ERICSSON Review

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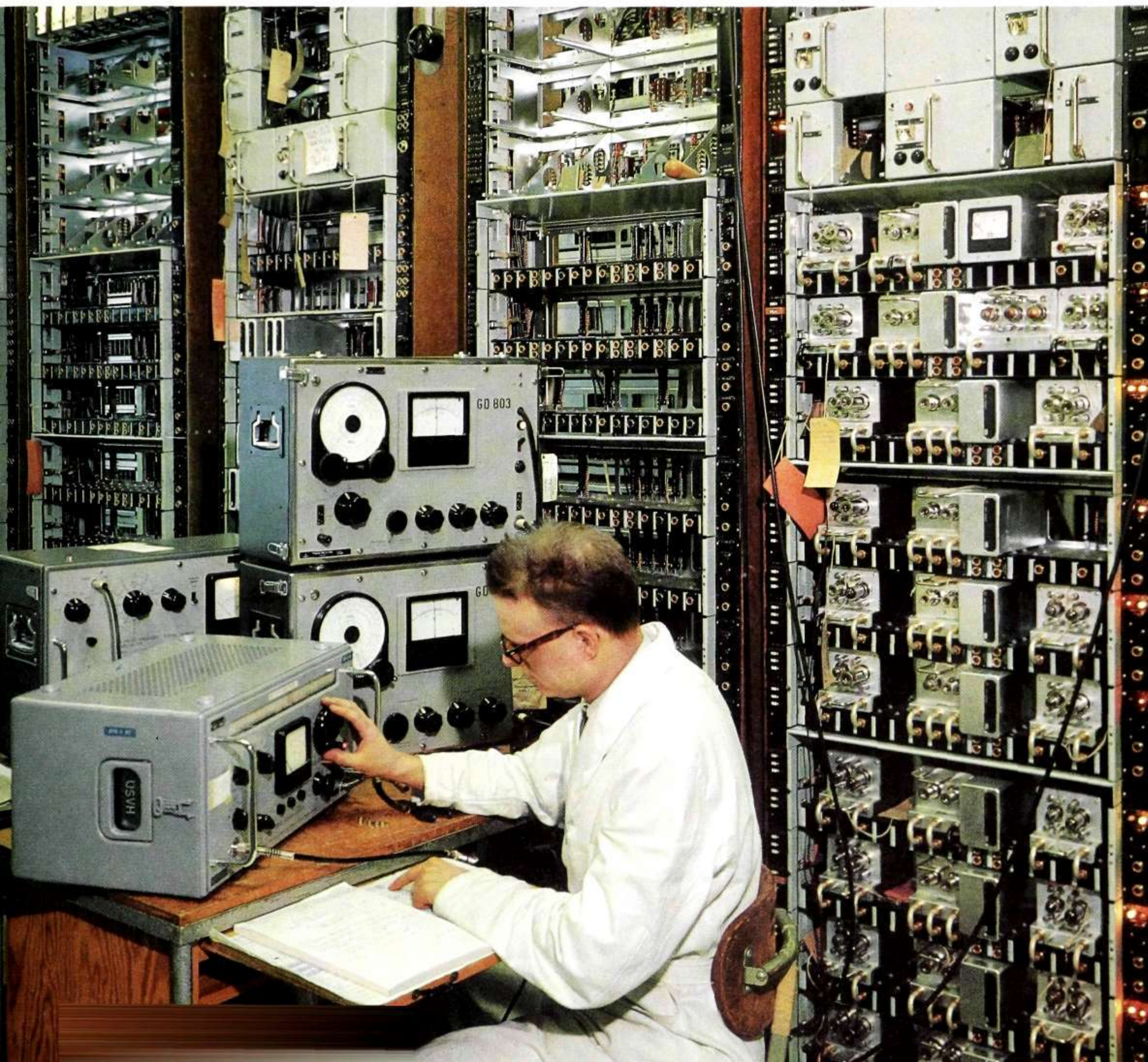
1963



ERICSSON REVIEW

Vol. XL 1963

RESPONSIBLE PUBLISHER: HUGO LINDBERG

EDITOR: SIGVARD EKLUND, DHS

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On cover: Final Testing of Bays for L M Ericsson's 2 700-circuit Carrier System.

Terminal Equipment for 2 700-circuit Carrier System

I. Modulation Equipment

S TRONSLI, TELEFONAKTIEBOLAGET LM ERICSSON, STOCKHOLM

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The present article deals with L M Ericsson's equipment for modulation from the basic supergroup to the line frequency band of the 12 Mc/s system. A brief description of the system is given and the most important technical data are presented.

The associated equipment for carrier frequency generation will be dealt with in an article to be published in a future number of Ericsson Review. The modulation equipment for the formation of the basic supergroup has been described in Ericsson Review, No. 1, 1961 and No. 2, 1962.

Introduction

The introduction of coaxial systems into long distance networks at the end of the 1940's in the form of 4 Mc/s systems (960 circuits) was followed by a large expansion of the long distance traffic. The reasons were the general industrial and economic development in many countries and the introduction of subscriber trunk dialling in the middle of the 1950's. Administrations were very soon presented with the problem of further expanding the trunk networks and as the laying of new cables is very expensive, there arose a demand for increasing the capacity of coaxial cables which were already in use. The most economic solution proved to be to reduce the repeater spacing in 4 Mc/s systems by half so that the repeater station buildings which already existed could also be used in the new system.

As the attenuation of a coaxial cable increases with the square root of the frequency and approximately the same amplification could be realized, it was soon appreciated that the maximum frequency transmitted could be increased by a factor 3. See the article in Ericsson Review No. 4, 1962, by E J Eriksen entitled "The Development and Future of Wide Band Carrier Systems".

