}$ by means of soldered straps causes one of the alarm trigger circuits to operate a reed relay whose make contact closes a common alarm circuit.

When there is a level deviation requiring regulation, the controlling memory device is operated by a control relay. The memory device consists of a potentiometer driven by a stepping motor whose design is patented by L M Ericsson: this rotates through a small defined angle in one or the opposite direction when an electrical impulse is applied and remains in this position until the next impulse arrives. The stepping motor does not contain any mechanical contacts; all coupling occurs magnetically thus giving maximum reliability. The potentiometer divides the voltage between the two thermistors in the attenuating network in the transmission path, as mentioned earlier. This part of the equipment is not supplied if only automatic supervision is required.

When there is a level deviation sufficient to cause an alarm, the make contact mentioned above not only gives central alarm but also lights a lamp associated with the faulty basic group. This lamp remains lit by means of hold contacts until a reset key has been operated. In addition, the regulation of this basic group level is blocked, thus avoiding incorrect level adjustment. If, due to a slow change of level, the potentiometer wiper reaches either of its end positions, the lamp will likewise light.

The basic group reference pilot levels can be read off on a built-in meter, using a rotary switch to select the desired basic group. When the measurement button is depressed, the automatic stepping relay chain is disconnected while the selected basic group and the meter are connected into circuit.

The equipment described has a number of advantages over the method using individual pilot receivers. Above all, the centralized pilot receiver saves both space and expense. As the regulating element is provided with a memory, the attenuation of the network connected in the transmission path is unchanged if for any reason there is an interruption in pilot transmission so that when speech transmission is restored after an interruption, there is no reduction of stability margins.

## IV. Signalling Blocking Equipment

When a carrier system is provided with low level out-band signalling, a signalling system of "tone idle" type is often used. This means that the signalling tone is sent as long as the channel is free and that the signalling tone is absent when a call is in progress. The tone remains absent for the whole duration of the call and its return means the end of the call.

Fig. 11
x 8377
Block schematic of signalling blocking equipment


The consequence of this is that a break in transmission would resuit in seizing signal on all free circuits, which could cause overloading of the exchange equipment. To prevent this the signalling receivers in question can be blocked immediately when there is a break in the connexion. This is carried out by a special pilot receiver as soon as the supergroup reference pilot frequency $411.92 \mathrm{kc} / \mathrm{s}$ is absent. This is thus used as the criterion for an unbroken connexion.

The principle of the equipment will be seen in the block schematic, fig. 11 . From the differential transformer at the input of the receiving side of the modulating equipment, some of the supergroup signal is passed via an h.f. U-link to a transistorized amplifier, the standardized supergroup amplifier. After amplification the pilot frequency $411.92 \mathrm{kc} / \mathrm{s}$ is extracted by a crystal filter consisting of a bridge filter with two crystals, is amplified again in a similar amplifier and applied to the sensing device. Here the pilot voltage is rectified and compared with a standard voltage. The difference voltage is sufficient to hold an electronic trigger operated with sufficient margin. This trigger operates a mercury relay of the type used in the signalling receivers.

When the pilot voltage is too low or disappears completely, the relay releases and relay voltage is connected across its break contact via a v.f. U-link to the signalling receivers of the channel translating equipment. As long as no call is in progress, an extra winding in its relay is affected so that this is held in the operated position despite the disappearance of the signal, and no seizure signal is sent out. The circuit through the relay is closed through its own change-over contact to signalling earth. If a call is in progress, the signalling receiver relay is not operated and the hold circuit for the blocking voltage is open.

At the same time as the relay voltage is connected to the channel translating equipment, it is also applied to a lamp and a thermal relay. This ensures that the above-mentioned signalling earth is disconnected via an auxiliary relay after about 20 secs. Release signal is then given in all circuits and all calls are cleared. Alarm is also sent out at the same time.

The v.f. U-link can be removed for maintenance purposes. The whole of the equipment connected to this except for the lamp is thereby disconnected. At the same time the sensitivity of the receiver is reduced, thereby checking that it does not operate too close to the limit. When the U-link is plugged into the jack placed adjacent to it, the sensitivity is appreciably reduced and the receiver relay must release for correct function. This is observed on the lamp.


Fig. 12
Group translating bay ZDG 811

## V. Technical Data

## FREQUENCY RANGE

Nominal frequency range of basic group ...... $60-108 \mathrm{kc} / \mathrm{s}$
Nominal frequency range of basic supergroup . . 312-552 kc/s
The group in the frequency range $504-552 \mathrm{kc} / \mathrm{s}$ can be inverted by using an alternative modulator unit.

NOMINAL LEVELS
Sending direction
On basic group side ............................. -26 dbr
On basic supergroup side ........................ -35 dbr
Receiving direction
On basic supergroup side ........................ . . 30 dbr
On basic group side ............................. -8 dbr
NOMINAL IMPEDANCES
On basic group side, sending and receiving direc-
$\qquad$ tions

75 ohms unbalanced, alternatively, 135 or 150 ohms balanced
On basic supergroup side, sending and receiving directions

75 ohms unbalanced

## VARIATION OF EQUIVALENT

Attenuation/frequency distortion in the range $60-108 \mathrm{kc} / \mathrm{s}$ band relative to $84.08 \mathrm{kc} / \mathrm{s}$ when measured with groups looped at basic supergroup frequencies does not exceed
$\pm 0.6 \mathrm{db}$

## CARRIER LEAKS

Level of any group carrier, measured selectively in the basic supergroup sending direction with 75 ohms termination does not exceed
$-35 \mathrm{dbm0}$
INTELLIGIBLE CROSSTALK
The near-end and far-end crosstalk ratio for all combinations of basic supergroups is greater than 80 db
UNINTELLIGIBLE CROSSTALK
Inverted crosstalk measured at the supergroup distribution frame is greater than85 db

## NOISE

Basic noise
(without loading in speech or signalling channel) measured psophometrically at a point of zero relative level is less than
Noise in a loaded system
Total mean noise per channel measured psophometrically at a point of zero relative level with all other channels loaded with white noise at a level of $-7.5 \mathrm{dbm0}$ per channel is less than

65 pW
POWER SUPPLY
Transistor voltage
$-22 \mathrm{~V}$
Relay voltage
$-24 \mathrm{~V}$
Power consumption for one supergroup (depending on the number of pilot receivers connected)
$10-15 \mathrm{~W}$

## VI. Use of the Supergroup in different L M Ericsson Carrier Systems

In this section, some examples will be given of group translating bays used in different carrier systems, i.e. the group translating bay $Z D G 811$ and the combined group and supergroup translating bay ZDG 815 .


Fig. 13 X 2643

Group and supergroup translating bay ZDG 815

## Group Translating Bay

The group translating bay is used in large stations where there are many supergroups. This is the case when a coaxial cable carrier system is to be built up and also when several 60 -circuit or 120 -circuit systems are included.

The bay contains equipment for modulation of 30 basic groups to 6 basic supergroups. The levels of the incoming groups are adjusted to that of the equipment by means of plug-in pads. The impedance on the basic group side which is nominally 75 ohms can, alternatively, be 135 or 150 ohms. By making a simple exchange of a plug-in unit, the upper group in the CCITT basic supergroup can be inverted.

