

# ERICSSON

## *Review*

3

1970





# ERICSSON REVIEW

Vol. 47

No. 3

1970

RESPONSIBLE PUBLISHER: CHR. JACOBÆUS, DR. TECHN.

EDITOR: SIGVARD EKLUND, DHS

EDITOR'S OFFICE: S-12611 STOCKHOLM 32

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

## CONTENTS

	page
Development of the LD Network in Brazil	78
Telephone Traffic Research in Sweden	89
Equipment for Maintenance of ARM 20 and ARM 50 Automatic Telephone Exchanges	99
ERICSSON NEWS from all Quarters of the World	109
On cover: Rio de Janeiro — View of Guanabara Bay	





# Development of the LD Network in Brazil

M. F. MELCOP, EMBRATEL, RIO DE JANEIRO & A. M. FERRARI, ERICSSON DO BRASIL, SÃO PAULO

UDC 621.395.74(81)  
LME 808

*Brazil is an enormous and largely inaccessible country. It has an area of 8.5 million square kilometres, which is more than 75 % of the area of Europe, and a population of more than 88 million. For a country of this character a well developed LD network with high-standard transit exchanges is of the greatest significance. A few years ago a nationwide extension of the LD network started, and the aim of this article is to give an idea of the now quickly advancing work on this project.*

## Introduction

Up to the mid-1960's Brazil had not yet found the way to integration of its 800 local telephone companies through an efficient long distance system. At that time there were already some routes equipped with radio links, coaxial cables and carrier on open wire lines, although operating on an *OTD* (operator toll dialling) or *RD* (ring-down) basis. A few routes, especially between some satellite cities of São Paulo and also of Rio de Janeiro, had *DDD* (direct distant dialling) circuits to both big cities.

The most important routes equipped with a reasonable number of good quality circuits late in 1965 were the following:

---

Rio de Janeiro-São Paulo	Radio link**
Petrópolis-Rio de Janeiro	Coaxial cable
Santos-São Paulo	Coaxial cable*
Nova Friburgo-Rio de Janeiro	Radio link*
Rio de Janeiro-Belo Horizonte	Radio link**

---

\* Fully delivered by L M Ericsson.

\*\* Multiplex equipment partly delivered by L M Ericsson.

Besides these routes, two others should be mentioned, in view both of the distances involved and of the short time available for the installation, two basic factors which have recurred in the subsequent installations. The first of these two routes, Rio de Janeiro-Belo Horizonte-Brasília-Goiânia, a distance of over 1,450 kilometres and with an installation time of 10 months for all the 26 repeater stations, was built in order to permit the transfer of the capital of Brazil in April 1960. The associated radio equipment was supplied by RCA, while the multiplex equipment was supplied by L M Ericsson and installed by Ericsson do Brasil.

Circuits were extended thereafter up to Corumbá, close to the Bolivian border. The installation of this route was a true Odyssey. Ericsson do Brasil installers lived for several months in a railway wagon towed along the route. Meanwhile the linemen were engaged on changing or straightening pole cross-arms, altering the transposition, and introducing by-pass filters at every railway station so as to allow the simultaneous use of existing selective calling systems.

Both of these routes pass through sparsely inhabited regions covered by tropical forest where no public mains are available. Diesel engines (with 100 % stand-by capacity) run day and night to supply the repeater stations. Helicopters were often used on the Belo Horizonte—Brasília section to deliver fuel and food to the repeater sites.

Another large venture in the Brazilian telecommunication history has been the installation of a carrier system composed of 8 circuits on open wire line more than 2000 km long, joining São Paulo and Campo Grande (capital of the State of Mato Grosso).

Before 1960 there was no Federal Communication Commission to control the operating companies. In the mid-60's telecommunication services in Brazil were placed under the "Ministério das Comunicações". Until that time any operating company could purchase any type of equipment without regard for its technical or economic features. All projects must now be previously approved by federal communication authorities, which prevents poor quality switching and transmission equipments from being installed.

CCITT standards and recommendations are followed and national regulations have been put into force to cover aspects which are left to the discretion of the individual country. In the past the concessions for telecommunication systems were granted by local authorities: the Municipality for local service; the State for services between towns within the boundaries of one state; the Federal authorities for *LD* circuits crossing state boundaries. According to the later regulations only the Federal authority is allowed to grant a concession for telecommunication services of any kind.

EMBRATEL, a fully government-owned company, was formed in 1965 mainly to operate the basic telecommunication networks, a high capacity system for *LD* between states as well as the international service. This company, whose full name is Empresa Brasileira de Telecomunicações (EMBRATEL), operates only the backbone network.

The regional and local private or government-owned companies operate the lower level networks serving particular regions, which may comprise one or a group of states, part of a state or merely a single town.

To give a general idea of the development of this backbone network, the Brazilian telephone network, is the main goal of this article.

## Numbering

Uniform numbering has been adopted for the Brazilian network, so that a national number will always contain 9 digits in accordance with CCITT recommendations (Blue Book, part VI, Q 11). For the trunk prefix the digit 0 has been assigned, and 00 for the international prefix on international *DDD* calls. The length of the trunk code varies according to the length of the subscriber number: the longer the subscriber number within a numbering area, the shorter its trunk code (Table 1).

**Fig. 1**  
National numbering regions



**Table 1. National numbering scheme**

Theoretical capacity of numbering area (lines)	National number	
	Trunk code	Subscriber number
8,000,000	$A_1 B_1$	Y N N N N N N
800,000	$A_1 B_2 C_2$	Y N N N N N
80,000	$A_1 B_3 C_3 D_3$	Y N N N N
8,000	$A_1 B_4 C_4 D_4 E_4$	Y N N N

$$A_1 \neq 0 \quad B_1 \neq B_2, B_3, B_4 \quad C_2 \neq C_3, C_4 \quad D_3 \neq D_4 \quad Y, C_2, D_3, E_4 \begin{cases} \neq 0 \\ \neq 1 \end{cases}$$

Some exceptions, however, are certain to occur in local networks where “step-by-step” exchanges prevent an economical solution for obtaining information concerning the subscriber number length. In these cases step-by-step subscriber numbers are one digit shorter than those of subscribers connected to register-controlled exchanges.

The country is divided into nine regions (see fig. 1). Some trunk codes have been assigned to regions in neighbouring countries so as to allow future traffic with these countries based upon bilateral agreements.

### Special Service Codes

Special services have 3 digits, always starting with digit 1. They have the general configuration 1 RS, where R usually indicates the class of special service, whether barred to the public or not, chargeable or free, emergency



service, or restricted for telephone administration use. *S* indicates the subdivision within the class or – in cases of *LD* special services – the different centres within a large metropolitan network where non-centralized special services are attended to.

#### *Public Local Special Services (R=0)*

##### *CODE SPECIAL SERVICE*

100	Assistance operator
101	Record line – <i>OTD</i> and <i>RD</i> routes to other states
102	Local information
103	Complaints
104	<i>LD</i> information at the origin
105	Local operating company
106	Record line – Rural service
107	Record line – <i>OTD</i> and <i>RD</i> within the State
108	Information on <i>LD</i> charging
109	Ringback circuit

#### *Chargeable Information Services (R=3)*

130	Time announcement (speaking clock)
132	Weather forecast
133	News
134	Wake-up service
135	Phonograms

#### *Emergency Services (R=9)*

190	Police
192	Ambulance
193	Fire brigade

#### *Maintenance of Local Network (R=1)*

110	Installers
112–116	Line test desk
117–118	Splicers
119	Automatic tester ( <i>APR</i> )

#### *Radio Services (R=5)*

151	Record line – International
152	Information on charging of international calls
153	Record line – HF and VF national circuits

#### *Long Distance Special Codes*

Are dialled after trunk prefix and trunk code of the numbering area where they are located.

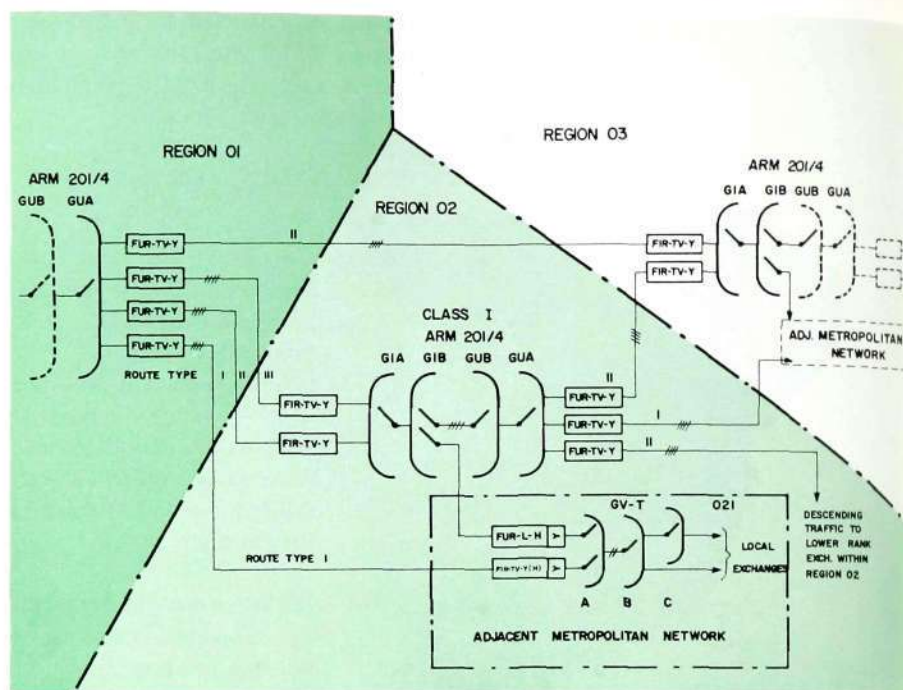
171	Operator to extend calls to areas not yet converted to <i>DDD</i>
121	<i>LD</i> information at the destination
181	Line measuring desk
185	<i>ATME</i> (automatic transmission measuring equipment)

## Switching

The Brazilian *LD* network is being built with high standard switching equipment. As early as 1966 the Federal authorities stipulated as a minimum requirement that crossbar switching on register control principles should be adopted at all local exchanges to be connected to the *OTD/DDD* network.

Besides these requirements, EMBRATEL and regional administrations stipulate that transit exchanges shall have common control, 4-wire switching,

Fig. 2  
Trunking diagram



4-wire pad switching, etc. The installation of step-by-step, motor-driven and other kinds of sliding contact equipments has not been allowed since 1966 in places which are to have *OTD/DDD* services.

Alternative routing is another feature required by administrations in charge of *LD* services, not only improve the *LD* circuit utilization but also to provide automatic rerouting in case of congestion, partial failure of multiplex equipment, etc.

The Switching Plan foresees five levels in the *LD* network structure: Terminal exchange (Local Exchange) Class *IV* (Group Centre), Class *III* (Zone Centre), Class *II* (District Centre) and Class *I* (Regional Centre).

All Class *I* exchanges will be directly interconnected in the future. Due to the traffic distribution now prevailing, which shows that some regions do not show a noticeable community of interest with others, the decision has been made provisionally to route the traffic between those regions via a third intermediate Class *I* exchange.

The large metropolitan networks in the most developed and larger States influence the traffic to a very great extent. A considerable part of the traffic terminates in the metropolitan networks.

In order to save switching equipment and to avoid disturbance of terminating traffic by transit traffic peaks, EMBRATEL adopted the route splitting principle to main metropolitan networks, as shown in fig. 2.

Route *I* is intended for terminal traffic in a metropolitan network close to the transit exchange. Route *II* is the first-choice route for terminating traffic within the area belonging to the transit exchange. This route also constitutes the first alternative for Route *I*. Route *III* is the first-choice route for transit traffic to a third region. It is, simultaneously, the first alternative route for Route *II* and the second alternative for Route *I*.

All Class *I* exchanges and some Class *II*, which are obviously 4-wire type (Table 2) lie along the basic structure. Furthermore EMBRATEL are installing several 2-wire incoming distribution stages in some local networks, which will start operation with full automatic *LD* terminating traffic, whereas during the initial period the originating stage will be maintained on an *OTD* basis. These



tandem stages are not included in the table. As mentioned above, most of Class II and all lower class exchanges do not form part of the basic structure for the high capacity *LD* routes. This means that from EMBRATEL transit exchanges there spread out regional or state systems, which are not dealt with in this article but follow the general requirements of the national network planning under its various aspects.

**Table 2. Transit exchanges in the backbone network**

Four-wire transit exchanges					
Exchange	Class	Initial capacity (trunks)	Charging	Operation starting in	Remarks
São Paulo	I	6,106	TT	1970	*
Rio de Janeiro	I	5,257	TT	1970	*
B. Horizonte	I	1,548	TT	1970	*
Curitiba	I	1,466	TT	1970	*
Pôrto Alegre	I	965	TT	1969	*
Brasília	I	803	TT	1970	
Salvador	I	588	TT	1970	*
Recife	I	706	TT	1970	*
Belém	I	479	TT	1971	*
Gov. Valadares	II	195	MM	1970	
Uberlândia	II	316	MM	1970	
Blumenau	II	161	MM	1970	**
Fortaleza	II	331	TT	1970	*
Baurú	II	837	TT and MM	1971	
Sorocaba	II	514	MM	1971	
Rib. Preto	II	658	TT	1971	
Vitória	II	469	TT	1970	*
Campos	II	342	MM	1970	*

\* ARM 201/4 equipment supplied by Ericsson do Brasil

\*\* ARM 503/2 equipment supplied by Ericsson do Brasil

TT centralized Toll Ticketing

MM centralized Multimetering

## Register Signalling

The compelled multifrequency system (*MFC*) is the one used for the standard register signalling in Brazil. All *LD* switching equipment and all city exchange installations since 1968 have complied with the principles of the *MFC* register signalling system approved in Mexico City as standard register signalling for *RIT* (Interamerican Telecommunication Network). The Brazilian *MFC* signalling scheme includes the fifth backward frequency, but the additional signals containing this frequency will not be used until the 4-backward-frequency system introduced before 1968 is altered to match the 5-backward-frequency system.

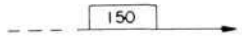
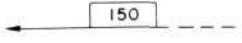
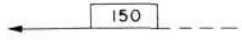
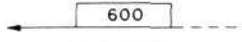
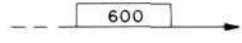

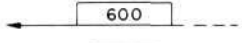
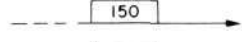
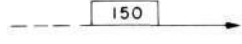
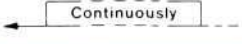
Some very slight differences of signal meanings have been introduced in the *MFC* scheme in order to keep the cost of alterations in the 4-backward-frequency system within reasonable limits.

## Line Signalling

Standard line signalling in the Brazilian long distance network is of the pulsed type. Two signal elements are used: short element ( $150 \pm 30$  ms) and long element ( $600 \pm 120$  ms). See table 3.

Line signalling on transmission equipments is of out-of-band tone-off-idle (high level) type.

Table 3. Line signalling scheme

Line signalling	
Designation	Signal
Seizure	
Answer	
Charging	
Clear forward	
Clear back	
Forced release	
Release guard	
Trunk offering*	
Re-ring*	
Blocking	

\* not used

## Audible Signalling

Information tones follow CCITT recommendation Q.35, with local additions for special and reference tones.

## Charging

Every Class *I* transit exchange is equipped with automatic toll-ticketing facilities (*TT*). Some class *II* exchanges in more automatized regions also have *TT* facilities. The *TT* equipment functions on a centralized basis, i.e. it charges calls originating from directly connected local networks as well as calls from distant transit exchanges which have multimetering (*MM*) facilities only. Analysis at *MM*-equipped transit exchanges based upon originating and terminating area information decides whether the call shall be charged at a certain multimetering rate or be toll-ticketed at the superior exchange.