Regulation of the received groups can either be made automatically using a centralized pilot receiver or manually using indirect control. Automatic supervision can also be provided with either of these two alternatives. Finally, direct level regulation using a switch can be provided. All these alternatives can be combined with each other as required and are simply obtained using plug-in units.

To prevent mass calling of the exchange if there is a break in transmission when using a signalling system of the type "tone idle", a special pilot receiver can be connected to each supergroup which blocks the signalling receivers in the channel translating equipment.

Fig. 12 shows the appearance of the bay and its mechanical construction. Immediately below the terminal strips at the top of the bay is seen the -24 Volt power supply unit for operation from 220,127 or 110 volts a.c. at a frequency of $45-65 \mathrm{c} / \mathrm{s}$. Alternatively, a -24 V d.c. battery can be connected to the bay. The output from the filter panel placed at the right of the power supply unit is used as transistor voltage. At the left is an alarm unit which is common to all alarms sent from pilot receivers, fuses, etc. in the bay.

Below the power units are seen the pilot receivers for signalling blocking. In the centre of the bay are seen the meter and switch with the associated regulating pilot receivers placed above and to the right and left of the meter and switch. The controlling elements for level regulation are placed below the meter. The remaining space in the bay is occupied by the six sets of group translating equipment.

## Group and Supergroup Translating Bays for 60 -circuit and 120-circuit Carrier Systems for Radio Links

One bay contains equipment for group and supergroup translating equipment for four supergroups which can alternatively be used for four 60 -circuit carrier systems for radio links or two 120 -circuit carrier systems for radio links.

The frequency ranges for the 60 -circuit system are $12-252 \mathrm{kc} / \mathrm{s}$ or $60-300$ $\mathrm{kc} / \mathrm{s}$ and $12-552 \mathrm{kc} / \mathrm{s}$ or $60-552 \mathrm{kc} / \mathrm{s}$ for a 120 -circuit system.

The group translating equipment is identical with the equipment described previously.

# Planning of Multi-exchange Networks with aid of a Computer 

Y R A P P, TELEFONAKTIEBOLAGET L M ERICSSON, STOCK HOLM

UDC 621.395.74
LME 8077
The planning of multi-exchange networks may involve extremely extensive numerical calculations. This applies especially to problems of determining the number of exchanges, their locations and boundaries, the traffic distribution between exchanges after modification of the network structure, and finally to the allocation of junctions between direct and tandem routes. To simplity this work, L M Ericsson has developed methods which permit programming of the most laborious operations for an electronic computer. The questions of exchange locations and boundaries, and the traffic between the exchanges, are dealt with briefly below. The structure of junction circuits will be considered later. Detailed discussions of these problems will be published shortly in Ericsson Technics.

## I. Locations and Boundaries of Exchanges in Multi-exchange Areas

The outside plant usually represents more than 50 per cent of the total cost of a telephone system. Any saving that can be made on outside plant is therefore an important factor in the economy of the system as a whole.

L M Ericsson's automatic telephone systems are characterized by very high flexibility and are adaptable to any desired network configuration. Networks can therefore be planned without any limiting conditions imposed by the circuitry.

In the planning of a multi-exchange network it is essential to make a correct estimate of the number of exchanges required and of their locations and boundaries. These are the basic data required for the detailed planning of subscribers' and junction cables and tandem stages.

But to determine the number of exchanges, and their locations and boundaries, so as to arrive at as small as possible an overall cost, often requires such extensive numerical calculations that one does not consider one can perform them with the necessary accuracy. The reason may be either shortage of staff or quite simply that one does not consider it worth the trouble and cost.

L M Ericsson has therefore made a study of this question with the aim of deriving methods for planning the locations of exchanges and their area boundaries which would permit the most laborious calculations to be programmed for a computer.

This study, which has now been completed, opens up entirely new possibilities of economic planning of multi-exchange networks. The calculations can be made quickly, which brings great savings in time and money. One can also calculate on different assumptions concerning future developments-both as regards subscriber growth, geographical distribution and the anticipated technical development-questions which can hardly be dealt with satisfactorily without a computer.

The underlying principles are set out in detail in a paper in Ericsson Technics No. 2, 1962, entitled "Planning of Exchange Locations and Boundaries in Multi-Exchange Networks". The present article will contain a brief survey of the calculation procedure and of the input and output data.

The planning of a multi-exchange network is based on a map divided into equal squares in which the numbers of subscribers are indicated. This subscriber inventory, which should apply to a point of time 10-20 years ahead, is made up from quarterly counts, building plans and statistical data describing the growth of population and telephone density.

One starts by estimating the number of exchanges required. The optimal result is obtained by comparing the total costs on the assumption of different numbers of exchanges.

In determining the locations and boundaries of the exchanges, one starts by assuming that the volumes of traffic initiated and received by all subscribers within the area are equal and that the junction network is mesh-shaped. To allow some consideration for the differences in community of interest between the exchange areas, an upper and a lower limit for this factor should be estimated.

Cable types-that is, conductor diameters and loading-in the subscribers' and junction networks are estimated by fixing the exchange locations and area boundaries on trial.

A distinction is made between exchanges whose locations are known, i.e. existing exchanges which are not to be moved or exchanges the location of which is fixed by other factors, and exchanges whose locations must be determined.

The input data for the computer before the calculation is started are:
The subscribers' inventory (one or more forecasts). In this inventory the positions of squares are indicated by row and column. Thus $a_{i j}$ indicates that $a$ subscribers are located in the square defined by row $i$ and column $j$.
Fixed locations of exchanges. (The exchange locations are determined by indication of row and column.)
Locations of exchanges which are to be determined.
Upper and lower limits for estimated traffic initiated per subscriber.
Formulx indicating relation between volume of traffic and number of junctions.

Unit costs for subscriber's and junction cables.

The calculations are then started in the computer and proceed roughly as follows:
a) The boundaries between the exchange areas are determined from

1. locations of exchanges fixed on trial (input data)
2. unit costs of subscribers' cables (input data).
b) The subscribers' inventory and the number of subscribers for each exchange area are determined from
3. the subscribers' inventory for the whole area (input data)
4. exchange boundaries determined under a).
c) The number of junction circuits between each two exchanges is determined from
5. subscribers' inventory for each exchange area as under b)
6. traffic initiated per subscriber (input data)
7. relation between volume of traffic and number of junctions (input data).
d) New exchange locations are determined from
8. number of subscribers for each exchange area as under b)
9. number of junctions as under c)
10. unit costs for subscribers' and junction cables (input data).
e) New exchange boundaries are determined from
11. exchange locations determined as under d )
12. number of subscribers within exchange areas under b)
13. relation between increase in number of junctions and increase in volume of traffic (input data)
14. unit costs of subscribers' and junction cables (input data).

The process is then iterated from b), using the exchange boundaries under e), until a predetermined value for the change of exchange locations is not exceeded.

The computer delivers the following printed data:
Exchange locations
Exchange boundaries
Number of subscribers within each exchange area
Mean length of line for each exchange area and the distribution functions showing the number of subscribers beyond different distances from the exchanges.

For a large number of exchanges it may be advisable to arrange also for the computer to print a table of the costs of the various subscribers' and junction networks, the total of these costs, and the number of junctions, to facilitate an approximate cost comparison for different numbers of exchanges.

All these data are obtained both for the upper and lower estimated limits of traffic initiated per subscriber, and in this way one generally acquires fully adequate figures for determining the locations and boundaries of the exchanges.

A survey of the calculating procedure and of the computer input and output data is shown in tabular form below.

Survey of calculating procedure


If greater accuracy is required, which may be desirable in areas where there is a considerable difference in the community of interest between different exchanges, one should make a new calculation after charting and calculating the junction circuits on the basis of traffic counts.

After these calculations one can enter the result on the map and make whatever adjustments may be necessitated by housing schemes, geographical factors, transmission conditions, etc. If the deviations are considered too large, a new calculation will have to be made; otherwise the exchange locations and area boundaries will now have been established, and the total cost of subscribers' and junction cables and exchange equipments can be estimated.

The procedure is then repeated in its entirety with other assumptions as to the number of exchanges.

The most favourable solution is finally selected, after which one can proceed with the detailed planning of subscribers' and junction cables, exchange equipments and tandem stages.

## II. Inter-Exchange Traffic

In a multi-exchange network one is often confronted with the problem of determining the quantities of traffic between and within the different exchange areas after some change has been made in the structure of the network. Such changes arise through the expansion of existing exchanges, the introduction of new exchanges, or the division or merging of two or more exchange areas.

The distribution of the traffic between exchanges provides a means of determining the number of switches required in the exchanges, the location of tandem stages, the size of tandem areas, and the numbers of circuits on direct and tandem routes.

This traffic distribution must be estimated for a future point of time determined by the anticipated development and the time taken to supply the equipment required.

To estimate the traffic distribution in large areas comprising many exchanges involves lengthy calculations; all the more so if, in view of the uncertainty naturally attaching to all forecasts, the calculations are to be made under different assumptions as to the future development. Mechanization of these calculations is therefore very desirable and saves much time and money.

The traffic distribution can be determined by different methods depending on the knowledge possessed of the internal traffic distribution between different sub-areas of the multi-exchange network.

Let us assume initially that we know this internal traffic distribution. It is then a simple matter to calculate the traffic distribution arising between different exchange areas formed by adding to each area a number of sub-areas. To take a simple example, say that the traffic between four sub-areas $1,2,3$ and 4 is as follows:

| From | To | 1 | 2 | 3 |
| :---: | :---: | :---: | :---: | :---: |
| 1 | 3 | 2 | 1 | 1 |
| 2 | 1 | 2 | 2 | 1 |
| 3 | 2 | 1 | 3 | 2 |
| 4 | 1 | 1 | 1 | 2 |

and that two exchange areas I and II are formed as follows:

| Exchange | Sub-areas |
| :---: | :---: |
| I | 1 |
| II | 2 |

This immediately gives:

| Traffic direction | Traffic intensity |
| :---: | :--- |
| Within I | $3+3+1+2=9$ |
| From I to II | $2+1+1+2=6$ |
| Within II | $2+2+1+1=6$ |
| From II to I | $1+2+1+1=5$ |

or summarized in a matrix:

$$
\left[\begin{array}{ll}
9 & 6 \\
5 & 6
\end{array}\right]
$$

This may appear entirely trivial. But with a large number of sub-areas and exchanges the calculation becomes cumbersome, and it is easy to make mistakes. It is therefore of interest that the result can be obtained by setting up the calculation on a routine basis as follows:
Sub-area
Exchange I
Exchange II $\quad\left[\begin{array}{llll}1 & 2 & 3 & 4 \\ 0 & 1 & 1 & 0 \\ 0 & 1\end{array}\right]\left[\begin{array}{llll}3 & 2 & 1 & 1 \\ 1 & 2 & 2 & 1 \\ 2 & 1 & 3 & 2 \\ 1 & 1 & 1 & 2\end{array}\right] \quad\left[\begin{array}{ll}1 & 0 \\ 0 & 1 \\ 1 & 0 \\ 0 & 1\end{array}\right]$
and performing the matrix multiplications

$$
\left[\begin{array}{llll}
1 & 0 & 1 & 0 \\
0 & 1 & 0 & 1
\end{array}\right]\left[\begin{array}{llll}
3 & 2 & 1 & 1 \\
1 & 2 & 2 & 1 \\
2 & 1 & 3 & 2 \\
1 & 1 & 1 & 2
\end{array}\right]=\left[\begin{array}{llll}
5 & 3 & 4 & 3 \\
2 & 3 & 3 & 3
\end{array}\right] \begin{gathered}
(\text { e. g.: } 1 \cdot 1+0 \cdot 2+ \\
+1 \cdot 3+0 \cdot 1=4)
\end{gathered}
$$

and

$$
\left[\begin{array}{llll}
5 & 3 & 4 & 3 \\
2 & 3 & 3 & 3
\end{array}\right]\left[\begin{array}{ll}
1 & 0 \\
0 & 1 \\
1 & 0 \\
0 & 1
\end{array}\right]=\left[\begin{array}{ll}
9 & 6 \\
5 & 6
\end{array}\right] \quad(\text { e.g. }: 2 \cdot 1+3 \cdot 0+3 \cdot 1+3 \cdot 0=5)
$$

If, instead, three exchange areas I, II and III are formed as follows:

| Exchange area | Sub-areas |  |
| :---: | :---: | :---: |
| I | $2^{1}$ |  |
| II | 2 |  |
| III | 4 |  |

the traffic distribution is obtained from the matrix multiplication

$$
\left[\begin{array}{llll}
1 & 0 & 0 & 0  \tag{1}\\
0 & 1 & 0 & 1 \\
0 & 0 & 1 & 0
\end{array}\right]\left[\begin{array}{llll}
3 & 2 & 1 & 1 \\
1 & 2 & 2 & 1 \\
2 & 1 & 3 & 2 \\
1 & 1 & 1 & 2
\end{array}\right]\left[\begin{array}{lll}
1 & 0 & 0 \\
0 & 1 & 0 \\
0 & 0 & 1 \\
0 & 1 & 0
\end{array}\right]=\left[\begin{array}{lll}
3 & 3 & 1 \\
2 & 6 & 3 \\
2 & 3 & 3
\end{array}\right]
$$

In addition to the gain in clarity which this method of setting up the problem brings in manual calculations, it allows easy programming for a computer.

Often, however, one has no knowledge of the traffic between different sub-areas, and approximate methods must be adopted. Say that the traffic distribution between two exchanges is given by the matrix

$$
\left[\begin{array}{ll}
9 & 6 \\
5 & 6
\end{array}\right]
$$

and that area 1, which according to the matrix has an initiated traffic of $9+6=15$, is to be divided between two exchanges I and III. One estimates that the initiated traffic after this division will be 7 for exchange I and 8 for exchange III. No other data of the traffic distribution are available.

Provided that the traffic within the new area III, internal and external, is proportional to the internal traffic of the original area, the traffic distribution after the division will be

$$
\begin{align*}
& {\left[\begin{array}{cc}
\frac{7}{15} & 0 \\
0 & 1 \\
\frac{8}{15} & 0
\end{array}\right]\left[\begin{array}{cc}
9 & 6 \\
5 & 6
\end{array}\right]\left[\begin{array}{ccc}
\frac{7}{15} & 0 & \frac{8}{15} \\
0 & 1 & 0
\end{array}\right]=} \\
& =\left[\begin{array}{lll}
9 \cdot\left(\frac{7}{15}\right)^{2} & 6 \cdot\left(\frac{7}{15}\right) & 9 \cdot\left(\frac{7}{15}\right) \cdot\left(\frac{8}{15}\right) \\
5 \cdot\left(\frac{7}{15}\right) & 5 \cdot\left(\frac{8}{15}\right) \\
9 \cdot\left(\frac{7}{15}\right) \cdot\left(\frac{8}{15}\right) & 6 \cdot\left(\frac{8}{15}\right) & 9 \cdot\left(\frac{8}{15}\right)^{2}
\end{array}\right. \tag{2}
\end{align*}
$$

This latter estimate, (2), usually differs from the preceding estimate (1), which was based on the traffic between the various sub-areas being known from the start.