The tariffs as functions of the distance between originating and terminating charging area are shown in the table below.

Distance (km)	Relative tariff	US\$ per minute of conversation
≤ 50	0.15	0.07
51– 100	0.20	0.09
101– 200	0.25	0.11
201– 300	0.32	0.14
301– 400	0.40	0.18
401– 500	0.50	0.23
501– 700	0.62	0.28
701–1000	0.70	0.32
1001–1500	0.80	0.36
> 1500	1.00	0.45

Charging (telephone to telephone) in April 1969 (1 US \$ = NCR \$ 4.00)

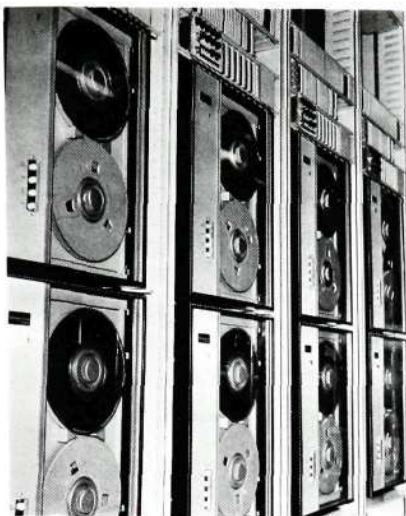


Fig. 3  
Toll-ticketing equipment at ARM exchange,  
São Paulo

Regional and state networks usually operate on a multimetering basis, but some large regional networks have *TT* equipment at their Class II exchanges. Charging in these exchanges is very complex as, when seizing a particular junction repeater, one does not know which kind of charging is to be applied by the exchange in question. This can be decided only after analysis of the calling and called subscribers' charging areas.

*TT* data are recorded on magnetic tape. Special subscribers who need an immediate accounting service have the data for each call additionally recorded on a punched card or in plain language in a teleprinter.

Experience gained with the first *ARM 201/4* equipped with *TT*, also delivered by Ericsson do Brasil, shows the suitability of the *TT* equipment as an aid during final testing, as it supplies quite a lot of information regarding traffic conditions in the distant terminating networks, the operation of the home *ARM* exchange, and the possibility of checking the reliability of the *A*-identification procedure. For this purpose the magnetic tape is processed and the computer prepares a listing which is carefully checked by a switching engineer, abnormal cases being noted. As the condition of the called subscriber's line is also recorded in *TT*, the computer can be programmed to provide statistical data regarding busy subscriber, no answer, idle subscriber and congestion level in terminating local networks.

## Transmission

The Transmission Plan for the Brazilian network complies with CCITT G.121. It is planned that the maximum number of sections to the international exchange will be five. Three of them will be four-wire. The task of the Plan is to keep 95 % of calls within the maximum limit for the reference equivalents of the national system ( $T = 20.8$  dB,  $R = 12.2$  dB).

Four-wire pad switching is used to the full extent. A 3.0 dB pad insertion is controlled by digit information stored in the transit exchange register.

The operational conditions of the *LD* circuits are continuously checked by the Automatic Transmission Measuring Equipment (*ATME*). For this purpose transit exchanges have also the facility of individual circuit selection. Testing of any *LD* circuit forming part of the *DDD* network is done under remote control from a centralized *ATME* parent unit. Data of the location of individual *LD* circuits within the network as well as test programme are recorded on punched cards. A feeding unit reads card after card corresponding to the circuits to be tested. A circuit presenting transmission characteristics outside the present limits results in a card being punched at the output unit with the transmission data for that circuit.

## LD Circuits

Development of new *LD* routes to connect remote regions to the backbone of the national system is being hastened on.

High capacity radio links are replacing old *HF* equipments, existing radio links are being extended or established on completely new routes. Microwave equipments (4 or 6 GHz) are being installed in the southern, eastern and north-eastern regions. Owing to reasons of traffic economy and topography, troposcattering systems are being installed in the northern and western regions (figure 4 and table 4).



Fig. 4

## Trunk network

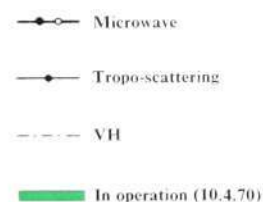


Table 4. Complementary data to Fig. 4

Route See map	Band GHz	Total length km	Repeater stations		Radio EQ. capacity		Facilities for TV			Provisional operation starting date
			Total	With demo- dulat.	Initial	Final	Stand- by	Addi- tional	Simult.	
1	6	972.3	22	1	1TF+1	2×(3+1)	yes	no	—	20.12.68
2	6	413.5	9	—	1TF	3+1	yes	yes	yes	24.04.69
3	6	413.5	9	4	1+1	3+1	yes	no	—	24.04.69
4	4	1,440.7	30	5	1TF 1TV	3+1	yes	yes	yes	6.05.69
5	6	1,906.2	54	4	1TF+1	2×(3+1)	yes	no	—	15.12.69
6	4	1,052.2	22	5	1TF+1	3+1	yes	no	—	9.07.70
7	6	857.1	20	2	1TF+1	2×(3+1)	yes	no	—	20.02.70
8	6	945.3	26	3	1TF+1	2×(3+1)	yes	no	—	30.10.71
9	6	2,005.2	45	12	1TF+1	3+1	yes	no	—	30.12.70
10	6	327.8	13	1	1TF+1	2×(3+1)	yes	no	—	20.12.69
11	6	295.3	8	2	1TF+1	2×(3+1)	yes	no	—	27.08.69
12	7	462.2	14	2	1TF+1	120 ch	yes	no	—	15.05.70
13	0.9	2,752.0	13	3	1TF (120 ch)	120 ch	no	no	—	27.06.71
14	2/6	263/150	5	—	1TF (120 ch)	120 ch	no	no	—	30.05.71
15	2	1,481.6	9	3	1TF (120 ch)	120 ch	no	no	—	30.11.70
16	2	784.4	4	2	1TF (120 ch)	120 ch	no	no	—	30.09.71
17	HF	660.0	—	2	4 ch	4 ch	—	—	—	Feb. 1970



Fig. 5  
Brazilian earth station with antenna in  
background

## International Circuits

Most of the international circuits are operated via a satellite (INTELSAT III). The Brazilian earth station was completed shortly before the first moon landing, which allowed Brazilians to watch the event.

The Tanguá earth station near Rio de Janeiro has a Cassegrain antenna with a 30 m diameter reflector and is also prepared to track non-synchronous satellites (fig. 5). The antenna structure rotates from  $+270^\circ$  to  $-270^\circ$  horizontally and can be elevated from  $2^\circ$  below to  $92^\circ$  above the horizon.

Interconnection between the international exchange and the earth station is performed by a 7 GHz microwave system, 960 channels final capacity. Multiplexing equipment at both ends is of *M4* type manufactured by L. M. Ericsson. The system is equipped, for the time being, with 120 + 12 circuits.

The international exchange routes the terminating traffic in Rio de Janeiro and São Paulo directly to corresponding local networks. Traffic to other points of Brazil is routed via Rio de Janeiro Class 1 transit exchange from which it is switched by the national system in a similar way to national traffic.

International satellite circuits exist to several European and American countries as per the table below (circuits in operation as per 1.1.70 within brackets).

---

Argentina	12 (6)	Italy	5 (3)	UK	5 (2)
Canada	4 (1)	Mexico	3 (1)	Uruguay	6
Chile	3 (1)	Peru	3 (1)	USA	27 (14)
Colombia	2	Portugal	5	Venezuela	3
France	6 (2)	Spain	3 (2)		
Germany	5 (2)	Switzerland	4 (1)		

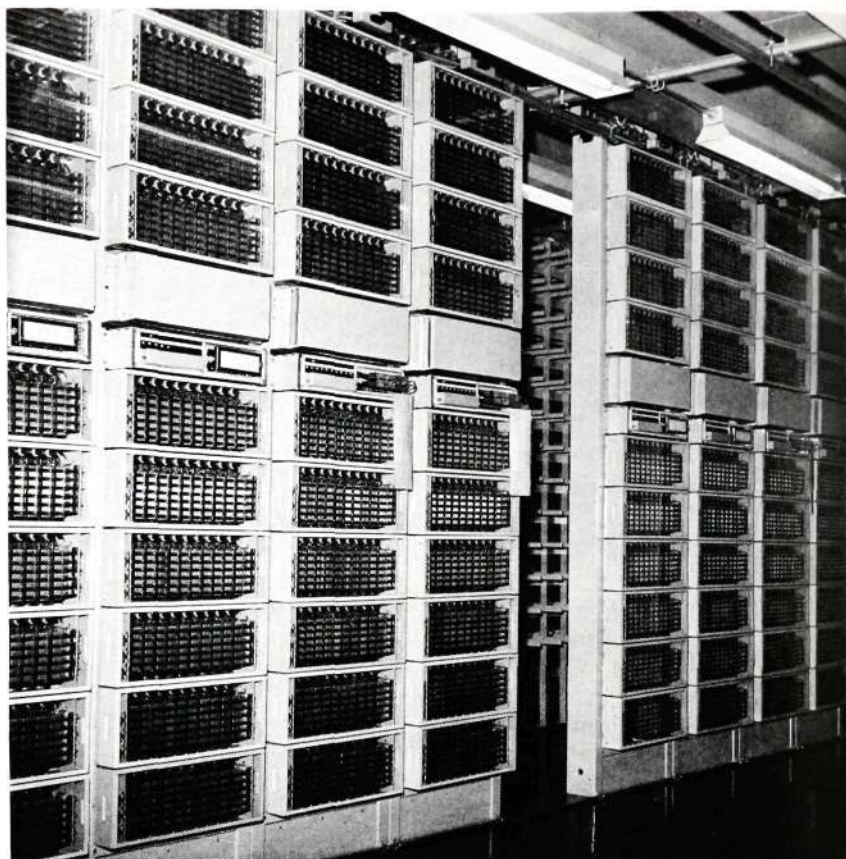
---

## Conclusion

This ambitious telecommunication development project being undertaken by EMBRATEL requires the parallel support of correlated fields, such as local and foreign telecommunication industries and agreements with technical and engineering schools for the supply of manpower. Local contractors were assigned special tasks all over Brazil for surveying the new routes, opening up

Fig. 6

Group selector racks at ARM exchange at  
Pôrto Alegre



most of the roads to the new antenna sites, erecting the buildings to house hundreds of repeater stations, most of them deep in unexplored equatorial jungle, and multistorey buildings in the heart of the major cities for 23 four-wire transit exchanges, totalling 22,490 trunks on Feb. 1, 1970.

Ericsson do Brasil's experience of the local manufacture of crossbar systems since 1957 played an important role when tendering for switching equipment, as contracts for most of the largest switching centres were granted to this company.

Effective cooperation between the technical staff of both companies permitted good solutions to the various problems involved in interconnecting the existing equipments of different operating principles and makes.

The results of such common efforts are now appearing. In December 1969 the Pôrto Alegre *ARM* exchange was put into service. During 1970 two *ARM* exchanges with a capacity of more than 5000 circuits each will be cut-over among others. These two exchanges located in Rio de Janeiro and São Paulo rank high among the highest capacity exchanges in the world.



# Telephone Traffic Research in Sweden

C. JACOBÆUS, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

UDC 513.21:654.15.02(093.3)  
LME 807  
0321

*This article is based upon a lecture presented in Tokyo in November 1969 to telephone engineers at the Laboratory of the Nippon Telegraph and Telephone Public Corporation NTT. The lecture was held within the framework of the Swedish Technical Mission to Japan arranged by the Swedish Academy of Engineering Sciences.*

The prominent position occupied in the world by the Swedish telephone industry and telephone service is a well known fact even in non-professional circles. The Swedish telephone industry — mainly L M Ericsson of course — has the entire world as its field and stands in the first rank within many spheres. The Swedish Telecommunications Administration can boast of a telephone density which is the second highest in the world. In the course of the years Sweden has also introduced a number of new features within the field of telephony. The crossbar switch systems were introduced on the world market by L M Ericsson around 1950 and gave our company a very strong position in the field of automatic telephony; the plastic telephone set, new carrier systems for coaxial cables etc. have been developed in Sweden. Sweden probably devotes a greater part of its resources to work within the telecommunication field than any other country.

It is perhaps difficult to analyse in detail the reasons for this state of affairs — here it may be said merely that an early interest on the part of industry created a tradition which has since been built upon. Naturally the prerequisites existed in the form of suitably trained manpower, venture capital and a market response, primarily in Sweden but later also to an increasing extent on the export market.



CONNY PALM

This article will be concerned with a field of significance for telephony, namely *telephone traffic research*. The role of telephone traffic research is naturally known — its aim is to provide a basis for the quantitative dimensioning principally of telephone plant. It thereby assumes a significance both for industry and for telephone operating enterprises. Industry acquires guiding lines as to how its systems should be built up and administrations can judge the quantity of investment needed and how investments should be distributed.

The first person in Sweden to engage in studies of telephone traffic problems was *Conny Palm*. During a 15-year period up to his death in 1951 he achieved a great deal within this field and gave Swedish telephone traffic research a place of international rank. The chief contribution made by Conny Palm was his doctor's thesis, "Intensitätsschwankungen im Fernsprechverkehr" (Ref. 13), in which he dealt with "inert variations" with an impressive expert knowledge and used a very advanced mathematical apparatus. He departed



C. JACOBÆUS



A. ELLDIN

from Erlang's assumption of statistical equilibrium and achieved results of a general applicability relating to variations in call intensity which lie outside the strict Poisson process.

Palm's work manifestly concerns the foundation for nearly all telephone traffic research, namely the mathematical model by which telephone traffic can be described. The practical significance of his work has perhaps not been so great — telephone traffic researchers in the past years have been concerned more with applications to plants and systems. But in the future a greater interest will inevitably be devoted to the nature of telephone traffic. Palm's work will then be a very essential point of departure. A sign of its continued interest is that his thesis will shortly be published in English.

Conny Palm also dealt with most "classical" problems within traffic research (Ref. 4, 8, 11, 15, 18, 19, 27). He was one of the first to establish exact expressions for the congestion in certain gradings (Ref. 2). He made use of the method of general equations of state for this purpose. He also studied delay problems (Ref. 5, 7, 14, 20, 21, 22, 26).

Conny Palm was in charge of the work on the first major analogue traffic machine in the world for congestion studies. This, too, was a pioneering achievement. This machine, which was constructed before the age of the electronic computers, was electromechanical and designed chiefly for studying gradings with sequential hunting. It was used for measuring a very large number of traffic cases in the 500-selector system.

Palm's interest in the question of how human behaviour affects telephone traffic was also manifested in a study of the annoyance caused by congestion (Ref. 10, 37).

Other persons who worked at an early stage with traffic problems were *N. Rönnblom* and *K. Lundkvist* (Ref. 3, 6, 12, 28). The earliest known publication of a traffic study was that by *R. Holm* in 1919 (Ref. 1).

Palm has had a very great significance for traffic research in Sweden. Through him Sweden advanced to the foremost rank in this field. He introduced modern statistical methods and methods of operational analysis. Subsequent research in Sweden has hardly matched his original achievements but has inherited his insistence on scientific stringency and integrity.

L. M. Ericsson and the Swedish Telecommunications Administration started to take an interest in the crossbar switching systems at the end of the forties.



These systems appeared to offer many advantages from the technical aspect. A difficulty, however, was that no simple and reliable methods for the computation of link systems existed. In the years 1947—1950 the author of this paper elaborated an approximative method for the calculation of congestion in these systems (Ref. 25, 31, 34). The method was published in his thesis, "A Study on Congestion in Link Systems" (Ref. 31). Very close agreement with measured values was obtained and the method may now be said to be a standard method used throughout the world. For L M Ericsson it had a very great significance since it permitted the design of crossbar systems with very good economy. This opened the way for the advance of L M Ericsson's automatic systems on the world market during the fifties and sixties.