Although the structure of expressions (1) and (2) is alike in principle, they represent two entirely different operations. In (1) a traffic matrix of order $4 \times 4$ is broken down into a matrix of order $3 \times 3$. In (2), on the other hand, a matrix of order $3 \times 3$ is built up from a matrix of order $2 \times 2$. An expansion of a traffic matrix in this way can, of course, not be done exactly without a knowledge of the internal traffic distribution.

In this simple case, of course, the latter arrangement can be written direct. But when several new exchange areas are to be formed by cutting out portions of one or more existing areas, an arrangement as in (2) is preferable both for manual and mechanical calculations.

As final example we assume that in an area of two exchanges and with the traffic distribution

|  | Total |  |
| :---: | :---: | ---: |
| Total $\left.\begin{array}{rr}138 & 81 \\ 80 & 47\end{array}\right]$ | 219 <br> 127 <br> 218 128 | 346 |

a new source of traffic, III, arises for which we can estimate only the following data:

$$
\begin{aligned}
\text { initiated traffic } & =123 \\
\text { received traffic } & =123 \\
\text { internal traffic } & =34
\end{aligned}
$$

To estimate the traffic distribution on the assumption that the initiated traffic for exchanges I and II is unchanged, one forms

$$
x=\frac{123-34}{346}=0.257 \quad 1-x=0.743
$$

after which the new traffic distribution is determined as follows:

$$
\begin{aligned}
& \text { Total } \\
& {\left.\left[\begin{array}{rrc}
138 \cdot 0.743 & 81 \cdot 0.743 & 219 \cdot 0.257 \\
80 \cdot 0.743 & 47 \cdot 0.743 & 127 \cdot 0.257 \\
218 \cdot 0.257 & 128 \cdot 0.257 & 34
\end{array}\right]=\underset{\text { Total } 218}{ } \begin{array}{rll|l}
{[28} & 123 & 469
\end{array} \right\rvert\,}
\end{aligned}
$$

These examples show the most important principles for calculating traffic distributions. The examples can be generalized to embrace multi-exchange networks with arbitrary numbers of exchanges in which new areas are formed by regrouping one or more portions of the existing areas into one or more new areas. The necessity for dividing up a network into several areas may be due to an increase of the traffic in existing areas through the addition of new traffic sources within and/or outside the areas or to the amalgamation of two or more areas under a single exchange. This is described in detail in "Calculation of Traffic Distributions in Multi-exchange Networks" in Ericsson Technics No. 1, 1962.

These calculations can be quickly carried out with a computer, which presents the results printed in tabular form indicating in the customary manner the traffic between and within the exchange areas.

## Portable 40-line Switchboard

T BJORKMAN, TELEFONAKTIEBOLAGET LM ERICSSON, STOCKHOLM

UDC 621.395.23
LME 8372
L M Ericsson has produced a 40-line portable switchboard which not only has the robustness and full telephonic facilities required for use in the field, but also meets the condition essential in field telephone equipment, that it shall not cause disturbance to radio stations even in its immediate vicinity. The switchboard was designed in close collaboration with the Swedish Army Ordnance Administration.

L M Ericsson's new field switchboard $A B M 101$ is of extremely robust construction. It has facilities for connection of 40 lines and has 10 cord pairs for establishment of 10 connections at one time.

The lines from the switchboard can be connected both to magneto telephones and to all kinds of public exchange.

Ordinary magneto telephones can be used when the switchboard is to operate solely between magneto extensions and magneto exchange lines. With C.B. exchange lines the magneto telephones must permit of a holding loop being formed through the telephone, and the receiver must be protected against direct current. The switchboard allows direct dialling by extensions, so that the magneto telephones may be fitted with dials.

The switchboard is designed to operate on a 12 -volt external source consisting of a storage battery. If there is no 12 -volt battery, or if a temporary interruption takes place in the external power supply, the switchboard will nevertheless function satisfactorily on two 3 -volt dry cell batteries. These batteries are automatically switched into circuit when the external power supply ceases.

To ease the work of the operator, the switchboard has a 12 V pole changer for generation of ringing current. There is also a hand generator as reserve equipment in the event of failure of the pole changer or absence of a 12 -volt

Fig. 1
40-line field switchboard ABM 101
(left) with transport covers removed (right) ready for transport
supply.



Fig. 2
X 2630
Cover with compartment for handset and cords

## Constructional Features

The switchboard is fitted in a robust light alloy case. For transport of the switchboard two covers should be attached to it, one on the front and one on the rear.

Fig. 1 shows the switchboard with and without cover. Slotted into the edges of the covers are rubber weatherstrips which prevent any entry of moisture into the switchboard. The covers are firmly secured to the case by powerful snap type catches. One cover has an inner compartment in which the handset and ten plug-ended cords for conference connections are accommodated during transport (fig. 2).

The switchboard has two handles. The case and covers are finished in a dark green enamel which is proof against infra-red light.

The switchboard chassis, which contains all delicate parts, is mechanically insulated from the case by rubber pads to protect the components against knocks and careless handling.

The switchboard with covers weighs 57 kg . Its dimensions are: height 560 mm , width 495 mm , depth 345 mm .

The front of the switchboard is shown in fig. 1. The calling devices and jacks are combined into line units, each serving 10 lines. Four line units are fitted at the upper left-hand side of the switchboard.

On the right of the line units is a conference unit which, in addition to conference jacks, contains lamps for illumination of the switchboard.

Under the conference and line units are ten switching sets and a position set. These sets are inclined 23 from the vertical for convenience of operation.

The rear of the switchboard, on which all wiring connections are made, is shown in fig. 3. The round sockets marked $0-3$ are for connection of the lines. Every round socket is connected in parallel with its respective rectangular socket to which, when required, various types of supervisory equipment can be connected direct to the lines.

The storage battery connects to one of the two jacks marked 12 V , which are in parallel.

Standby 3 -volt batteries are accommodated in the rectangular battery boxes $M B$ and $S B$.

Jacks $I J$ and $O J$ are used for concentration of positions when two switchboards are coupled together.

An earth conductor must be connected to the terminal at the bottom right, marked with the earth symbol.

## Line Units

The calling devices consist of drop indicators with 500 -ohm d.c. resistance. Being built integral with their respective jacks, the advantage is gained that the indicator is automatically restored when the call is answered by plugging

Fig. 4
X 8358
Line unit


Fig. 5
X 2644
Switching set


Fig. 6
X 2631
Position set

into the jack. In order to be able to connect magneto and C.B. lines to any jacks. a capacitor has been placed in series with the clearing indicator so as to block the direct current from the C.B. exchange. Another capacitor in conjunction with a resistor constitutes the line termination. This is necessary for the avoidance of self-oscillation on amplified lines. All these components are built into a very stable and compact unit. As seen from fig. 4, this unit is cabled to two sockets, a circular 24 -pole and a rectangular 30 -pole socket, on the rear of the switchboard (fig. 3). For adjustment of the indicators the line unit can be pulled out forwards by releasing the two fixing plates.