A large number of studies on different types of link systems followed. Among other things the dependence between the loadings on secondary stages and outlets was studied (*Elldin*, Ref. 50, 70). Possibilities for more accurate calculation of link systems with high congestion and overflow traffic (*Wallström*, Ref. 71, 89, 98, 112) resulted from these studies.

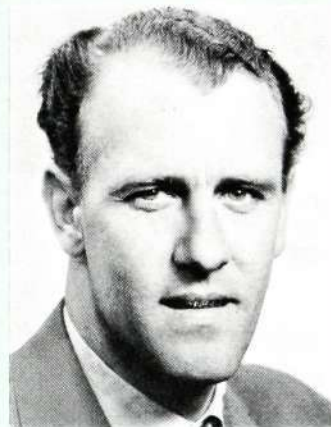
Apart from link systems, a large number of problems have been treated by *A. Elldin*. His doctor's thesis, "On the Congestion of Gradings with Random Hunting", dealt with a special type of grading (Ref. 41, see also 52). Elldin has also studied the use of general equations of state for a large number of different constellations of devices (Ref. 51, 53, 61, 101). Of great practical importance are his and his collaborators' studies of the capacity of the common control systems in the crossbar systems (Ref. 86).

The method of using a digital computer for traffic simulation was first demonstrated by *G. Neovius* in 1955 (Ref. 42). He dealt with certain simple gradings in this way. Neovius' method of simulation has since been developed into standard methods which are used throughout the world for traffic cases for which the theory is either too cumbersome or otherwise unsatisfactory (Ref. 62, 82, 91, 107, 108, 119). *K. M. Olsson*, in particular, has made valuable contributions to the development of simulation technique (Ref. 94, 99, 106).

In a long series of papers *Y. Rapp* has dealt with different problems concerning the planning of urban and trunk networks (Ref. 9, 32, 74, 77, 87, 88, 96, 111, 121, 128, see also 117). His results have been applied to a number of practical cases, with great savings as a result. Rapp has also treated with great success questions concerning the economic location of exchanges, and likewise problems relating to the most favourable stages of expansion for exchanges and cable networks. Rapp's work has met with a very great international appreciation.



Y. RAPP



K. M. OLSSON



*S. Ekberg* assisted *Palm* in the construction of the Swedish traffic machine and thereafter, during a number of years, was in charge of the measurements on the machine (Ref. 36, 44, 82, 83, 91). *Ekberg* has also studied gradings with the aid of derivative parameters of telephone traffic distribution functions (Ref. 45, 46, 63, 65).

Among other researchers may be mentioned *K. Lundkvist* who, in a number of theoretical studies, dealt with fundamental problems concerning the nature of telephone traffic (Ref. 29, 35, 40).

*K. M. Olsson* has studied, too, different problems concerning dispersion in traffic measurements (Ref. 47, 55, 85, 93, 99, 106). These types of problems were studied also by *G. Lind* (Ref. 103, 120, 127). *Olsson* has also developed further the theories for the full availability group and for simulations (Ref. 94, 106). He has also made simulation studies of different groupings. *I. Tänge*, apart from his work in C.C.I.T.T., has published valuable papers concerning alternative routing and gradings (Ref. 48, 54, 66, 73, 83, 92).

Measurements on systems in practical operation have early attracted a great interest among Swedish researchers. The first studies of this kind which included comprehensive measurements on systems with common control were made by *Conny Palm* (Ref. 13, 23). A new method for the investigation of the traffic conditions in crossbar systems was the so-called lamp panel method (*Elldin, Jacobæus, von Sydow*, Ref. 38). They recorded the occupation conditions in a switching system photographically at regular intervals. Important information was provided in this way concerning the distribution of states in different stages. During a number of years *Elldin* and *Tänge* have studied the traffic development on some routes from the Swedish city of Malmö (Ref. 66, 125). The studies were specially concerned with the seasonal variations and the growth of the telephone traffic. The work was mainly done as a contribution to C.C.I.T.T.'s studies for measuring and dimensioning international routes. The results from the measurements contributed to a great extent to the recommendation on this subject given by C.C.I.T.T. in 1964. Further results have been reported by *S. Westerberg* and *M. Anderberg* (Ref. 113, 124).

The studies by *Elldin* on the possibilities of taking into account traffic variations in the drawing up of congestion standards may be considered as a continuation and consequence of the above-mentioned measurements (Ref. 100).

Investigations by *H. Y. Kræpelien* concerning the influence on telephone traffic of the tariff system have provided interesting results which unfortunately, however, have not been followed up (Ref. 58, 59). *Rapp* has studied the dimensioning of telephone plant having regard to the value of the subscriber's time, by linking together congestion, service quality and transmission quality (Ref. 67, 68, 69, 72, 75). Here again further research is required for the achievement of results of practical significance.

Sweden has done much work within the field of telephone traffic theory in C.C.I.T.T. Mention may be made of the problems of dimensioning and optimization of alternative routes, general standards for the permissible level of congestion on international connections, etc.

Swedish work within the field of telephone traffic theory has been a recurrent feature at the international telephone traffic congresses. The Swedish participators have played a prominent role both as lecturers and in the discussions. The author was for that matter one of the initiators of these congresses. Many of the papers referred to above have been presented on these occasions. Other valuable contributions have been made by *G. Lind*, *G. Wikell*, *L. Håkansson*, *E. Szybicki*, *J. Gerstl Valenzuela* and others (Ref. 60, 76, 90, 92, 95, 97, 102, 107, 109, 110, 122, 123, 126).

These have been the main achievements during the last 30 years. A large number of other valuable papers and reports have been published (Ref. 16, 24,



S. EKBERG



B. WALLSTRÖM

30, 33, 39, 49, 57, 64, 116, 118). Several authors have published a large number of surveys or papers of a general nature or intended for teaching, and these have been valuable for studies in this field (Ref. 6, 56, 72, 78, 79, 80, 81, 84, 104, 105, 114, 115).

What is it that at present captures the interest of Swedish telephone traffic researchers? One may perhaps say that since solutions of many fundamental problems have been found, not many problems remain. But it is characteristic of all scientific work that solutions of one problem give rise to new ones. The same applies to telephone traffic research. The new type of computer-controlled exchanges that are now being marketed — stored-programme-controlled exchanges — have brought partially new problems concerning the call handling capacity of the computer (Ref. 110). Various optimization problems both within the exchange and within the line plant will also require much future work. Finally there is the problem of acquiring a more profound knowledge of the nature of telephone traffic and of subscriber reactions in different traffic situations. This field has perhaps been neglected since technique has been the dominant interest in the last 25 years.

Work within the telephone traffic field is being conducted both at L M Ericsson and at the Swedish Telecommunications Administration. Intimate cooperation has been established between these organizations, comprising discussion and allocation of assignments, joint measurement programmes, and evaluation of results. Manufacturer and Administration work hand in hand for the achievement of the best possible results.

At the institutes of technology research is also being done in this field, mostly in cooperation with L M Ericsson and the Administration. In Stockholm the work is being led by Professor *Stellan Ekberg*, earlier a member of the Administration's group of traffic researchers. At Lund the department is headed by Professor *Bengt Wallström*, formerly of L M Ericsson. Thanks to these prominent researchers, who are well versed in telephone traffic theory, students have been ensured the possibility of research and teaching under the best guidance. This provides industry and administration with an admirable basis for recruitment of researchers within the field.

The prominent position occupied by Swedish telephone traffic research is due naturally to the fact that managements within industry and administration have understood that this research is necessary for successful and internationally competitive work within telecommunications. Sweden has been able to foster a number of prominent researchers in this field, who have created a tradition — a tradition which we are anxious to maintain and develop.



## References

1. HOLM, R.: *Calculation of Congestion for Automatic Exchanges*. [In Swedish.] Tekn. Bil. K. Telegr.styr. Cirkulär 1919: 8—9, pp. 57—72.
2. PALM, C.: *Calcul exact de la perte dans les groupes de circuits échelonnés*. Ericsson Tech. 4(1936): 3, pp. 41—71.
3. LUNDKVIST, K.: *Calculation of the Grade of Service in Automatic Telephone Systems*. Ericsson Tech. 4(1936): 4, pp. 75—81.
4. PALM, C.: *Inhomogeneous Telephone Traffic in Full-Availability Groups*. Ericsson Tech. 5(1937): 1, pp. 3—36.
5. PALM, C.: *Étude des délais d'attente*. Ericsson Tech. 5(1937): 2, pp. 39—56.
6. RÖNNBLUM, N.: *Determination of the Number of Circuits and Connecting Devices in Telephony*. [In Swedish.] Tekn. Medd. K. Telegr.styr. 1937: 1, pp. 13—44.
7. PALM, C.: *Some Investigations about Waiting Times in Telephone Exchanges*. [In Swedish.] Tekn. Medd. K. Telegr.styr. 1937: 7—9, pp. 109—127.
8. PALM, C.: *Analysis of the Erlang Traffic Formulae for Busy-Signal Arrangements*. Ericsson Tech. 6(1938): 4, pp. 39—58.
9. RAPP, Y.: *Economic Stages of Extension of a Telephone Network*. Ericsson Tech. 7(1939): 5, pp. 87—96.
10. PALM, C.: *Service Quality of Telephone Plants*. [In Swedish.] Ericsson Rev. 17(1940): 3, pp. 66—76.
11. PALM, C.: *Accuracy of Traffic Volume Estimates Obtained by Periodical Sampling*. [In Swedish.] Tekn. Medd. K. Telegr.styr. 1941: 7—9, pp. 97—115.
12. LUNDKVIST, K.: *Determination of the Congestion Probability for so called Common Group Connections*. [In Swedish.] Tekn. Medd. K. Telegr.styr. 1942: 4—6, pp. 49—61.
13. PALM, C.: *Intensitätsschwankungen im Fernsprechverkehr*. Thesis. Ericsson Tech. 1943: 44, 187 pp.
14. PALM, C.: *A Form Factor for Judging Waiting Time Distributions*. [In Swedish.] Tekn. Medd. K. Telegr.styr. 1943: 1—3, pp. 1—6.
15. PALM, C.: *Some Corollaries to the Erlang Formulae*. [In Swedish.] Tekn. Medd. K. Telegr.styr. 1943: 1—3, pp. 6—8.
16. MODÉE, G.: *On Internal Congestion and the Calculation of Associated Losses*. [In Swedish.] Tekn. Medd. K. Telegr.styr. 1943: 1—3, pp. 14—24.
17. PALM, C.: *New Results in Telephone Traffic Research*. [In Swedish.] Tekn. Medd. K. Telegr.styr. 1944: 4—5, pp. 53—99.
18. PALM, C.: *Some Propositions Regarding Flat and Steep Distribution Functions*. Tele 1957: 1, pp. 3—17. English ed. [First published in Swedish in Tekn. Medd. K. Telegr.styr. 1946: special issue.]
19. PALM, C.: *Some Observations on the Erlang Formulae for Busy-Signal Systems*. Tele 1957: 1, pp. 18—36. English ed. [First published in Swedish in Tekn. Medd. K. Telegr.styr. 1946: special issue.]
20. PALM, C.: *Contribution to the Theory on Delay Systems*. Tele 1957: 1, pp. 37—67. English ed. [First published in Swedish in Tekn. Medd. K. Telegr.styr. 1946: special issue.]
21. PALM, C.: *Waiting Times with Random Served Queue*. Tele 1957: 1, pp. 68—87. English ed. [First published in Swedish in Tekn. Medd. K. Telegr.styr. 1946: special issue.]
22. PALM, C.: *Duration of Congestion States in Delay Systems*. Tele 1957: 1, pp. 88—107. English ed. [First published in Swedish in Tekn. Medd. K. Telegr.styr. 1946: special issue.]
23. PALM, C.: *Fluctuations of Measured Telephone Traffic*. Tele 1957: 2, pp. 1—9. English ed. [First published in Swedish in Tekn. Medd. K. Telegr.styr. 1946: 3, pp. 127—135.]
24. JACOBÆUS, C.: *Influence of the Size of Selectors on the Number of Selectors in Telephone Plants*. Ericsson Rev. 24(1947): 1, pp. 2—9.
25. JACOBÆUS, C.: *Blocking Computations in Link Systems*. Ericsson Rev. 24(1947): 3, pp. 86—100.
26. PALM, C.: *Waiting Times when Traffic has Variable Mean Intensity*. Ericsson Rev. 24(1947): 4, pp. 102—108.
27. PALM, C.: *Recording of Calls*. [In Swedish.] Tekn. Medd. K. Telegr.styr. 1947: 1, pp. 1—15.



28. LUNDKVIST, K.: *Calculation of the Congestion Probability for Telephone Traffic with Non-Random Call Distribution*. [In Swedish.] Tekn. Medd. K. Telegr.styr. 1947: 2, pp. 68—85.
29. LUNDKVIST, K.: *Method of Computing the Grade of Service in a Selection Stage Composed of Primary and Secondary Switches*. Ericsson Rev. 25(1948): 1, pp. 11—17.
30. MODÉE, G.: *Calculations of Congestion for the Link System of the Swedish Telecommunications Administration*. [In Swedish.] Tekn. Medd. K. Telegr.styr. 1948: 1, pp. 9—22.
31. JACOBÆUS, C.: *A Study on Congestion in Link Systems*. Thesis. Ericsson Tech. 1950: 48, 68 pp.
32. RAPP, Y.: *The Economic Optimum in Urban Telephone Network Problems*. Thesis. Ericsson Tech. 1950: 49, 132 pp.
33. MODÉE, G.: *Congestion Calculations for the SLV-Units in the Crossbar System A-204*. Tele 1950: 2, pp. 13—24. English ed.
34. JACOBÆUS, C.: *Theoretical Aspects of Crossbar Exchange Design*. Ericsson Rev. 28(1951): 4, pp. 104—110.
35. LUNDKVIST, K.: *General Theory for Telephone Traffic*. Ericsson Tech. 9(1953): 2, pp. 111—140.
36. EKBERG, S.: *The Telephone Traffic Machine*. Tele 1953: 1, pp. 51—57. English ed.
37. PALM, C.: *Methods of Judging the Annoyance Caused by Congestion*. Tele 1953: 2, pp. 1—20. English ed.
38. ELLDIN, A., JACOBÆUS, C. & SYDOW, L. VON: *Traffic Measurements with Lamp Panel*. Ericsson Tech. 10(1954): 1, pp. 107—187.
39. SYDOW, L. VON: *On the Accuracy of Traffic Values Determined with the Aid of an Ah-meter*. Ericsson Tech. 10(1954): 2, pp. 309—323.
40. LUNDKVIST, K.: *Analysis of General Theory for Telephone Traffic*. Ericsson Tech. 11(1955): 1, pp. 3—32.
41. ELLDIN, A.: *On the Congestion in Gradings with Random Hunting*. Ericsson Tech. 11(1955): 1, pp. 33—94.
42. NEOVIUS, G.: *Artificial Traffic Trials Using Digital Computers*. Ericsson Tech. 11(1955): 2, pp. 279—291.
43. ELLDIN, A.: *Automatic Telephone Exchanges Based on the Link Connection Principle. Switch Calculations. General Survey*. L M Ericsson, Ordering No. 0218720 Ue, 3rd ed. Stockholm 1969. [First ed. 1955.]
44. EKBERG, S.: *Telephone Traffic Research with the Aid of the Swedish Traffic Analyser*. Tele 1955: 1, pp. 1—29. English ed.
45. EKBERG, S.: *Approximate Calculation of Loss in Gradings*. [In Swedish.] Tele 1955: 1, pp. 35—40.
46. EKBERG, S.: *Approximate Calculation for the Individual Traffic Sources of Loads and Losses on the Common Circuits of Gradings*. [In Swedish.] Tele 1955: 2, pp. 80—83.
47. OLSSON, K. M.: *Some Recording Principles Applied in Time-Zone Metering*. Tele 1956: 1, pp. 1—7. English ed.
48. TÅNGE, I.: *Optimal Use of Both-Way Circuits in Cases of Unlimited Availability*. Tele 1956: 1, pp. 8—16. English ed.
49. ELLDIN, A. & LIND, G.: *Statistical Methods for Supervision of Telephone Exchanges and Networks*. Ericsson Tech. 12(1956): 1, pp. 3—28.
50. ELLDIN, A.: *On Equations of State for a Two-Stage Link System*. Ericsson Tech. 12(1956): 1, pp. 61—104.
51. ELLDIN, A.: *A Survey of the Applicability of Equations of State in the Theory of Telephone Traffic*. Ericsson Tech. 13(1957): 1, pp. 143—157.
52. ELLDIN, A.: *Further Studies on Gradings with Random Hunting*. Ericsson Tech. 13(1957): 2, pp. 175—257.
53. ELLDIN, A.: *Applications of Equations of State in the Theory of Telephone Traffic*. Thesis. Stockholm 1957.
54. TÅNGE, I.: *Optimum Methods for the Designing of Routes and Number of Lines in Telephone Networks with Alternative Traffic Routes*. Tele 1959: 2, pp. 49—70. English ed. [First published in Swedish in Tele 1957: 1, pp. 1—21.]
55. OLSSON, K. M.: *Calculation of Dispersion in Telephone Traffic Recording Values for Pure Chance Traffic*. Tele 1959: 2, pp. 71—78. English ed. [First published in Swedish in Tele 1957: 4, pp. 213—220.]
56. ELLDIN, A.: *Brief Presentation of the Theory of Telephone Traffic*. Ericsson Rev. 35(1958): 1, pp. 13—22.

57. SWENSSON, O.: *An Approach to a Class of Queuing Problems*. Ericsson Tech. 14(1958): 1, pp. 71—90.
58. KRÆPELIEN, H. Y.: *The Influence of Telephone Rates on Local Traffic*. Ericsson Tech. 14(1958): 2, pp. 103—180.
59. LEUNBACH, G.: *Factors Influencing the Demand for Telephone Service*. Ericsson Tech. 14(1958): 2, pp. 181—196.
60. LIND, G.: *Statistical Supervision of Telephone Plant*. Ericsson Tech. 14 (1958): 2, pp. 197—220.
61. CARLSSON, S. G. & ELLDIN, A.: *Solving Equations of State in Telephone Traffic Theory with Digital Computers*. Ericsson Tech. 14(1958): 2, pp. 221—244.
62. WALLSTRÖM, B.: *Artificial Traffic Trials on a Two-Stage Link System Using a Digital Computer*. Ericsson Tech. 14(1958): 2, pp. 259—289.
63. EKBERG, S.: *Determination of the Traffic-Carrying Properties of Gradings with the Aid of Some Derivative-Parameters of Telephone Traffic Distribution Functions*. Thesis. Tele 1958: 1, pp. 1—93. English ed.
64. RÖNNBLÖM, N.: *Traffic Loss of a Circuit Group Consisting of Both-Way Circuits, which is Accessible for the Internal and External Traffic of a Subscriber Group*. Tele 1959: 2, pp. 79—92. English ed.
65. EKBERG, S.: *Approximate Calculation of Traffic Rejected from Gradings*. [In Swedish.] Tele 1959: 3, pp. 147—168.
66. ELLDIN, A. & TÄNGE, I.: *Long-Time Observations of Telephone Traffic*. Tele 1960: 1, pp. 21—40. English ed.
67. RAPP, Y.: *Extension of Telephone Plant with Regard to the Value of Subscribers' Time. I. Economic Optimum for Conductor Diameter and Number of Switches on Telephone Circuits*. Ericsson Tech. 17(1961): 1, pp. 3—59.
68. RAPP, Y.: *Extension of Telephone Plant with Regard to the Value of Subscribers' Time. II. Extension of Telephone Plant to Match a Growing Need*. Ericsson Tech. 17(1961): 1, pp. 61—101.
69. RAPP, Y.: *Extension of Telephone Plant with Regard to the Value of Subscribers' Time. III. The Reference Equivalent within a National Network*. Ericsson Tech. 17(1961): 2, pp. 151—182.
70. ELLDIN, A.: *On the Dependence between the Two Stages in a Link System*. Ericsson Tech. 17(1961): 2, pp. 183—259.
71. WALLSTRÖM, B.: *Alternative Routing in a Two-Stage Link System. Congestion Theory and Simulated Traffic Studies*. Ericsson Tech. 17(1961): 2, pp. 261—285.
72. RAPP, Y.: *Extension of Telephone Plant with Regard to the Value of Subscribers' Time*. Ericsson Rev. 38(1961): 4, pp. 92—100.
73. EINARSSON, K.-A., HÅKANSSON, L., LUNDGREN, E. & TÄNGE, I.: *Simplified Type of Grading with Skipping*. Tele 1961: 2, pp. 74—96. English ed.
74. RAPP, Y.: *Calculation of Traffic Distributions in Multi-Exchange Networks*. Ericsson Tech. 18(1962): 1, pp. 3—33.
75. HANSSON, H. & LIND, G.: *Estimation of the Increase in Conversation Time as Function of the Overall Reference Equivalent of a Telephone Circuit*. Ericsson Tech. 18(1962): 1, pp. 35—59.
76. CHRISTIANSEN, U. & LIND, G.: *Maintenance of Telephone Plant from Statistical and Economic Aspects*. Ericsson Tech. 18(1962): 1, pp. 61—88.
77. RAPP, Y.: *Planning of Exchange Locations and Boundaries in Multi-Exchange Networks*. Ericsson Tech. 18(1962): 2, pp. 91—113.
78. RAPP, Y.: *Planning of Multi-Exchange Networks with Aid of a Computer. I. Locations and Boundaries of Exchanges in Multi-Exchange Areas*. Ericsson Rev. 39(1962): 2, pp. 44—47.
79. RAPP, Y.: *Planning of Multi-Exchange Networks with Aid of a Computer. II. Inter-Exchange Traffic*. Ericsson Rev. 39(1962): 2, pp. 47—50.
80. RAPP, Y.: *Planning of Multi-Exchange Networks with Aid of a Computer. III. Planning of Junction Circuits in Multi-Exchange Networks. Some Fundamental Principles*. Ericsson Rev. 39(1962): 4, pp. 102—104.
81. RAPP, Y. & OLLUS, Y.: *Practical Application of the Planning of Multi-Exchange Networks with Aid of a Computer. Exchange Locations and Boundaries*. Ericsson Rev. 39(1962): 4, pp. 105—111.
82. EKBERG, S. & HARMSSEN, A.: *Studies on Simulated Traffic in Large Telephone Exchanges*. Tele 1962: 1, pp. 25—46. English ed.
83. EKBERG, S., REINHOLDSSON, S. & TÄNGE, I.: *Traffic Measurements on an Alternative Network in Sweden*. Tele 1962: 2, pp. 117—124. English ed.



84. ELLDIN, A. & LIND, G.: *Elementary Telephone Traffic Theory*. L. M. Ericsson, Ordering No. Dhu 105B Ue, 3rd ed. Stockholm 1967. [First ed. 1962.]
85. OLSSON, K. M.: *Calculation of the Accuracy of Congestion State Counters*. [In Swedish.] *Tele* 1963: 1, pp. 12—20.
86. BJÖRKLUND, M. & ELLDIN, A.: *A Practical Method of Calculation for Certain Types of Complex Common Control Systems*. *Ericsson Tech.* 20(1964): 1, pp. 3—75.
87. RAPP, Y.: *Planning of Junction Network in a Multi-Exchange Area. I. General Principles*. *Ericsson Tech.* 20(1964): 1, pp. 77—130.
88. RAPP, Y.: *The General Plan for a Multi-Exchange Area*. *Ericsson Tech.* 20(1964): 2, pp. 171—182.
89. WALLSTRÖM, B.: *A Distribution Model for Telephone Traffic with Varying Call Intensity, Including Overflow Traffic*. *Ericsson Tech.* 20(1964): 2, pp. 183—202.
90. SZYBICKI, E.: *Some Numerical Methods Used for Telephone Traffic Theory Applications*. *Ericsson Tech.* 20(1964): 2, pp. 203—229.
91. EKBERG, S. & HARMSSEN, A.: *Measurements of Handled Traffic Intensity and Occurring Call Congestion in a Simulated Telephone Exchange*. *Tele* 1964: 1, pp. 1—3. English ed.
92. TÄNGE, I. & WIKELL, G.: *Comparative Studies of Congestion Values Obtained in Gradings when Holding-Times are Constant Respectively Follow the Negative-Exponential Distribution Law*. *Tele* 1964: 2, pp. 96—106. English ed.
93. OLSSON, K. M.: *On the Accuracy of Results from Certain Types of Counters Used for Traffic Supervising Purposes*. *Tele* 1964: 2, pp. 106—112. English ed.
94. OLSSON, K. M.: *Simulation on Computers. A Method for Determining the Traffic-Carrying Capacities of Telephone Systems*. *Tele* 1970: 1, pp. 39—57. English ed. [First published in Swedish in *Tele* 1964: 4, pp. 271—294.]
95. GERSTL VALENZUELA, J.: *Study of Certain Types of Cyclic Gradings for Random Hunting*. *Ericsson Tech.* 21(1965): 1, pp. 111—184.
96. RAPP, Y.: *Planning of Junction Network in a Multi-Exchange Area. II. Extensions of the Principles and Applications*. *Ericsson Tech.* 21(1965): 2, pp. 187—240.
97. LIND, G.: *A Class of Stochastic Processes Applicable to the Control of Service Quality in Telephone Systems*. *Ericsson Tech.* 21(1965): 2, pp. 269—315.
98. WALLSTRÖM, B.: *Congestion Studies in Telephone Systems with Overflow Facilities*. Thesis. *Ericsson Tech.* 22(1966): 3, pp. 187—351.
99. OLSSON, K. M.: *Some Accuracy Problems by Traffic Supervision in a Full Availability Group*. [In Swedish.] Report No. TTS 4—66, K. Tekn. Högskolan, Stockholm 1966, 29 pp.
100. ELLDIN, A.: *Dimensioning for the Dynamic Properties of Telephone Traffic*. *Ericsson Tech.* 23(1967): 3, pp. 315—344.
101. ELLDIN, A.: *Approach to the Theoretical Description of Repeated Call Attempts*. *Ericsson Tech.* 23(1967): 3, pp. 345—407.
102. SZYBICKI, E.: *Numerical Methods in the Use of Computers for Telephone Traffic Theory Applications*. *Ericsson Tech.* 23(1967): 4, pp. 439—475.
103. LIND, G.: *Accuracy of Traffic Measurements in a Poisson Traffic Process. Arbitrary Distribution of Intervals between Observations and Fixed Measuring Period*. *Ericsson Tech.* 23(1967): 4, pp. 477—504.
104. RAPP, Y. & ERIKSSON, B.: *Planning of Junction Networks with the Aid of a Computer*. *Ericsson Rev.* 44(1967): 2, pp. 77—84.
105. JACOBÆUS, C. & ELLDIN, A.: *Telephone Traffic Theory — Present Status and Future Trends*. *Ericsson Rev.* 44(1967): 4, pp. 153—168.
106. OLSSON, K. M.: *Some Different Methods in Using Markov Chains in Discrete Time Applicable to Traffic Simulations and Certain Accuracy Problems in this Context*. Fifth Int. Teletraffic Congr., New York 1967. [Abbreviated version of paper published in Swedish in *Tele* 1967: 4, pp. 255—274.]
107. HÅKANSSON, L.: *Some Further Studies on Optimal Grading Design*. Fifth Int. Teletraffic Congr., New York 1967.
108. LUNDGREN, E.: *Two-, Three-, and Four-Stage Link Systems — a Comparison between Congestion Results Obtained from Calculation and Simulation*. Fifth Int. Teletraffic Congr., New York 1967.



109. WIKELL, G.: *On the Consideration of Waiting-Times of Calls Departed from the Queue of a Queuing System*. Fifth Int. Teletraffic Congr., New York 1967.
110. BJÖRKLUND, M. & NORÉN, L. O.: *Traffic Design and Engineering of a Stored Program Controlled Telephone System*. Fifth Int. Teletraffic Congr., New York 1967.
111. RAPP, Y.: *Planning of Junction Network in a Multi-Exchange Area. III. Optimum Types of Physical and Carrier Circuits*. Fifth Int. Teletraffic Congr., New York 1967.
112. WALLSTRÖM, B.: *Survey of Congestion Studies in Telephone Systems with Overflow Facilities*. Fifth Int. Teletraffic Congr., New York 1967.
113. ELLDIN, A. & WESTERBERG, S.: *Traffic Growth and Seasonal Variations in Subscriber Habits. Some Results from Seven Years Daily Measurements on Two Trunk Routes in Sweden*. Third Int. Symp. on Human Factors in Telephony. The Hague 1966. PTT-Bedrijf 15(1967): 1/2, pp. 175—196.
114. RAPP, Y.: *Some Economic Aspects on the Long-Term Planning of Telephone Networks. Part I*. Ericsson Rev. 45(1968): 2, pp. 61—71.
115. RAPP, Y.: *Some Economic Aspects on the Long-Term Planning of Telephone Networks. Part II*. Ericsson Rev. 45(1968): 3, pp. 122—136.
116. OLSSON, K. M.: *The Waiting Time Distribution for Random Service*. [In Swedish.] Tele 1968: 1, pp. 59—62.
117. WALLSTRÖM, B.: *Methods for Optimizing Alternative Routing Networks*. Ericsson Tech. 25(1969): 1, pp. 3—28.
118. RAPP, Y. & OHLSSON, E.: *Separation of Multiplex and Physical Circuits in Trunk and Local Networks*. Ericsson Rev. 46(1969): 2, pp. 59—64.
119. EKBERG, S. & GRUSZECKI, M.: *Artificial Traffic Study on a 3-Stage Link System with Resetting and Loss-Delay Facilities*. Elect. Commun. 44 (1969): 1, pp. 33—38.
120. LIND, G.: *Accuracy of Traffic Measurements in a Poisson Traffic Process. Arbitrary Distribution of Intervals between Observations and Fixed Number of Observations*. Ericsson Tech. 25(1969): 4, pp. 211—246.
121. RAPP, Y.: *The Use of Dynamic Programming for Planning of Extensions of Conduits and Main Cable Networks in a Local Exchange Area*. Ericsson Rev. 46(1969): 3, pp. 102—112.
122. HAKANSSON, L.: *A GPSS-Simulation for the Study of the Capacity of a SPC Exchange Computer*. Sixth Int. Teletraffic Congr., Munich 1970.
123. WIKELL, G.: *Manual Service Criteria*. Sixth Int. Teletraffic Congr., Munich 1970.
124. ANDERBERG, M. & WESTERBERG, S.: *Covariation of Traffic in an Alternative Routing Network. Observations from Malmö Transit Exchange*. Sixth Int. Teletraffic Congr., Munich 1970.
125. ELLDIN, A.: *On the Extent of Routine Measurements in Telephone Plant. An Operational Research Approach*. Sixth Int. Teletraffic Congr., Munich 1970.
126. FAKHR EL DIN, M. E.: *Comparison between Measured and Calculated Values in a Link System with Overflow Facility*. Sixth Int. Teletraffic Congr., Munich 1970.
127. LIND, G.: *Accuracy in Measurements of the Mean of a Markov Process. Arbitrary Distribution of Intervals between Observations and Fixed Number of Observations or Fixed Measuring Period*. Sixth Int. Teletraffic Congr., Munich 1970.
128. RAPP, Y.: *Planning of Junction Network with Non-Coincident Busy Hours*. Sixth Int. Teletraffic Congr., Munich 1970.