## Switching Sets

Each switching set consists of two cords with plugs, two cord winders, clearing signal indicator, speak-and-ring key and monitoring key. With ten switching sets ten connections can be set up simultaneously.

The switchboard cords coil up on two nylon cord winders. These are a new feature in manual switchboards. Three flat helical springs of stainless steel serve both to wind up the cord and to connect its a, b and c conductors to the switching set. No sliding contacts are employed. The cord cannot be pulled off the winder by mistake, but is nevertheless easy to remove when desired.

The clearing indicator has a 2000 -ohm d.c. resistance. The indicator is in series with a capacitor to permit direct dialling from extensions to exchange lines.

The switching set key is of 3-way type, speaking position up, normal position centre and ringing position down. The clearing indicator is automatically restored when the operator throws the key to speaking position.

The switching set is connected to the chassis by plug and jack. It can be removed for adjustment or replacement simply by releasing the two fixing screws.

## Position Set

The position set contains all the necessary common equipment such as dial, speak-and-ring key on answering cord, speak-and-ring key on ringing cord, key for audible calling and clearing signals, and concentration key. The position set also contains the hand generator, ringing indicator and bell.


Fig. 7
Conference unit

It is connected to the switchboard chassis by plug and jack. It can be removed for adjustment in the same convenient manner as the switching sets, simply by releasing the fixing screws.

## Conference Unit

Conferences can be set up by means of the conference unit (fig. 7) and flexible cords (fig. 2).

Conferences can be established between magneto lines alone or between magneto lines and C.B. exchange lines. Every group of four jacks is connected in parallel. Four lines can be connected together on a vertical row of jacks. If more than four lines are to be in conference simultaneously, two or more rows of jacks can be interconnected by pressing one or both keys in accordance with the engravings on the front panel. The right-hand row, marked CB, is for connection of C.B. exchange lines to a conference.

Four jacks and a lamp with red lens are placed under the sign WAIT JACKS. This is to remind the operator that a call is waiting for an engaged extension. The operator plugs the waiting subscriber's ringing cord into one of the jacks, whereupon a lamp lights as a reminder of the waiting call.

At the top of the conference unit are two 5 W lamps for illuminating the front panel. The lamps function only off a 12 -volt battery. They have built-in switches which light the lamps when the lamp covers are pulled outwards. The covers can be rotated to direct the light in the desired direction. One lamp should preferably shine on the jack field and the other on the cord pairs.

## Connection of Lines

The line connections are shown in fig. 8. Every group of 10 lines is run to a terminal box from which distribution cables proceed to the individual extensions and to the public exchanges. The distribution point may be located at a varying distance from the switchboard, depending on the number and length of the line cables between the switchboard and terminal box.

Fig. 8
Rear view of switchboard with 20 lines connected



Fig. 9
X 2633
Terminal box ABM 9211


Fig. 10
X2634
Line cable type RPM 970


Fig. 11
X 2636
Connector type 2H660 for panel mounting

## Terminal Box

The terminal box, ABM 9211, has ten pairs of screw terminals for the field telephone lines and an earth terminal for an earth conductor. A round 24 -pole socket of the same type as that on the line unit is fitted at one end of the box (fig. 9).

Overvoltage protectors for the lines are placed in the terminal box, which is watertight. The cover is made of glass fibre reinforced plastic, and the base of a light alloy. The base has three holes for suspension of the terminal box on a tree, wall or other suitable mounting. When no cable is connected to the box, the socket is protected by a cover secured to the box with a chain.

## Line Cable

The line cable, type RPM 970 (fig. 10), consists of 24 polythene-insulated conductors stranded around an insulated steel wire. The plastic cover around the conductors is reinforced with steel wire braid. On the outside is a layer of watertight PVC. The cable withstands both high and low temperatures. The line cables are supplied in lengths of 5,20 or 100 metres. They have a 24 pole connector at each end.

## Battery Cable

Every switchboard is supplied with a 2 -metre battery cable with identical plugs at both ends (fig. 8). These cables are used for connecting a 12 -volt battery to the switchboard and for interconnecting two boards when operating as an 80 -line switchboard.

## The Multipole Connector

The 24-pole connectors with bayonet grip (fig. 11) on the field switchboards were originally designed as coupling device for the line cable. They are made for use out-of-doors under severe conditions. They function satisfactorily at a relative humidity of around 100 per cent within a temperature range of $+55^{\circ}$ to -30 C .

They are concentrically shaped and are made both for cable grip and panel mounting. The coupling component is identical in both cases, being of threeprong bayonet type. The prongs are placed asymmetrically to ensure correct coupling in only one position. The coupling component is made in one piece on the fore end of a steel casing which supports and encloses the terminal insert. The latter contains 24 individually sprung pin terminals, the spherical surfaces of which are automatically cleaned when two connectors are coupled together. The pins are constructed for soldered termination and are plated with gold over nickel. For panel mounting the connector is fitted with a rubber gasket and lock nut. For cable mounting it is fitted with a rubber cable guard and a metal casing. The casing is attached to the connector by a lock nut and has in its centre a strain-relieving device so designed that all tensile strains are taken up by the centre steel wire and the metal braiding. Both types of connector can be fitted with a cap for protection of the terminals against wet and mechanical damage.

## 80-line Field Switchboard

If 40 lines should prove insufficient, an 80 -line switchboard can be made up by combining two 40 -line boards, placed side by side as shown in fig. 12. All 20 cord pairs can be used between any jacks in either switchboard.

Fig. 12
80-line field switchboard consisting of two 40 -line boards


During low traffic conditions only one operator may be required, and in such case all cord pairs can be connected to the speaking equipment of one board. This facility can be arranged at the time of setting up the switchboards by connecting a plug-ended cord between the jacks on the rear sides of the switchboards. When one of the operators completes his period of duty, he presses the concentration key on his position set.

## Interference Suppression and Earthing

The switchboard is equipped with interference suppressors to prevent disturbance of nearby radio stations.

The components for which interference suppressors are required are the pole changer, dial, hand generator and bell. For effective interference suppression the switchboard must be earthed.

## Shock and Drop Tests

The switchboard has been subjected to a very severe shock test with an acceleration of 50 g along the three main axes. No serious faults were revealed. This test was performed in order to ascertain the ability of the switchboard to withstand the shocks it may be exposed to under rough transport conditions.

The object of the drop test was to find out particularly whether the casing provides adequate protection against careless handling when loading onto and unloading from a truck.

The switchboard was allowed to drop freely from a height of 1 metre onto a floor of 5 cm thick planks butted to a concrete floor. The test was repeated three times on different sides of the switchboard. The switchboard suffered no damage such as to jeopardize its function.

## Climatic Tests

The switchboards have stood up satisfactorily to comprehensive cold, heat and moisture tests.

The new design of cord winder has been subjected to severe wear tests, to which it has stood up satisfactorily.