# Equipment for Maintenance of ARM 20 and ARM 50 Automatic Telephone Exchanges

V. ERIKSSON, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

UDC 621.395.722.7  
LME 1548

*Ericsson Review No. 2, 1966, under the heading "Centralization Trends in Exchange Maintenance", contains an account of the maintenance philosophy recommended by L M Ericsson and of how maintenance work can be rationalized through centralization.<sup>1</sup>*

*The present article contains a brief account of the standard equipment used for maintenance of ARM 20 and ARM 50 exchanges and of the automatic transmission measuring equipment used on the trunk lines.*

Owing to the high requirements placed on the reliability of circuitry, cross-bar switches and components, the ARM exchanges are highly reliable in operation. This is an ensurance of cheap maintenance, as confirmed also by many administrations.<sup>2</sup>

But even if the fault rate is very low, it is important that disturbances which affect the traffic should be immediately indicated and that means should exist for tracing of faults. This requirement is fulfilled with a minimum of manual labour as equipment is available which automatically supervises the functional quality and provides indications when it becomes unsatisfactory. This equipment is supplemented by supervisory circuits, built into common control devices, which indicate disturbances in the function of these devices.<sup>3</sup>

## Maintenance Equipments

The maintenance philosophy recommended by L M Ericsson is called "controlled corrective maintenance". It is very labour-saving and presumes the use of extremely reliable maintenance equipment, the objectivity of which cannot be doubted. Such maintenance equipments are described below.

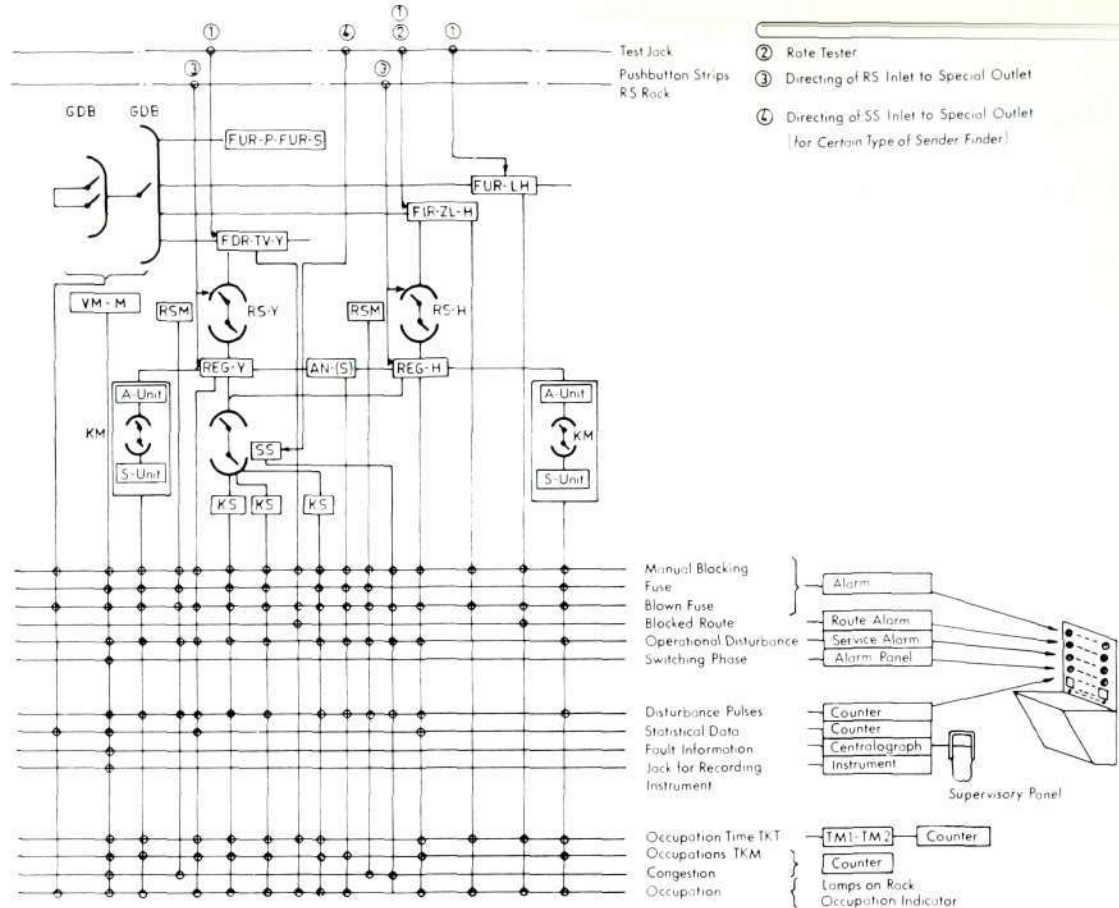
They may be divided into six groups for the following purposes:

- supervision
- indication
- fault tracing and testing of switching equipment
- repair of faults
- traffic measurements
- centralized supervision
- tests of trunk circuits

## Supervisory Equipments

Figs 1 and 2 show how different equipments continuously supervise the function of the ARM 20 and ARM 50 exchanges.

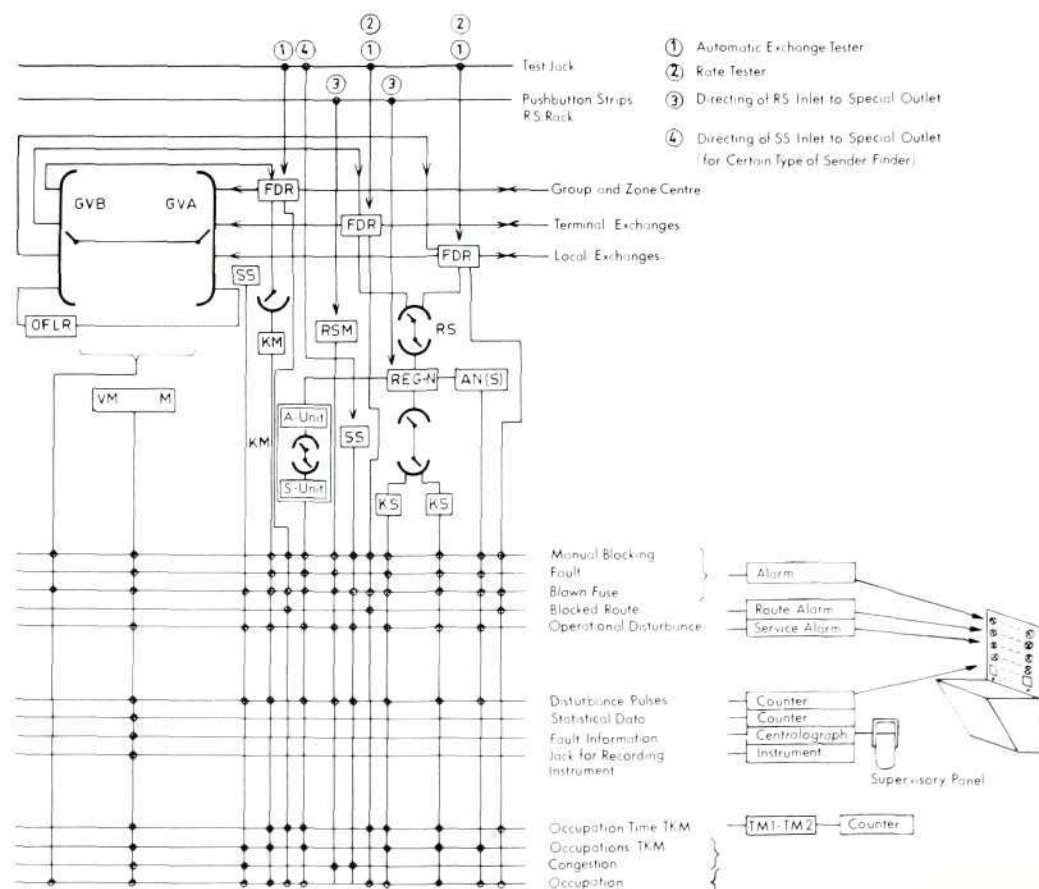
The information from the built-in supervisory equipment is then analysed, in most cases entirely automatically, and the results are presented on a CENTRALOGRAPH or at the observation desk.



**Fig. 1**  
Test and supervisory facilities for ARM 20

For the *ARM* exchanges the centralograph equipment is one of the chief aids for supervising the grade of service through the exchange. The equipment is standard for *ARM 20* and can also be connected to *ARM 50* exchanges, since provision for this purpose has been made in the route marker. Whether *ARM 50* should be equipped with a centralograph or not must be decided from case to case.

**Fig. 2**  
Test and supervisory facilities for ARM 50





Normally the fault rate is low and consists of temporary faults which it does not pay to search for. If a serious fault occurs, the fault rate rises in a sudden jump. For quick information of such a condition the common control devices are equipped with an equipment for "disturbance ratio supervision". A "disturbance memory" in the form of a relay chain sums the number of disturbances. At the same time the number of occupations is summed on a counter which can be preset to a given level. When this counter records the preset number of occupations, the disturbance memory is zeroed. If the number of disturbances is too large before zeroing takes place, a "service alarm" is issued. The disturbance ratio, i.e. the number of permissible faults for a given number of occupations, is chosen at a level such as to avoid alarms resulting from temporary random faults but to ensure that an alarm is issued on a sudden increase caused by persistent faults. The disturbance ratio can be set at a very much higher level than the average fault rate.

The following devices are equipped with disturbance memories:

- route marker (*VM*)
- marker (*M*)
- register (*REG*)
- register finder (*RS*)
- sender finder (*SS*)
- code sender (*KS*)

## Supervision of outgoing Routes

The junction relay sets are blocked in the event of a fault and an alarm is issued. For route supervision the blocking alarm circuit for all junction relay sets on a route is connected to a detecting relay in blocked route alarm relay set. This relay set contains circuits for 10 routes, and by means of strapping per route one can decide the number of blocked devices for which a route alarm shall be issued. When a device on a route has been blocked, its alarm lamp glows faintly but changes to a bright light when the preset number of blocked junction relay sets has been reached. Only then is an alarm issued.

When special importance is attached to the traffic carrying capacity of a given route, the congestion tendency can be supervised with a disturbance memory, a so-called route congestion alarm relay set. Automatic zeroing can be done either at specific time intervals or after a given number of occupations. If the number of congestion conditions within an interval exceeds a preset value, an alarm is issued.

## Indication Equipments

### Alarm System

This system is so arranged that the type of alarm — e.g. blown fuse, service alarm, blocking, locking — is indicated on lamps on the relay set or rack where the fault has occurred.

For indication on the suite supervisory equipment or on centrally placed alarm panels, a category of alarm is instead issued which indicates how quickly action must be taken.

Fault alarms are divided into the following categories:

- A1 fault which must be repaired immediately, both within and outside working hours (day and night)
- A2 fault for repair as soon as possible, but only in normal working hours
- A3 fault which can be repaired when convenient.

Observation alarms are divided into the following categories:

- 01 condition which must be investigated as soon as possible, but only in normal working hours
- 02 condition which can be remedied when convenient.

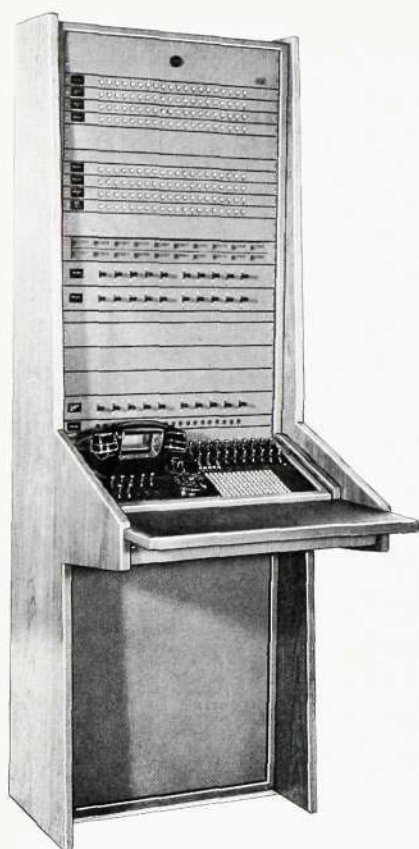


Fig. 3  
Supervisory panel for ARM

## Supervisory Panel

As will have been apparent from the above remarks, lamps, counters and keys are required for operation of the supervisory equipments and for indication of the results. For effective supervision, and at the same time to keep the maintenance personnel outside the switchroom as far as possible, it has been arranged that all operation and indication from the supervisory equipments take place on a supervisory panel in a room outside the switchroom. Fig. 3 shows a supervisory panel for an *ARM* exchange.

The supervisory panel contains counters used for statistics and analysis of disturbances from registers, code senders, code receivers, register finders, sender finders, route markers and markers.

## Occupation Indicator

For deciding whether a condition is caused by the traffic load in the exchange or faults in the switching equipment, it is important to know whether all available switching paths in the group in which the congestion occurs are being utilized. For this purpose every crossbar switch vertical has been furnished with a supervisory circuit connected to a terminal of a 200-point jack in the rack jack box.

An occupation indicator can be connected to the jack. When a vertical is occupied, a hole is burnt in a replaceable metallized chart.

At the end of the test one can decide from the holes in the chart whether all verticals have been in operation.

## *Equipment for Fault Tracing and Testing of Switching Equipment*

When fault indications or statistics show that fault tracing is required, special units are used for supervision and testing of individual devices.

## Automatic Exchange Tester for ARM 20 and ARM 50

The automatic exchange tester connects to one of the junction relay sets *FIR*, *FUR* or *FDR*, and is thus intended chiefly for testing of these units. When connected to an *FIR* or *FDR* (incoming traffic), however, the tester can

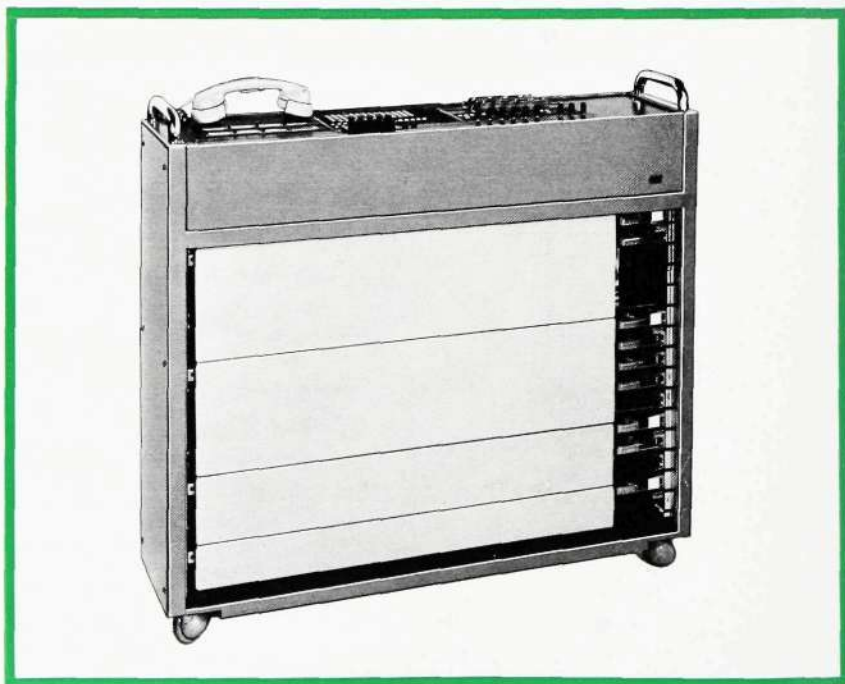
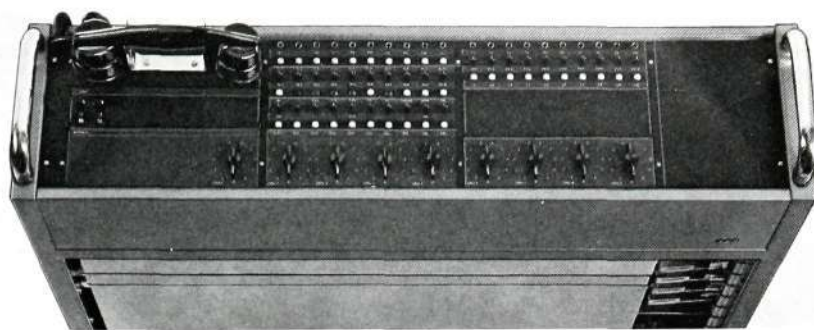


Fig. 4  
Exchange tester



Fig. 5  
Rate tester



be used for testing a given register, as RS has a built-in device which enables a connection to be directed from a given inlet to a given outlet. This device is controlled from pushbutton strips on the jack box of the RS rack. If the exchange is equipped with a 20-pole sender finder, moreover, "control box", a unit for directing calls in code sender finders SS, can be connected to the sender finder. In this way the connection can be directed from a given register to a given code sender or code receiver. Means thus exist for testing of registers, code senders and code receivers with the exchange tester. The exchange tester has statistical counters and a lamp on which the switching procedure can be followed.

### Rate Tester

The rate tester connects to *FIR* or *FDR* and is designed for testing of the metering circuits in these devices. Indirectly the rate determination in *VM* is also tested.

The rate tester has the same mechanical design as the exchange tester and can in most cases also be used as such. The rate tester is used when the exchange has no toll ticketing equipment.<sup>4</sup>

### Lamp Panel for Recording of Switching Processes (DKL)

For ease of fault tracing, recording contacts have been introduced on certain relays in route marker and marker. The contacts are wired to jacks and, by connecting *DKL*, which in principle is a lamp panel with relay memory, information can be obtained as to which relays in the route marker and marker are operated when a disturbance occurs.

### Multirecorder

The multirecorder is used for simultaneous recording of a number of functions (max. 30). As the recorder has a high impedance inlet, it can be connected either directly to a relay winding or to the jacks referred to above, or to special measuring contacts placed on the relay armatures. From the multirecorder chart one can read how the supervised relays work in relation to one another in time (fig. 6).



Fig. 6  
Multirecorder







**Fig. 10**  
Electronic time meter

## Equipment for Analysis of Disturbances

In case of a service alarm from a group of devices, e.g. a register, code sender or marker, fault tracing is simplified if the group of devices or marker is connected to special analysis counters.

For devices within a group a record is obtained of individual occupations and disturbances, and one can easily see which device has the highest fault rate.

For the markers the counters are connected so that, in addition to occupations, a record is obtained of the number of disturbances in different switching phases, from which conclusions can be drawn for fault tracing.

## Other Instruments

Various instruments can be used for special investigations, e.g. *MFC* tester, electronic time meter (fig. 10), pulse timers and recorders of different types.

## Filing of Circuit Diagrams

If circuit diagrams are kept in a file and taken out when required, there is a risk that in due course they will become torn or dirtied. By placing often used circuit diagrams in a plastic pocket file they are readily available when required and do not become dirty or torn. Plastic pocket files are supplied in three sizes.

## Equipment for Fault Repair

Even if faults in relays and switches occur very seldom, there must be special tools for adjustment or replacement of components. A tool cabinet (fig. 11) contains the necessary tools for a large crossbar exchange. At small unattended exchanges the tools need not be kept at the exchange but can be carried by the maintenance-man in a tool case (fig. 12).

**Fig. 11 (left)**  
Tool cabinet

**Fig. 12 (right)**  
Maintenance tool case





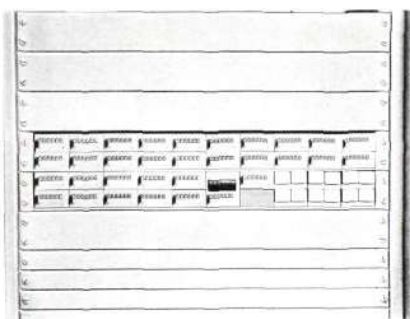


Fig. 13  
Stationary traffic meter

## Equipment for Traffic Measurement

The traffic intensity, *TKT*, is measured with an automatic traffic meter. Depending on the size of the exchange and the desires of the administration, this traffic meter can be either permanently installed or portable. *TKT* wires from 20 devices are interconnected into a group on the *I.D.F.* Connection to the jack of the traffic meter is thereafter done in such a way that, if possible, all devices of the same type, e.g. *FIR*, can be measured simultaneously.

The traffic meter scans the number of occupied devices in every group 100 times during an hour. On every scan the number of occupied devices in the group is recorded on individual counters. The meter can be started and stopped automatically. The number of scans can be preset on a zeroable counter.

The permanently installed traffic meter can at the same time measure the traffic intensity of  $20 \times 60$  devices and consists of relays for automatic connection of the *TKT* wires, measuring equipment, and counters for the groups of devices to be measured (fig. 13).

With an auxiliary unit *TMVS* four programmes can be selected with keys, with 1200 devices in each programme.

The number of occupations, *TKM*, is measured on separate counters. For measurement of *TKM* during the same period as *TKT*, the voltage to the *TKM* counters is steered via a relay in the traffic meter.

The portable traffic meter is assembled in two portable cases, one of which contains the measuring equipment and the other the *TKT* counters. This meter can simultaneously measure the traffic on 20 devices in 45 groups, i.e. 900 devices. In one type of this traffic meter the counters have been replaced by a tape punch. A code is punched on the tape, indicating the number of occupied devices in each group at the time of measurement.

## Equipment for Centralized Supervision

### Traffic Route Tester (TRT)

*TRT* is an equipment for generation of traffic for supervisory purposes. *TRT* is connected to a local exchange having direct circuits to the *ARM* exchange. The reliability of the exchange as shown by *TRT* will thus be identical to the reliability of the traffic offered to the telephone subscribers. Lost calls are recorded by *TRT*.

The traffic to other local exchanges accessible only via transit exchanges (*ARM*) can also be supervised by *TRT*. To the test number used in the remote local exchange there is connected a code answerer which, when the call has been put through, delivers a signal back to *TRT*. Reception of the signal by *TRT* means that the attempted connection has been successful, and *TRT* releases the circuit and starts on the next test. In this way the *ARM* exchange on the switching path has also been supervised.

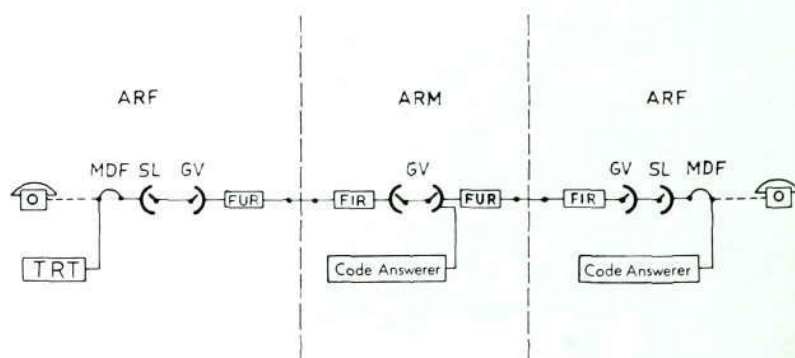


Fig. 14  
Switching path TRT — ARF — ARM —  
ARF — CODE ANSWERER SET



*ARM* can also be equipped with code answerers. These are connected like a *FUR* to a given route reserved for test traffic.

*TRT* is a very important link in the centralized supervision, as it permits central supervision of the operational quality for different exchanges in a group. One of the practical consequences of this is that the maintenance personnel can be directed to the point where they are most needed. This contributes to the achievement of equivalent operational quality for the exchanges of the group (fig. 14).

### *Equipment for Measurement of Trunk Circuits*

#### Automatic Transmission Measuring Equipment (ATME)

ATME is an equipment for automatic measurement of the transmission characteristics of circuits. Measurements are made in respect of attenuation and noise.

The equipment exists in two types, one for measurement of national networks, the other for measurement of international networks. The measurements in national networks are controlled from a central point.

Three equipments are used, equipments *A*, *B* and *C*. Equipment *A* is the controlling equipment, equipment *B* is required at exchanges of which the outgoing circuits are to be measured, and equipment *C* is required at exchanges to which measurements are to be made from an *A* or *C* equipment.

The measurements can be carried out quickly during low-traffic periods, e.g. during the nighttime.

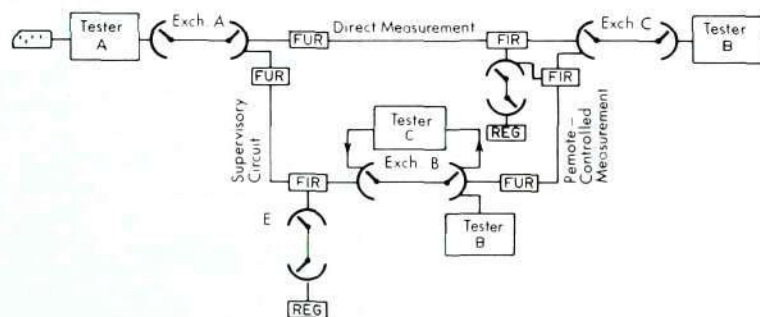
The measurements are controlled either from punched cards, punched tape, or manually from an observation desk. The transmission of orders for measurements and results is done by *MFC* signalling. The results are presented centrally at the *A* exchange on punched cards or teleprinter. With manually programmed measurement the result is shown on lamps. For details of these equipments we refer to Reprints 1374 and 1390 from Ericsson Review.

### Table of Maintenance Equipment for ARM Exchanges

The table on the following page shows the maintenance equipment which should exist in *ARM* exchanges. The quantity of equipment required has not been indicated, as this varies from case to case.

### Concluding Remarks

Even if the description given in this article is brief, it should be apparent that great opportunities exist for economical provision of suitable maintenance equipment at telephone exchanges so as to obtain a high reliability at a low maintenance cost. More detailed information concerning the function and use of the equipments can be obtained from L. M. Ericsson representatives.



**Fig. 15**  
Automatic transmission measuring equipment (ATME) for measurement of national networks

Maintenance equipment ARM	ARM 20	ARM 50
<i>Service observation equipment</i>		
Supervisory desk or supervisory frame .....	X	X
Blocked route alarm relay set .....	X	X
Route congestion alarm relay set .....	X	X
Supervisory desk or supervisory frame .....	X	
Service alarm unit, DL .....	X	X
General alarm unit, CL .....	X	X
Statistics counter .....	X	X
Fault counter .....	X	X
Connecting relay set .....	X	X
Zeroing relay set NR .....	X	X
Lamp panel VM-M .....	X	
Centralograph .....	X	(X)
Occupation indicator .....	X	X
<i>Testing equipment</i>		
Automatic exchange tester .....	X	X
Rate tester .....	X	
Used with FUR-P/FUR-S } When exchange not equipped for toll ticketing	X	
Code answering unit FUR-SP .....	X	X
Fault indicator DKL .....	X	X
Counter box DKR .....	X	X
<i>TM equipment</i>		
TKT meter, fixed .....	X	
TKT meter, portable .....	X	X
TM plugs .....	X	X
TM clock .....	X	X
<i>Instruments*</i>		
Multirecorder .....	X	X
Electronic time meter .....	X	X
Pulse recorder .....	X	X
Pulse timer .....	X	X
Pulse generator .....	X	X
MFC tester .....	X	X
Universal instrument .....	X	X
<i>Tools and miscellaneous*</i>		
Tool cabinet .....	X	X
Maintenance tool case .....	X	X
Drawing file .....	X	X
Steps, 8-rung .....	X	X
Steps, 5-rung .....	X	X
Wheeled bench .....	X	X

\*) The choice both of instruments and tools will depend on the number of exchanges within the area.

## References

1. ERICSSON, O.: *Centralization Trends in Exchange Maintenance*. Ericsson Rev. 43(1966): 2, pp. 56—66.
2. *Automatic Telephone Exchanges with Crossbar Switches, Maintenance Results*. Telefonaktiebolaget L M Ericsson, Stockholm 1968. (Publication No. 2226.)
3. *Maintenance Manual, ARM*. Telefonaktiebolaget L M Ericsson, Stockholm 1964. (Ordering No. B 20311.)
4. SONE, K.-A.: *L M Ericsson's Toll Ticketing System*. Ericsson Rev. 46(1969): 4, pp. 118—131.



## Record Attendance at 1970 Maintenance Conference

L M Ericsson's 1970 Maintenance Conference—the eleventh since the start of these conferences in 1956—was held this year between May 25 and June 5. The year's conference broke a number of records. The numbers of delegates and of participating nations and administrations have never been as great as this year. Apart from 22 delegates from L M Ericsson in Sweden and four from the Swedish Telecommunications Administration, there were no less than 49 foreign delegates representing 34 administrations and 23 nations. France, Hungary, Iraq, Kuwait and Saudi Arabia were represented for the first time.

During the first week of the conference in Stockholm a series of addresses and discussions were held on

various maintenance problems, while the second week was devoted to a 4-day visit to the Danish telephone administrations and to the Repeater Station and Maintenance Centre of the Swedish Telecommunications Administration in Malmö.

Centralization tendencies within maintenance were one of the main subjects of discussion. In Denmark a visit was made to the Maintenance Centre in Odense, which, like the new Swedish Maintenance Centre in Malmö, attracted a great interest. As at the last year's conference, much interest was devoted to the SPC system, both as subject of addresses and through visits to the Tumba exchange.

New L M Ericsson products and production methods were presented in addresses and at a special exhibition.

## LM Ericsson Receives 42 Mkr Order from Lebanon

L M Ericsson has received an order for telephone exchange equipment to a total value of 42 Mkr. from the Lebanese Administration des Téléphones.

The contract covers telecommunications equipment for 60 automatic telephone exchanges, which will offer service to an additional 38,800 subscribers in Lebanon. Nineteen exchanges, six of which will be installed in the capital, Beirut, and 13 in other parts of the country, will be entirely new installations. Equipment has been ordered for extension and modernization of 41 exchanges already in operation.

The contract includes installation and maintenance of the equipments ordered.

All exchanges are calculated to be in operation by the autumn of 1973.

LME received its first order for telephone exchanges from the Lebanese Administration in the early fifties and has since installed exchanges which today provide service for more than 115,000 subscribers. With this last order LME has sold exchange equipment to Lebanon for nearly 200,000 subscribers.

When the contracted equipment has been installed, Lebanon's telephone density will have passed the level of 10 telephones per 100 inhabitants, the fourth highest figure in Africa and Asia together. The corresponding levels for the USA and Sweden are 54 and 52 telephones per 100 inhabitants respectively.

After having had a Technical Office in Lebanon for some 20 years, LME has now established a subsidiary company, Société Libanaise des Téléphones Ericsson (SLT). With Head Office in Beirut it will undertake installation, documentation and technical consultation assignments. It is expected to have some 150 employees by the end of this year.

N. H. Loh from Singapore Telephone Board tries out L M Ericsson's new observation desk for automatic telephone exchanges at the Maintenance Conference Exhibition.





## Exhibition in Rotterdam

Manifestatie Communicatie '70—C '70 for short—is an event which is being held in Rotterdam between May and September this year to celebrate the liberation of the city 25 years ago. Through exhibitions and by other means it is desired to show what has happened during these 25 years and what Rotterdam has to offer as port and as industrial, cultural, athletics and festival centre.

L M Ericsson is taking part in the exhibition with a large stand in the PTT building at Coolsingel. During May alone the stand was visited by more than 15,000 persons interested in the new features shown within the telecommunications field: videophones. Electrowriter, alarm systems, telephone exchanges, general demonstration tableaux etc.