## dixale NEWS from All Quarters of the World



## Tunisian Minister of Communications Visits L M Ericsson

The Tunisian Minister of Communications, Rachid Driss, also head of the P.T.T., made a semi-official visit to Sweden at the end of February, accompanied by his wife and the Technical Director of the Ministry of Communications, Mohamed Mili. His very full programme included a visit to the L M Ericsson factory at Söderhamn and, of course, to the head factory in Stockholm. The 45-year-old Minister - journalist by profession and Minister of Communications since 1957 - did not confine his interest to the technical side of production but posed a multitude of questions also on welfare conditions, unemployment problems, the status of women, etc.

The photograph above shows a group examining a 500 -line switch at the Söderhamn factory. (From left) Sven T Aberg, president of L M Ericsson, Minister Driss, Gösta Skoglund, Swedish Minister of Communications, Mohamed Mili, and L M Ericsson engineer Rune Häggö

Minister Driss also visited the Midsommarkransen factory and Ericsson Kindergarten. He is seen below with his wife at a round table conference with the children.

Tunisia is at present one of L M Ericsson's main markets and, since

## Another Large Ericsson Order from Colombia

A contract has been signed between L M Ericsson and Empresa de Teléfonos de Bogotá, the telephone operating company in the capital of Colombia, for telphone exchange equipment to a value of about 19 million Kronor. The bulk of the equipment, which is of crossbar type, will be used for 21 new exchanges in the Bogotá area. Old exchanges are also being re-equipped, so that the Bogotá telephone network as a whole will be brought thoroughly up to date.

The first contract between Empresa de Teléfonos de Bogotá and L M Ericsson was for 40000 lines in 1946. After installation of the equipment now on order Bogotá will have a total of 136000 dial lines, all supplied by L M Ericsson. Bogotá is now fourth South American city in number of telephones.

L M Ericsson has also signed contracts with Colombia for extension of the telephone plants at Armenia, Cartagena, Ibagué, Pasto and Santa Rosa de Cabal, for a total amount of over 5 million Kronor.

1959, has purchased about 23 million Kronor's worth of equipment. By the end of 1962 L M Ericsson expects to have some 28000 lines in service in Tunisia. The installations at present on order are expected to be completed by 1964 .



# Ericsson Factory in Brazil to be Extended 

The Ericsson factory in Brazil lies on the autostrada between Rio de Janeiro and São Paulo, at São José dos Campos, about 50 miles from São Paulo. It was completed in 1955 and has since between twice extended. It today employs about 400 persons, but next year the number is expected to have increased to 700 .

Work on the first part of the factory, covering an area of 25000 sq.
ft., started in 1954. The architect was Oscar Niemeyer. Niemeyer is considered one of the world's foremost architects and is co-creator of most of the public buildings in the new capital, Brasilia. The factory was officially opened in 1955. The inauguration ceremony was attended by 500 600 persons from all parts of Brazil and was surrounded by considerable publicity, which added to Swedish good will in Brazil. In the same year

(Left) Exterior view of the factory at São José dos Campos.
(Below) The forming of cables in the factory.
the factory was extended to an area of 45000 sq. ft., and again in 1960 to the present 130000 sq. ft .

Originally the factory produced telephones only. After the first extension, work started on the assembly of crossbar switches, cable forming, wiring and testing of crossbar racks. The work has now progressed to the assembly, cabling and testing of relay sets, manual switchboards, trunk boards, and P.A.X.

Manufacture of crossbar switch parts has already started, and by the autumn the first Brazilian-produced switch will have been completed. A bit later will come the first RAF relay. Except for certain specialized parts and cable, the entire manufacture will by then be located in Brazil.

Products are regularly sent to Stockholm for testing, and the Brazilian quality has been found to be fully comparable with that from Swedish factories.

## North Electric Provides Controls for Big Pipeline

North Electric Company of Galion, Ohio, has been awarded a major contract by Mid-Valley Pipeline Company, Longview, Texas, for the complete modernization of the latter's pipeline facilities by installation of automation controls on all 14 pump stations in the system. North Electric will provide "Paricode" supervisory control and telemetering equipment to automate Mid-Valley's 930 -mile pipeline network from Longview to Lima, Ohio.

Upon completion of this programme, Mid-Valley will have one of the largest automated crude oil pipelines in the world. Mid-Valley is a 20 -inch and 22 -inch crude oil common carrier pipeline, interconnecting with other carriers in the Southwest and Midwest.

Supervised indications, alarms and field data quantities will be telemetered back to the central control station, also North-designed, providing the dispatcher with the necessary information to maintain optimum pipeline operating conditions and to take corrective action, if and when necessary.

The Swedish Institute in Rome is devoted to archaeological research. Twenty years ago the Institute acquired a fine building through contributions from the Swedish and Italian governments and a number of private donors. Among the latter, whose names are recorded on the memorial tablet recently unveiled by the King of Sweden, is Telefonaktiebolaget L M Ericsson, which, in cooperation with SIELTE, presented a modern telephone installation for the use of the Institute.

In the middle of February Egypt's first Ericsson crossbar type city exchange, the Abbassia exchange, was cut over in the presence of, among others, Dr. Mahmoud Mohamed Riad, Director General of the United Arab Republic Telecommunications Organization (UARTO). In the photograph below, taken during the reception following the opening ceremony, are seen (from left) Ambassador Sven Dahlman, Mr. Sven T. Aberg, Dr. Riad and the Minister of Communications, Mostafa Khalil.
(Below right) In conjunction with the 50 -year jubilee of Ericsson's French subsidiary, Societe des Téléphones Ericsson, the board of L M Ericsson and a number of selected guests visited the Ateliers Vaucanson factory at St. Nicholas. (From left) G. Forssius, Swedish Consul General in Paris, Vice Admiral E. Anderberg, H. Lindberg, W. Söderman, E. Browaldh, Dr. M. Wallenberg and Ambassador E. Boheman.


The Director General of the Jugoslavian Railways, Vojin Nicolic, on a visit to the main Ericsson factory in Stockholm, was shown the newly established Language Laboratory. (From right) Director General Nicolić, Erik Lundquist, I. Veselić, Svetislav Miladinov, L. Sekulić, Secretary of the Jugoslavian Embassy, and N. Kallerman and H . Insulander of L M Ericsson.

# Copenhagen Exchanges to be Equipped with Code Switches 

Around the turn of the century the Copenhagen Telephone Company introduced the so-called Copenhagen system, the idea of which was to concentrate all subscribers with a high calling rate to a single exchange called Central. The time is now ripe for a change, and the Central exchange subscribers are being successively transferred to the automatic district exchanges to which they belong geographically. The roughly 10000 subscribers resident in the central area will in due course be transferred to the new all-automatic exchanges which the Copenhagen Telephone Company is building on Norregade.

These exchanges are being equipped with the LM Ericsson code switching system. This system offers certain advantages to the transferred subscribers since they can retain their four-digit numbers with the addition of a two-digit prefix.

The Ericsson code switch is considered one of the foremost inventions in Swedish telephone engineering in recent years. Apart from the Copenhagen Telephone Company, the Swedish Telecommunications Admin-
istration has ordered a plant for initially 4000 lines for the new suburban exchange at Drevviksstrand, and from Italy orders have been received for line concentrators serving a total of 7000 lines.

The main feature of the new system is its compactness of structure. The code switch has a larger capacity but requires far less space than the crossbar switch. It also permits a different method of construction, with the racks suspended on ceiling girders placed side by side like books on a shelf. All relay sets and switching units are detachable and can be plugged in after the racks have been assembled. The exchange cabling is placed on the floor under the racks instead of, as hitherto, on runways above the racks. Installation work is thus greatly facilitated.

The compact structure of the code switch is due to two factors. The first is that wire springs have been used instead of leaf springs in the multiple; and the second is the use of an entirely new system of selection. This has enabled the number of magnets per vertical unit to be halved although the capacity of the vertical has been doubled.



## Out-of-the-way Ericsson Assignments

L M Ericsson has people at work throughout the world. Two places to which few find their way in the normal course of events are the Libyan desert and the Himalayas, where Ericsson engineers were engaged on telephone exchange construction during the summer and autumn of 1961. A 500-line crossbar exchange type ARF 101 has been built in the El Beida oasis, and a new 1000 -line automatic exchange at Katmandu in Nepal.

The pioneering work at El Beida -new capital of Libya-was started in May last year. Apart from the local exchange, L M Ericsson has supplied a manual trunk centre, which was cut over at the same time.

At Katmandu two Ericsson engineers have been serving as instructors to the Nepalese during the past years. For more than one year they have been teaching the art of using electricity, soldering, connecting and splicing cables; and the mysteries of circuitry have been taught in the schoolroom. All this schoolwork has prepared the way for the construction of the outside plant and for the installation and testing of the new automatic exchange equipment.

[^0]UDC 621.395.44
LME 8421
Hallberg, P-A \& Schilling, H: Transistorized Group Translating Equipment for Carrier Terminals. Ericsson Rev. 39(1962): 2, pp. 34-43.
This article is associated with the description of the channel translating equipment for carrier terminals given in Ericsson Review No. 2, 1961. In addition to the group translating equipment the description covers the pilot-controlled level regulation of the basic group and also an equipment for signalling blocking when there is a break in the transmission path.

UDC 621.395.74
LME 8077
Rapp, Y: Planning of Multi-exchange Networks with aid of a Computer. Ericsson Rev. 39(1962): 2, pp. 44-50.
The planning of multi-exchange networks may involve extremely extensive numerical calculations. This applies especially to problems of determining the number of exchanges, their locations and boundaries, the traffic distribution between exchanges after modification of the network structure, and finally to the allocation of junctions between direct and tandem routes. To simplify this work. L M Ericsson has developed methods which permit programming of the most laborious operations for an electronic computer. The questions of exchange locations and boundaries, and the traffic between the exchanges are dealt with briefly. The question of the structure of junction circuits will be dealt with later. Detailed discussions of these problems will be published shortly in Ericsson Technics.

UDC 621.395.23
LME 8372
Björkman, T: Portable 40-line Switchboard. Ericsson Rev. 39(1962): 2, pp. 51-56.
L M Ericsson has produced a 40 -line portable switchboard which not only has the robustness and full telephonic facilities required for use in the field, but also meets the condition essential in field telephone equipment, that it shall not cause disturbance to radio stations even if located in its immediate vicinity. The switchboard was designed in close collaboration with the Swedish Army Ordnance Administration.

# The Ericsson Group 

## Associated and co-operating enterprises

## - europe.

Denmark
L M Ericsson A/S Kebenhavn F. Finsensvej 78, tel: Fa 6868, tgm: ericsson
Telefon Fabrik Automatic A/S Kabenhavn K, Amaliegade 7, tel: C $5188, \mathrm{tgm}$ : aulomatic
Dansk Signal Industri A/S Kaben. havn F. Finsensvei 78, tel: Fa 6767 , tgm: signaler

## Finland

O/Y LM Ericsson A/B Helinki, Fabianinkatu 6, tel: A8282, tgm: ericssons

## France

Société des Téléphones Ericsson Colombes (Seine), Boulevard de la Finlande, tel: CHArlebourg 35-00, tgm: ericsson
Paris 17e, Rue de Courcelles, tel: CARnot $95-30$, 1 gm : eric
Ateliers Vaucanson, Paris $\times \times, \mathrm{B}$. igm: atelcanson

## Great Britain

Swedish Ericsson Company Lid. London, W. C. 1, 329 High Holborn, tel: Holborn 1092, tgm: teleric
Production Control (Ericsson) Lid. London. W. C. 1, 329 High Holborn, iel: Holborn 1092. tgm: productrol holb

## Italy

Setemer, Soc. per Az. Roma, Via G. Paisiello 43, tel: 868.854, 863.855, Igm : setemer

SIELTE, Soc. per Az. Roma, C. P. 4024 Appio, tel: 780221 , tgm: siclte
F. A. T. M. E. Soc. per Az. Roma, fatme

## Agencies

## - EUROPE

Belgium
Electricité et Mécanique Suédoises Bruxelles 5, 56 Rue de Stassart. tel: 111416, tgm: electrosuede

## Greece

"ETEP" S. A. Commerciale \& Technique Athens, Rue Lycavittou 11, tel: 617041, tgm: aeter-athinai

## Iceland

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

## Ireland

Communication Systems Ltd. Dublin 4. 138 Pembroke Road. Ballsbridge, tel: 680787 tgm: crossbar

## Yugoslavia

Merkantile Inozemna Zastupstva Zagreb. Pošt pretinać 23, tel: 36941, tgm : merkantile, telex 02-139

## Burma

Burma Asiatic Co. Lid. Ericsson Department Rangoon, P.O.B. 1008 , tel: $10999,1 \mathrm{gm}$ : ericsson

## Cambodia

The East Asiatic Company LId. Phnom-penh, P.O.E. 129. tel: Central 8300, 1 gm : plandep

## Ceylon

Vulcan Trading Co. (Private) Ltd. Colombo 1. 19. York Strcet, tel: $36-36, \mathrm{tgm}$ : vultra

## China

The Ekman Foreign Agencies Thd Shanghai P. O. B. 855, tel: 16242-3, tgm: ekmuns

L M Ericssons Signalaktiebolag signalbolage!
L M Ericssons Svenska Försaljningsaktiebolag Stockholm 1, Box 877. tel: 223100 , tgm : ellem

Mexikanska Telefonaktiebolaget Ericsson Stockholm 32, tel:190000, tym: mexikan
Sieverts Kabelverk $A B$ Sundby. berg, tel: $282860,1 \mathrm{gm}$ : sieverts-fabrik-stockholm
Svenska Radioaktiebolaget Stockholm 12. Alströmergatan 14, tel: 2231 40, 1 gm : svenskradio
AB Östmarks Lásfabrik Eskilstuna, Munktellsgatan 5, tel: 31455

## Switzerland

Ericsson Telephone Sales Corp. $A B$, Stockholm, Zweigniederlassung Zürich Zürich, Postfach Zurich 32, tel: 325184, tgm: telericsson

## West Germany

Ericsson Verkaufsgesellschaft $m$. b. H. Düsseldorf, Postfach 2925 tel: 84461 , tgm: erictel

## India

Ericsson Telephone Sales Cor-
poration AB New Delhi 1, P.O.B. 669, reg,mail: $1 / 3$ Asaf Ali Road (Delhi Estate Building), tel: 228512, tgm: inderic
Calculta, P. O. B. 2324, tel: 45 4494, Igm : inderic

## Indonesia

Ericsson Telephone Sales Corporation $A B$ Bandung, Djalan Dago 151, tel: 8294, 1gm: javeric Diakarta, Dialan Gunung Saheri 26, tel: Kota 22255, igm: javeric