## LM Ericsson's French Subsidiary Concludes Agreement with Another French Enterprise

L M Ericsson's French subsidiary, Société Française des Téléphones Ericsson (STE), and Compagnie Industrielle des Télécommunications (CIT) have concluded an agreement for joint technical development, particularly in respect of computer-controlled telephone exchanges for the French PTT. They have also concluded an agreement concerning coordination of production in order that each party may achieve longer production series.

## Training of Installers and Testers in Tunisia

Since the end of last year an extensive programme of training has been arranged in cooperation between the Tunisian PTT, SIDA (Swedish International Development Authority) and L M Ericsson. The goal of the programme is to train a large number of PTT technicians for installation and testing work on the telephone equipments from L M Ericsson which are at present under installation.

After a brief period of assistance from L M Ericsson personnel when a training course is started, the training will be conducted by the PTT itself. A number of engineers and technicians who have earlier been trained at



From the Rotterdam Exhibition "Manifestatie Communicatie '70". (Left) Mr. E. Brandsma, President of Ericsson Telefoonmaatschappij, (right) Mr. Sven-Ture Aberg, former President of LME, during a visit to the stand.

In conjunction with the agreements between STE and CIT, it has been agreed between L M Ericsson and the parent company of CIT, Compagnie Générale d'Electricité, that CIT shall acquire 16 % of the share capital of STE.

After completion of the transaction L M Ericsson will retain a majority holding in STE.

All agreements are subject to approval by Swedish and French authorities and by the boards of L M Ericsson and Compagnie Générale d'Electricité.

L M Ericsson in Stockholm will act as instructors. The goal for the present training programme is that in the near future the PTT will be able entirely to take over the installation and testing of new exchanges.

One of the aids used on the courses is the instruction tape recorder working on the RITT method, i.e. each pupil has an individual tape recorder with the various sections of the course recorded on tape cartridges. This procedure has proved to save much time and to be an effective method, since the pupil can adapt the instruction to his own working rhythm.

Hitherto some 80 Tunisian PTT engineers and technicians have been trained in Stockholm. Another 30 are expected to undergo training in the near future.

## STE Delivers Telephone Equipments to Gaboon and Madagascar

Société Française des Téléphones Ericsson (STE) is to deliver telephone equipment for the new government plan for extension of the Gaboon telephone network.

Two new exchanges are to be put in operation at the end of 1971 in Libreville. A third exchange will be built later in conjunction with the planned deep-water harbour at Owendo. Three further exchanges will be built in Libreville at a later stage.

STE is also to deliver equipment for extension of the traffic facilities in other towns in Gaboon. The exchange at Port-Gentil, for example, will be extended to 2000 subscriber lines at the beginning of next year.

In Madagascar as well the P. & T. has employed the services of Ericsson's French subsidiary for the planned extension of the Madagascan telephone network; an order for 11 telephone exchanges has recently been placed with STE. Two of these exchanges are intended for transiting of the automatic telephone traffic between the capital, Tananarive, and the port of Tamatave. The expected final capacity is 1200 automatic circuits and 9000 subscriber lines.

Tunisian installer being instructed by the RITT method.







During a recent trip to Brazil, Mr Björn Lundvall, President of L M Ericsson, visited the Governor of São Paulo, Dr Roberto Costa de Abreu Sodré. (From left) Sr Juracy M. Magelhães, Chairman of Ericsson do Brasil, Mr. Lundvall, Governor Sodré, and Mr. Hans Sund, L M Ericsson.



The Head of the National Telecommunications Department of Brazil (DENTEL), General Kleber Rollin Pinheiro, and the Brazilian Ambassador to Sweden, Dr Aluzio Napoleão, during a visit to L M Ericsson in Stockholm in May 1970.



An exhibition was arranged in Geneva in May in conjunction with the 100th Anniversary of the Swiss Fire Brigade Association. L M Ericsson's Swiss subsidiary, Ericsson AG, exhibited in particular fire alarm equipments, and radio communication equipments from Svenska Radio AB.



At the end of June the Malaysian Prime Minister visited the Head Factory in Stockholm. (From left) Mr Arne Mohlin, LME, Prime Minister Tunku Abdul Rahman Putra, and Mr Björn Lundvall, President of LME.

L M Ericsson's subsidiary, Instruktionsteknik AB, participated in the Teaching Aids Fair, DIDACTA, in Basel at the end of May and beginning of June. The RITT, instruction unit and equipments for multiple choice methodology attracted a large number of visitors.



The Orchard Exchange and Engineering Centre, the new telephone exchange at Singapore, for which L M Ericsson supplied its crossbar system ARF 102, was cut over in May.





## Ellemtel Utvecklings AB Approved by the Crown

On June 5, 1970, Parliament authorized the Crown to approve the agreement between the Swedish Telecommunications Administration and L M Ericsson for joint development work conducted by Ellemtel Utvecklings AB. The agreement had earlier been approved by the board of L M Ericsson.

It is planned that the Board of Ellemtel shall consist of the following members: from the Telecommunications Administration—Director General Bertil Bjurel, Operational Director Torsten Larsson, and Technical Director Eric Waldelius; from L M Ericsson—President Björn Lundvall, Vice President Fred Sundkvist and Dr Christian Jacobæus.



E. Eriksen

The President of Ellemtel will, as earlier mentioned, be Mr Erik Eriksson.

## New Member of the Management

The Board has appointed Mr Karl-Axel Lunell Vice President of the Company and head of the Management Staff Department for Licence Questions.



K.-A. Lunell

Mr Lunell succeeds Mr Olof Hult, who, however, after attaining pensionable age, will remain with the company for special agreement questions.

Mr Lunell entered into his new appointment on June 1, 1970.

## New Appointments

Mr Sven-Olof Tonnæus has been appointed head of L M Ericsson's re-

cently formed company in Beirut, Société Libanaise des Téléphones Ericsson. He took up this post on August 1.



S.-O. Tonnæus

M. Marcel Coutier was appointed President of LME's French subsidiary, Société Française des Téléphones Ericsson at the Annual General Meeting on June 1, 1970, in succession to M. André Duprez, who leaves the post as Head and Chairman of the Board on attaining pensionable age.

At the same time M. Marcel Cazes was appointed Chairman of the Board.

M. André Duprez will remain on the Board of the Company and has at the same time been appointed Honorary Chairman.

## Ericsson Technics

Ericsson Technics Nos. 1 and 2 for 1970 contain two papers each.

The first paper in No. 1, *Digital Filters with Multiple Shift Sequences*, by T. Fjällbrant, describes how, in digital filters for sampled signals, the time between the samples can be used for signal processing since the storage time in each shift register is a sub-multiple of the sampling interval. The multiplication constants in the filter equipment can assume different values during the various shift sequences. With this method variable filters can be effectively realized since the desired filter characteristic can often be obtained by variation of a single parameter. Furthermore a reduction of the requirement of coefficient accuracy in filters of higher degree can be obtained.

The second paper, by T. Ericson, *An Information Theory Approach to the Source Approximation Problem*, deals with the problem of approximating a

random time series from the point of view of information theory. Mc Millan's theorem and the entropy concept form the basis for the theory developed. Two classes of approximation processes are studied: finite order unifilar Markov sources and renewal processes. Both classes are shown to possess certain desirable properties for approximation purposes. The treatment is far from exhaustive and the theory as given must be regarded as preliminary.

Ericsson Technics No. 2 starts with a paper by O. Ekholm and N. O. Johannesson, *Loading Effects with Continuous Tone Signalling*. It describes a carrier system with continuous outband signalling loaded, inter alia, with sine voltages. Unless special precautions are taken, the system quality may be seriously impaired by, for example, overloading of line repeaters, unacceptably low crosstalk ratios and interference tones in programme channels. These phenomena are studied in detail and it is shown that there is a very effective remedy—

random phasing. Analytical expressions are derived and the theories are compared with extensive measurements. All carrier systems with outband signalling in Sweden have now been converted to random phasing.

Finally in *A Simple Iterative Method for Evaluation of the Characteristic Function in Filter Synthesis*, H. Rapp describes how arbitrarily prescribed insertion and/or reflexion losses specified in the form of connected rectilinear sections for an arbitrary number of pass and stop bands are uniformly approximated by the characteristic function, which is evaluated by an iterative single-step method. The method consists of an equalization procedure making use of all degrees of freedom for the approximation. The computer programme is described. The computation demands have been reduced by a special transformation and by describing the approximation error in terms of physical requirements. The programme is characterized by modest demands on storage requirements.





# The Ericsson Group

## Associated and co-operating enterprises and technical offices

### • EUROPE •

#### Denmark

L M Ericsson A/S DK-2000 København F, Finsensvej 78, tel: (01) 34 6868, tgm: ericsson, telex: 9020 "ERICSSON KH"

Søborg, Telefonvej 6, tel: (01) 69 5188, tgm: nortelmatic, telex: 5264, "GNT AUTOMATIC KH"

Dansk Signal Industri A/S DK-2650 Hvidovre, Stamholmen 175, Avedøre Holme, tel: (01) 49 0333, tgm: signaler københavn, telex: 6503

#### Finland

O/Y L M Ericsson A/B Helsinki 13, P.O.B. 13018, tel: (90) 121 41 tgm: ericsons, telex: 12546, "LME SF"

#### France

Société Française des Téléphones Ericsson F-92-Colombes, 36, Boulevard de la Finlande, tel: Paris (1) 781 3535, tgm: ericsson colombes, telex: 62179, "ERICSSON CLOMB"

F-75-Paris 17e, 147, rue de Courcelles, tel: Paris (1) 227 9530, tgm: eric paris, telex: 29276, "ERICSSON PARIS"

Etablissements Ferrer-Auran, 13 Marseille, 2, Rue Estelle, tel: 20 6940, tgm: etabferrer, telex: 42579, "RINGMARS"

#### Great Britain

Swedish Ericsson Company Ltd. Morden, Surrey, Crown House, London Road, tel: (01) 542 1001, tgm: teleric, telex: 935979, "SWEDERIC LDN"

Swedish Ericsson Telecommunications Ltd., Morden, Surrey, Crown House, London Road, tel: (01) 542 1001, tgm: teleric, telex: 935979, "SWEDERIC LDN"

Production Control (Ericsson) Ltd. Morden, Surrey, Crown House, London Road, tel: (01) 542 1001, tgm: productrol, telex: 935979, "SWEDERIC LDN"

Centrum Rentals Ltd. Morden, Surrey, Crown House, London Road, tel: (01) 542 1001, tgm: telefon, telex: 935979 "SWEDERIC LDN"

#### Ireland

L M Ericsson Ltd. Dublin 2, 32, Upper Mount Street, tel: (01) 619 31, tgm: ericsson, telex: 5310, "ERICSSON DUBLIN"

#### Italy

FATME, Soc. per Az. 1-00100 Roma, C.P. 4025 Appio, tel: (06) 4694, tgm: fatme, telex: 61327, "61327 FATME"

SETEMER, Soc. per Az. 1-00198 Roma, Via G. Paisiello 43, tel: (06) 86 8854, tgm: setemer

SIELTE, Soc. per Az. 1-00100 Roma, C.P. 5100, tel: (06) 577 8041, tgm: sielte, telex: 61225, "61225 SIELTE"

#### Netherlands

Ericsson Telefoonmaatschappij N.V. Rijen (N.Br.), P.O.B. 8, tel: (01612) 3131, tgm: erictel, telex: 54114, "ERICTEL RIJEN"

Voorburg 2110, P.O.B. 60, tel: (070) 81 4501, tgm: erictel den haag, telex: 31109, "ERICTEL DEN HAAG"

#### Norway

A/S Elektrisk Bureau Oslo 3, P.B. 5055 Maj, tel: (02) 46 1820, tgm: elektriken, telex: 11723, "TELEB N"

A/S Industrikontroll Oslo 6, Grenseveien 86/88, 3. etg., tel: (02) 68 7200, tgm: indtroll

A/S Norsk Kabelfabrik Drammen, P.O.B. 369, tel: (02) 83 7650, tgm: kabel, telex: 18149, "KABEL N"

A/S Telesystemer Oslo 6, Tvetenveien 32, Bryn, tel: (02) 68 7200, tgm: telesystemer, telex: 16900, "ALARM N"

#### Poland

Telefonaktiebolaget L M Ericsson, Technical Office, Warszawa, Ul. Nowy Swiat 42, tel: 26 4926, tgm: tellme, telex: 813710, "813710 TELLME PL"

#### Portugal

Sociedade Ericsson de Portugal Lda. Lisboa 1, Rua Filipe Folque 7, 1º, tel: 56 3212, tgm: ericsson

#### Spain

Cia Española Ericsson, S.A. Getafe, Paseo Felipe Calleja 6, tel: 295 2100, tgm: ericsson, telex: 22666, "ERIGE E"

#### Sweden

Telefonaktiebolaget L M Ericsson, S-126 11 Stockholm 32, tel: (08) 19 0000, tgm: telefonbolaget, telex: 17440, "LME S"

Björhagens Fabriker AB, S-212 15 Malmö, Fack, tel: (040) 93 4770

AB Rifa, S-161 30 Bromma 11, tel: (08) 26 2600, tgm: elrifa, telex: 10308, "ELRIFA STH"

Instruktionsteknik AB, S-117 47 Stockholm 44, tel: (08) 68 0870, tgm: instruktect

L M Ericsson Data AB, S-171 88 Solna, tel: (08) 83 0700, tgm: ericdata, telex: 10793 "ERICDATA STH"

L M Ericsson Telemateriel AB, S-135 01 Stockholm-Tyresö 1, Fack, tel: (08) 712 0000 tgm: ellem, telex: 1275, "1275 TELERGA S"

Sievert Kabelverk AB, S-172 87 Sundbyberg, tel: (08) 28 2860, tgm: sievertfabrik, telex: 1676, "SIEV-KAB STH"

Svenska Radioaktiebolaget, S-102 20 Stockholm 12, tel: (08) 22 31 40, tgm: svenskradio, telex: 10094, "SRA S"

AB Transvertex, S-140 11 Vårby, Fittja industriområde, tel: (08) 710 0935

#### Switzerland

Ericsson A.G. 8061 Zurich, Postfach, tel: (051) 41 6606, tgm: telericsson, telex: 52669, "ERIC CH"

#### Turkey

Ericsson Türk Ticaret Ltd. Sirketi Ankara, Rumeli Han, Ziya Gökalp Cad. tel: 12 3170, tgm: ellem

#### West Germany

Deutsche Ericsson G.m.b.H. Telematerial, 4 Düsseldorf 1, Postfach 2628, tel: (0211) 35 3594, tgm: eric: tel: telex: 8587912, "ERIC D"

Centrum Electronic G.m.b.H. 3 Hannover, Postfach 1247, tel: (0511) 63 1018, tgm: centronic, telex: 0922913, "CELEC D"

### • ASIA •

#### India

Ericsson Telephone Sales Corporation AB Calcutta 22, P.O.B. 2324, tel: (032) 45 4494, tgm: inderic

New Delhi 49, L25, South Extension Part II, tel: (011) 62 6505, tgm: inderic

#### Indonesia

Ericsson Telephone Sales Corporation AB Djakarta, P.O.B. 2443 tel: (07) 463 97, tgm: javeric

Bandung, Djalat Ir. H. Djuanda 151, tel: (082) 820 94, tgm: javeric

#### Iraq

Telefonaktiebolaget L M Ericsson, Installation Branch, Baghdad P.O.B. 2388, Alwiyah, tel: 947 14, tgm: ellemco

#### Kuwait

Telefonaktiebolaget L M Ericsson, Technical office, Kuwait, State of Kuwait, P.O.B. 5979, tel: 200 74 tgm: erictel

#### Lebanon

Société Libanaise des Téléphones Ericsson, Beyrouth B.P. 8148, tel: 25 2627, tgm: ellem, telex: 876, "ELLEM BERYT"