## L.ebanon

Telefonaktiebolaget L M Ericsson, Technical Office Beyrouth Rue du Parlement. Immeuble Bisharat, tel: 252627, tgm: ellem
Thailand
Ericsson Telephone Sales Corporalion AB , Eongkok, P. O. B. 824, tel: 339 91, tgm : ericsson

Turkey
Ericsson Türk Ticaret Lid. Sirketi Ankarn. Âdil Han, Zafer Meydani, Yenişehir, fel: $23170, \mathrm{tgm}$ : ellem

The Swedish Trading Co. Lid
Honskong. P. O. B. 108, |e| 35521-5, tgm: swedetrade

## Iran

Irano Swedish Company $A B$ Teheran, Khiabane Sevom Esfand 23, tel: $36761, \operatorname{tgm}$ : iranoswede
Iraq
Koopman \& Co. (Iraq) W.L.L. Baghdad, P. O. B. 22, tel: 6534 , gm: koopiraq
Japan
Gadelius \& Co. Lid. Tokyo C,
P. O. B. 1234, tel: $408-2131, \mathrm{gm}$ :
goticus
Cored
Gadelius \& Co. Lid. Scoul.I.P.O.
Box 1421, tel: 2-9866, tgm: gadeliusco
Kuwait
Latiff Supplies Lıd. Kuwait, P. O. B.
67. 1 gm : lalisup

Lebanon
Swedish Levant Trading (Elie B. Hélou) Beyrouth, P. O. B. 931, tel: 231624, Igrn: skefko

## Pakistan

Vulcan Industries Ltd. Korochi City, P. O. B. 4776, 1el: 32506 tgm: vulcan
Philippines
USI U.S. Industries Philippines inc. Manila P. R., P. O. B. 125 , tel: 8-93-51, Igm: usiphil

## Saudi Arabia

Mohamed Fazil Abdulla Arab Jeddah, P.O. B. 39, tel: 2690, 1gm: arab
Singapore and Malaya
The Swedish Trading Co. Ltd. Singapore 1, 42 Chartered Bank Chambers, Baltery Road, tel: $24964, \mathrm{gm}$ : swedetrade

## Syria

Georgiades. Moussa \& Cie Da-1-02-89, 1gm: georgiades

## Thailand

ricsson Agency Office. Telephone Organization of Thailand Bangkok. Ploenchitr Road, tel: 55183, tgm: telthai

Vietnam
Vo Tuyen Dien-Thoai Viet-Nam saigon, 34 Dai-lo Thong-Nhut. tel: 20805, tgm: telerad

## - AFRICA.

British East Africa
Transcandia Lid. Nairobi, Kenya, P. O. B. 5933, tel: 3312, tgm: ranscanda

## Congo (Fed. Rep.)

Société Anonyme Internationale de Télégraphie sans Fil (SAIT) Bruxelles (Belgique), 25, Bouleard du Regent, lel: 125070 and carrier)

## Ethiopia

Swedish Ethiopian Company Addis Ababo, P. O. B. 264, tel: 1447, tgm : efiocomp

## Ghana

The Standard Electric Company Accro, P.O.B. 17, tel: 62785 , tgm: standard
Liberia
Swedish Agencies Liberia Co. Monrovia, P.O.B. 506, tel: 745 tgm: salco

## Libya

The Gulf Trading Co. Tripoli, P.O.B. 417, tel: 5715, tgm: gultraco

## Mauritius

Mauritius Trading Co. Lid. Polt Louis, P.O.B. 201, tgm: agentou

## Morocco

Erancisco V. A. - SEYRE Tangier,
gm: elmar

## - AFRICA.

## Egypt (UAR)

Telefonaktiebolaget LM Ericsson, Egypt Branch Coiro, P. O. B. 126 tel: $43684,50553, \mathrm{tgm}$ : elleme

## Rhodesia

LM Ericsson Telephone Co. (Pty.) Lid. (Branch Office of LM Ericsson Telephone Co. Piy. Lid. in Johannesburg) Solisbury, Southern Rhodesia, P.O.B. 2891, tel: 27001, tgm: ericsson
Republic of South Africa
L M Ericsson Telephone Co. Ply
Lid. Johannesburg, Tronsvaal, P O. B. 2440 , tel: $33-2742$, 1 gm : ericofon
Tunisia
Telefonaktiebolaget LM Ericsson, Technical Office Tunis, Boite Postale 780, tel: 240520 , tgm: ericsson

AMERICA.

Argentine
Cía Ericsson S. A. C. I. Buenos
Aires. Casilla de correo 3550 , tel : 332071 , tgm: ericsson
Cia Argentina de Teléfonos S. A. Buenos Aires, Perú 263, tel: 3050 11, Igm: catel
Cía Entrerriana de Teléfonos S. A. Buenos Aires. Perú 263, tel 305011 , tgm: catel
Industrias Eléctricas de Quilmes S. A. Quilmes FCNGR, 12 de Octubre 1090, tel: 203-2775, tgm: indelqui-buenosaires

## Brazil

Ericsson do Brasil Comércio e Indústria S. A. Rio de Janeiro, C. P. 3601, tel: $43-0990$, 1 gm : ericsson
Sioo Paulo, C. P. 5677, tel: 36-6951, tgm: ericsson

## Canada

L.M Ericsson Lid. Montreal 9, P.Q..

2300 Laurentian Boulevard C.O.. of St. Laurent, tel: 331-3310, tgm: caneric
Toronts 18, Ont., P. O. B. 161, tel: BE 1-1306

## Chile

Sant Ericsson de Chile, S. A. 82555 , Casilla 10143, tel: dechile

## tgm: ericsson

Ecuador
Teléfonos Ericsson C. A. Quite Cosilla 2138, tel: 16100, Igm ericsson
Guayaquil, Casilla 376, tel: 16892 tgm: ericsson

## Mexico

Teléfonos Ericsson S. A. Méxice D.F., Apartado 9958, tel: 464640, Igm: coeric
Industria de Telecomunicación S.A. de C.V. México 6, D.F., Lond res No. 47, tel: 250405, tgm: in dustel

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

## EI Salvador

Telefonaktiebolaget LM Ericsson, Technical Office, San Salvador, Apartado Postal 188, tel: 4989, gm: ericsson

## Uruguay

Cia Ericsson S. A. Montevideo
Casilla de Correo 575, tel: 9-26. 11, tgm : ericsson

## USA

The Ericsson Corporation Ne* York 17. N. Y., 100 Park Avenue tel: Murray Hill 5-4030, tgm: erictel
North Electric Co. Galion, Ohio, P. O. B. 417, tel: Howard 8-2420 tgm: northphone-galionohio

## Venezuela

Cla Anónima Ericsson Coracos, Apartado 3548, tel: $543121, \operatorname{tgm}$ ericsson
Teléfonos Ericsson C. A. Carocos Apartado 3548 , tel: 543121 , $\operatorname{tgm}$ : tevela

## AUSTRALIA \& OCEANIA

Australia
L M Ericsson Telephone Co. Ply. LId. Melbourne C 1 (Victoria), 20 Collins Street, tel: 635646, tgm: ericmel
L M Ericsson Trimax Ply. Lid. Coburg N 13 (Victoria), P.O.B. 2, cl: 35 1203, tgm: trimax


[^0]:    (Above) Two Nepalese working on the installation of the new Katmandu exchange.
    (Left) The first parts for the new exchange at El Beida being unloaded after arrival at the oasis.