#### Malaysia

Ericsson Talipon SDN BHD, Petaling Jaya, P.O.B. No 9, tel: Kuala Lumpur (03) 56 1523, tgm: kuleric, telex: 265 "ERICMAL KL"

Telecommunication Manufacturers (Malaysia) SDN BHD, Petaling Jaya, P.O.B. 9, tel: Kuala Lumpur (03) 56 1523, tgm: kuleric, telex: 265, "ERICMAL KL"

#### Pakistan

L M Ericsson Telephone Company, Technical office, Karachi, P.O.B. 7398, tel: (90) 51 6112, tgm: ericsson

#### Singapore

Ericsson Telephone Co. Private Ltd. Singapore 1, P.O.B. 3079, tel: 98 1155, tgm: sineric

#### Thailand

Ericsson Telephone Corp. Far East AB Bangkok, P.O.B. 824, tel: (02) 580 41, tgm: ericsson, telex: 2274, "THAERIC"

### • AFRICA •

#### Algeria

Société Algérienne des Téléphones Ericsson, El Biar (Algiers), 4, rue Mouloud Hadjen, tel: 78 2692, tgm: eric alger

#### Egypt (UAR)

Telefonaktiebolaget L M Ericsson, Technical office Egypt Branch Cairo P.O.B. 2084, tel: (02) 465 83, tgm: elleme, telex: 2009, "ELLEME UN"

#### Ethiopia, Sudan

Telefonaktiebolaget L M Ericsson, Technical office, Addis Ababa, P.O.B. 3366, tel: (01) 492 60, tgm: ericsson, telex: 21090 "MOSFIRM ADDIS"

#### Libya

Telefonaktiebolaget L M Ericsson Technical Office, Tripoli, P.O.B. 3002, tel: 361 93, tgm: ericsson

#### Malawi

Ericsson Telephone Sales Corporation AB Blantyre, P.O.B. 431, tel: 300 95, tgm: ericofon

### Morocco

Société Marocaine des Téléphones Ericsson Casablanca, 87, Rue Karachi, tel: 788 75, tgm: ericsson

### South Africa, Southwest Africa, Botswana, Lesotho, Swaziland

L M Ericsson (Pty.) Ltd, Marshalltown, Transvaal, P.O.B. 61391, tel: 836 0956, tgm: ericofon johannesburg

### Tunisia

Telefonaktiebolaget L M Ericsson, Technical office, Tunis, Boite Postale 780, tel: (01) 24 0520, tgm: ericsson, telex: 695, "ERICSSON TUNIS"

### Zambia

Ericsson Telephone Sales Corporation AB Lusaka, P.O.B. 2762, tel: (146) 744 42, tgm: ericofon

Ndola, P.O.B. 2256, tel: (143) 3885, tgm: ericofon

### • AMERICA •

#### Argentina

Cia Ericsson S.A.C.I. Buenos Aires Casilla de Correo 3550, tel: 33 2071, tgm: ericsson, telex: 0122196, "CATEL BA"

Cia Argentina de Telefonos S.A. Buenos Aires, Belgrano 894, tel: 33 2076, tgm: catel, telex: 0122196, "CATEL BA"

Cia Entrerriana de Telefonos S.A. Buenos Aires, Belgrano 894, tel: 33 2076, tgm: catel, telex: 0122196, "CATEL BA"

Industrias Eléctricas de Quilmes S.A. Quilmes FNGR, 12 de Octubre 1090, tel: 253 2775, tgm: indelqui buenosaires, telex: 0122196, "CATEL BA"

#### Brazil

Ericsson do Brasil Comércio e Indústria S.A. São Paulo, C.P. 5677, tel: 287 2011, tgm: ericsson, telex: 021817, "ERICSSON SPO"

Fios e Cabos Plásticos do Brasil S.A. (FICAP), Rio de Janeiro, caixa postal: 1828, tel: 29 0185, tgm: ficap, telex: 031563, "FICAP RIO"

#### Canada

L M Ericsson Limited Montreal 381, Quebec, 2300 Laurentian Boulevard St. Laurent, tel: (514) 331 3310, tgm: caneric, telex: 05-267682, (TWX) 610-421-3311, "CANERIC MTL"

#### Central America

Telefonaktiebolaget L M Ericsson, Oficina Técnica de Centroamérica y Panama, San Salvador, Apartado 188, tel: 21 7640, tgm: ericsson

#### Chile

Cia Ericsson de Chile S.A. Santiago, Casilla 10143, tel: (04) 825 55, tgm: ericsson, telex: SGO 389, "ERICHILO SGO389"

#### Colombia

Ericsson de Colombia S.A. Bogotá, Apartado Aéreo 4052, tel: (92) 41 1100, tgm: ericsson, telex: 044507, "ERICSSON BOG"

Fabricas Colombianas de Materiales Eléctricos Facomec S.A. Cali, Apartado Aéreo 4534, tel: 42 1061, tgm: facomec, telex: 55673, "FACOMECCLO"

#### Costa Rica

Telefonaktiebolaget L M Ericsson, Technical office San José, Apartado 10073, tel: 21 1466, tgm: ericsson

#### Ecuador

Telefonos Ericsson C.A. Quito, Casilla 2138, tel: 52 4000, tgm: ericsson

Guayaquil, Casilla 376, tel: 52 6900, tgm: ericsson

Cont. on next page



## Associated and co-operating enterprises and technical offices (Cont. from preceding page)

### Mexico

Telefonos Ericsson S.A. Mexico D.F., Apartado Postal 9958, tel: (25) 46 4640, tgm: coeric, telex: 01772485, "ERICSSON MEX" PARA COERIC

Latinoamericana de Cables S.A. de C.V. Mexico 12 D.F., Apartado Postal 12737, tel: (2) 549 3650, tgm: latincasa, telex: 01772485, "ERICSSON MEX" PARA LATINCASA

Teleindustria, S.A. de C.V. Mexico 1, D.F., Apartado Postal 1062, tel: (2) 546 4640, Factory: (2) 576 3166, tgm: ericsson, telex: 01772485, "ERICSSON MEX"

Telemontaje, S.A. de C.V. Mexico 1, D.F., Apartado Postal 1062, tel: (2) 576 4044, tgm: ericssonmexicodf, telex: 01772485, "ERICSSON MEX" PARA TELEMONTAJE

### Peru

Cia Ericsson S.A. Lima, Apartado 2982, tel: 31 1005, tgm: ericsson, telex: 3540202, "ERICSSON 3540202"

Soc. Telefónica del Perú, S.A. Arequipa, Apartado 112-1012, tel: 6060 tgm: telefonica

### El Salvador

Telefonaktiebolaget L M Ericsson, Technical office San Salvador, Apartado 188, tel: 21 7640, tgm: ericsson

### Uruguay

Cia Ericsson S.A. Montevideo, Casilla de Correo 575, tel: 926 11, tgm: ericsson

### USA

The Ericsson Corporation New York, N.Y. 10017, 100 Park Avenue, tel: (212) 685 4030, tgm: ericstel, telex: 620484, "ERICTEC 620484"

Ericsson Centrum Inc. New York, N.Y. 10016, 16, East 40th Street, tel: (212) 679 1000, tgm: ericstel, telex: 620149, "ETELSAC 620149"

### Venezuela

Cia Anónima Ericsson Caracas, Apartado 3548, tel: (02) 34 4661, tgm: ericsson, telex: 22734, "22734 ERIC VEN"

Alambres y Cables Venezolanos C.A. (ALCAVE) Caracas, Apartado del Este 62107, tel: (02) 33 9791, tgm: alcave, telex: 845, "ALCAVE VE"

### • AUSTRALIA & OCEANIA •

#### Australia

L M Ericsson Pty. Ltd. Broadmeadows, Victoria 3047, P.O.B. 41, tel: (03) 309 2244, tgm: ericmel, telex: AA 30555, "ERICMEL"

Rushcutters Bay N.S.W. 2011, 134 Barcom Avenue, tel: (02) 31 0941, tgm: ericsyd, telex: AA 21358 "ERICSYD"

Port Moresby, Territory of Papua and New Guinea, P.O.B. 1367, Boroko, tel: 569 65, tgm: ericpor

Teleric Pty. Ltd. Broadmeadows, Victoria 3047, P.O.B. 41, tel: (03) 309 2244, tgm: teleric, telex: AA 30555, "ERICMEL"

Rushcutters Bay N.S.W. 2011, 134 Barcom Avenue, tel: (02) 31 0941, tgm: teleric, telex: AA 21358, "ERICSYD"

Conqueror Cables Pty. Limited, Dee Why, N.S.W. 2099, P.O.B. 69, tel: (02) 98 0364, tgm: concab sydney

A.E.E. Capacitors Pty. Ltd. Preston, Victoria 3072, 202 Bell Street, P.O.B. 95, tel: (03) 480 1211, tgm: engicup melbourne

## Representatives

### • EUROPE •

#### Austria

Telecom Handelsgesellschaft m.b.H., 1160 Wien, Postfach 98, tel: (0222) 43 5956, tgm: teleric, telex: 75976, "75976 TELECOM A"

#### Belgium

Allumage Lumière S.A. Bruxelles 7, 128-130 Chaussée de Mons, tel: 22 9870, tgm: allumalux, telex: 21582, "ALLUMALUX BRU"

#### Greece

Angelos Cotzias Athens, 18, Odos Omirou, tel: (021) 62 6031, tgm: cotziasan, telex: 215252, "215252 CTS GR"

#### Iceland

Johan Rönning Reykjavík, P.O.B. 883, tel: 224 95, tgm: rönning, telex: 40, "ROENNING RYK"

#### Spain

TRANSA Transacciones Canarias S.A., Las Palmas de Gran Canarias, Tomas Morales 38, tel: 21 8508, tgm: transa, telex: 824, "MAVAC LPE"

Santa Cruz de Tenerife, Sabino Berthelot, 3, tel: 24 5897, tgm: transa

#### Yugoslavia

Merkantile Inozemna Zastupstva Zagreb post pretinac 23, tel: (041) 41 6655, tgm: merkantile, telex: 21139, "21139 YU MERTIL"

Beograd, Ul. 7. jula br. 18, tel: (011) 62 1773, tgm: merkantile, telex: 11506, "YU MERKAN"

### • ASIA •

#### Bahrain & Trucial States

Yusuf Bin Ahmed Kanoo, Bahrain, Arabian Gulf, tel: 40 8188, tgm: kanoo, telex: BHN 215

#### Burma

Myanma Export Import Corp., Agency Div. Rangoon, P.O.B. 404, tel: 146 18, tgm: myanimport

#### Cambodia

Comin Khmere S.A. Phnom-Penh, P.O.B. 625, tel: 233 34, tgm: engineer

#### Cyprus

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

S.A. Petrides & Sons Ltd. Nicosia, P.O.B. 1122, tel: 627 88, tgm: armature, telex: 2308, "ARMATURE"

#### Hong Kong and Macao

Swedish Trading Co. Ltd. Hong-Kong, P.O.B. 108, tel: 23 1091, tgm: swedetrade

#### Iran

Irano Swedish Company AB, Teheran Khabane Sevom Esfand 29, tel: 31 4160, tgm: iranowsede

#### Iraq

Usam Sharif Company W.L.L. Baghdad, P.O.B. 492, tel: 870 31, tgm: alhamra

#### Jordan

The Arab Trading & Development Co. Ltd. Amman, P.O.B. 6141, tel: 259 81, tgm: aradeve

#### Kuwait

Morad Yousuf Behbehani Kuwait, State of Kuwait, P.O.B. 146, tel: 270 71, tgm: barakat, telex: 048, "BEHBEHANI KUWAIT"

#### Lebanon

Swedish Levant Trading (Elié B. Hérou) Beyrouth, P.O.B. 931, tel: 23 1624, tgm: skefko

#### Pakistan

Panasian Marketing Service Ltd., Karachi, P.O.B. 3941, tel: (90) 51 2051, Ext. 53, tgm: panasian

#### Philippines

USIPHIL Inc. Manila, P.O.B. 125, tel: 88 9351, tgm: usiphil, telex: PN 3550, "USIPHIL"

#### Saudi Arabia

Engineering Projects & Products Co. Ltd. (Eppco), Riyadh, P.O.B. 987, tel: 222 22, tgm: eppcol

Yeddah, P.O.B. 1502, tel: 4567, tgm: eppcol

Dammam, P.O.B. 450, tel: 222 22, tgm: eppcol

#### Syria

Constantin Georgiades, Damas, P.O.B. 2398, tel: 266 73, tgm: georgiades

#### Taiwan

Trans-Eurasia Enterprise, Ltd. Taipei, P.O.B. 3880, tel: 51 7038, tgm: esbtrading

#### Republic of Vietnam

Vo Tuyen Dien-Thoi Vietnam, Saigon, P.O.B. 1049, tel: 226 60, tgm: tolerad

International Business Representative, Saigon, 26-28, Hai Ba Trung Street, tel: 226 60, tgm: ibur

### • AFRICA •

#### Congo (Kinshasa)

I.P.T.C. (Congo) Ltd. Kinshasa 1, P.O.B. 8922, tel: 253 45, tgm: indu-expan, telex: 327, "PTC KIN"

#### Ethiopia

Mosvold Company (Ethiopia) Ltd. Addis Ababa, P.O.B. 1371, tel: (01) 101 00, tgm: mosvold, telex: 21090 "MOSFIRM ADDIS"

#### Ghana

R.T. Briscoe Ltd. Accra, P.O.B. 1635, tel: 669 03, tgm: briscoe, telex: 295, "BRISCOE ACCRA"

#### Liberia

Post & Communications Telephone Exchange, Monrovia, Corner Ashmun & Lynch Streets, tel: 222 22, tgm: radiolibe

#### Libya

ADECO African Development & Engineering Co Tripoli, P.O.B. 2390, tel: 339 06, tgm: adeco

#### Mozambique

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

#### Sudan

El Rahad Trading Corporation Khartoum, P.O.B. 866, tel: 776 95, tgm: suconta, telex: BHN 251

### • AMERICA •

#### Bahama Islands

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

#### Bolivia

Prat Ltda, La Paz, Casilla 4790, tel: 277 12, tgm: prat

#### Costa Rica

Tropical Commission Co. Ltd. San José, Apartado 661, tel: 22 5511, tgm: troco

#### Dominican Republic

Humberto Garcia, C. por A. Santo Domingo, Apartado 771, tel: 3645, tgm: gartier

#### Guatemala

Nils Pira Ciudad de Guatemala, Apartado 36, tel: (021) 622 57, tgm: nilspira

#### Guyana

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

#### Honduras

Quinchón Leon y Cia Tegucigalpa, Apartado 85, tel: 251 71, tgm: quinchon

#### Netherlands Antilles

S.E.L. Maduro & Sons, Inc. Willemstad, Curaçao P.O.B. 304, tel: 130 00, tgm: madurosos, telex: CU 92

#### Nicaragua

Roberto Teran G. Managua, Apartado 689, tel: 224 00, tgm: roteran

#### Panama

Sonitel, S.A. Panama 5, R.P., Apartado 4349, tel: 64 3600, tgm: sonitel, telex: 368674, "368674 SONITEL"

#### Paraguay

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

#### El Salvador

Dada-Dada & Co. San Salvador Apartado 274, tel: 21 7940, tgm: dada

#### Surinam

W.E. van Romondt's Trading Company Ltd., Paramaribo, tel: 2831, tgm: vanromondt

#### Trinidad, W.I.

Leon J. Aché Ltd. Port-of-Spain, 100 Frederic Street, tel: 323 57, tgm: achegram

### • AUSTRALIA & OCEANIA •

#### New Zealand

ASEA Electric (NZ) Ltd. Wellington C. 1., P.O.B. 3239, tel: 706 14 tgm: asean, telex: 3431, "ASEAWELL NZ 3431"