This resulted in the standardization by CCITT of the 12 Mc/s system, which has a capacity of 2 700 telephone circuits in the frequency band 312/316 kc/s–12 388 kc/s.

Together with the Swedish Board of Telecommunications, L M Ericsson took an active part in the work of CCITT in standardizing the 12 Mc/s system. This gave us at an early stage of development the possibility of fixing important system characteristics, and led to L M Ericsson being the first company in the world to put terminal equipment of this type into operation in 1962 in the cities of Stockholm, Västerås, and Örebro.

The function and construction of this equipment is now described.

Modulation Plan

For technical and traffic reasons, the channels are not modulated directly to the prescribed line frequency range 312/316–12 388 kc/s. Instead, the modulation is carried out in stages up to larger and larger groups.

The size of the group and the position of the frequency band are standardized by CCITT.

English nomenclature	Frequency band	Number of channels
basic group	60 –108 kc/s	12
basic supergroup	312 –552 "	60
basic mastergroup	812 –2 044 "	300
basic supermastergroup	8 516–12 338 "	900

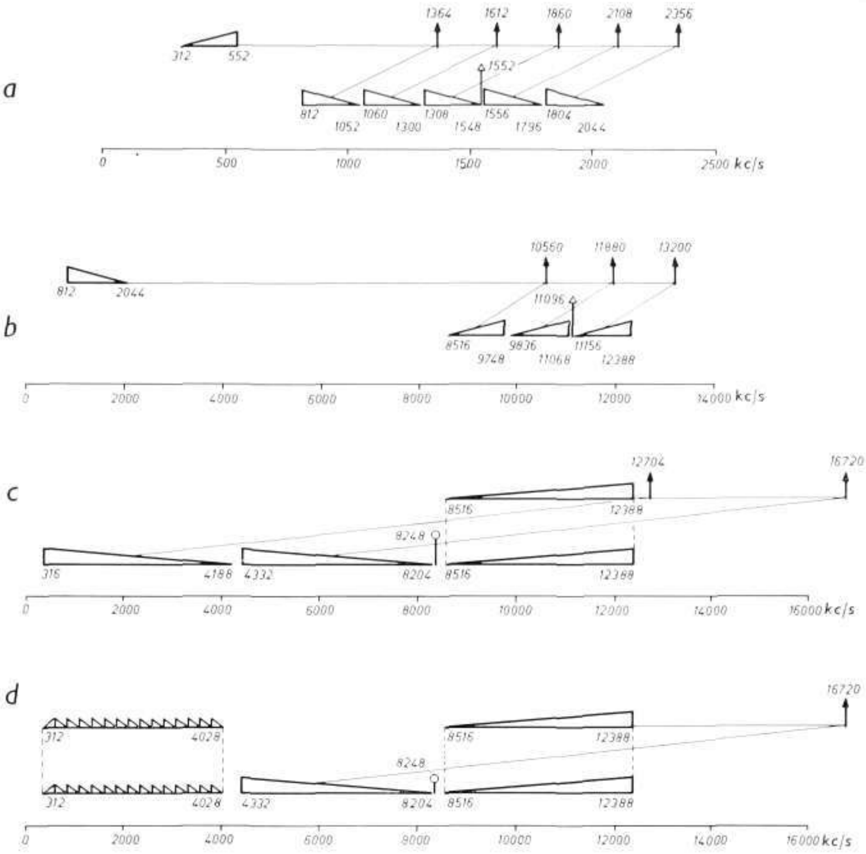


Fig. 1 X 8339

Modulation plan for 12 Mc/s system

a) modulation of basic supergroup to basic mastergroup
b) modulation of basic mastergroup to basic supermastergroup
c) supermastergroup modulation to form line frequency band, alternative 1
d) formation of line frequency band, alternative 2
All frequencies are in kc/s

The line frequency band in the 12 Mc/s system containing 2 700 channels consists of 3 supermastergroups, equivalent to 9 mastergroups, each mastergroup containing 5 supergroups and each supergroup containing 5 groups.

The modulation equipment for the formation of the supergroup (channel translating and group translating equipment) is described in previous articles in Ericsson Review (No. 2, 1961 and No. 2, 1962) and will not be dealt with here.

The modulation plan is shown in figs. 1a, 1b, and 1c.

Five basic supergroups in the frequency range 312–552 kc/s are modulated with the respective carriers 1 364 kc/s, 1 612 kc/s, 1 860 kc/s, 2 108 kc/s and 2 356 kc/s. The lower sidebands are extracted and combined to form a basic mastergroup in the frequency band 812–2 044 kc/s. The channels are inverted in this frequency band.

Three basic mastergroups are then modulated again with carriers 10 560 kc/s, 11 880 kc/s and 13 200 kc/s. The lower sidebands are extracted and combined to form a basic supermastergroup in the frequency band 8 516 kc/s–12 388 kc/s with the channels erect.

The line frequency band 316–12 388 kc/s is formed by modulating two basic supermastergroups with the carriers 16 720 kc/s and 12 704 kc/s respectively, extracting the lower sidebands and combining these with a basic supermastergroup in the range 8 516–12 388 kc/s. An alternative to this method of forming the line frequency band is obtained by putting in a normal 4 Mc/s band (the first supergroup is removed) consisting of 15 supergroups in the frequency range 312 kc/s–4 028 kc/s, instead of the supermastergroup which is translated to the frequency range 316 kc/s–4 188 kc/s using the carrier 12 704 kc/s. See fig. 1d. This permits the integration of earlier type equipment in a modern 12 Mc/s network in a simple manner.

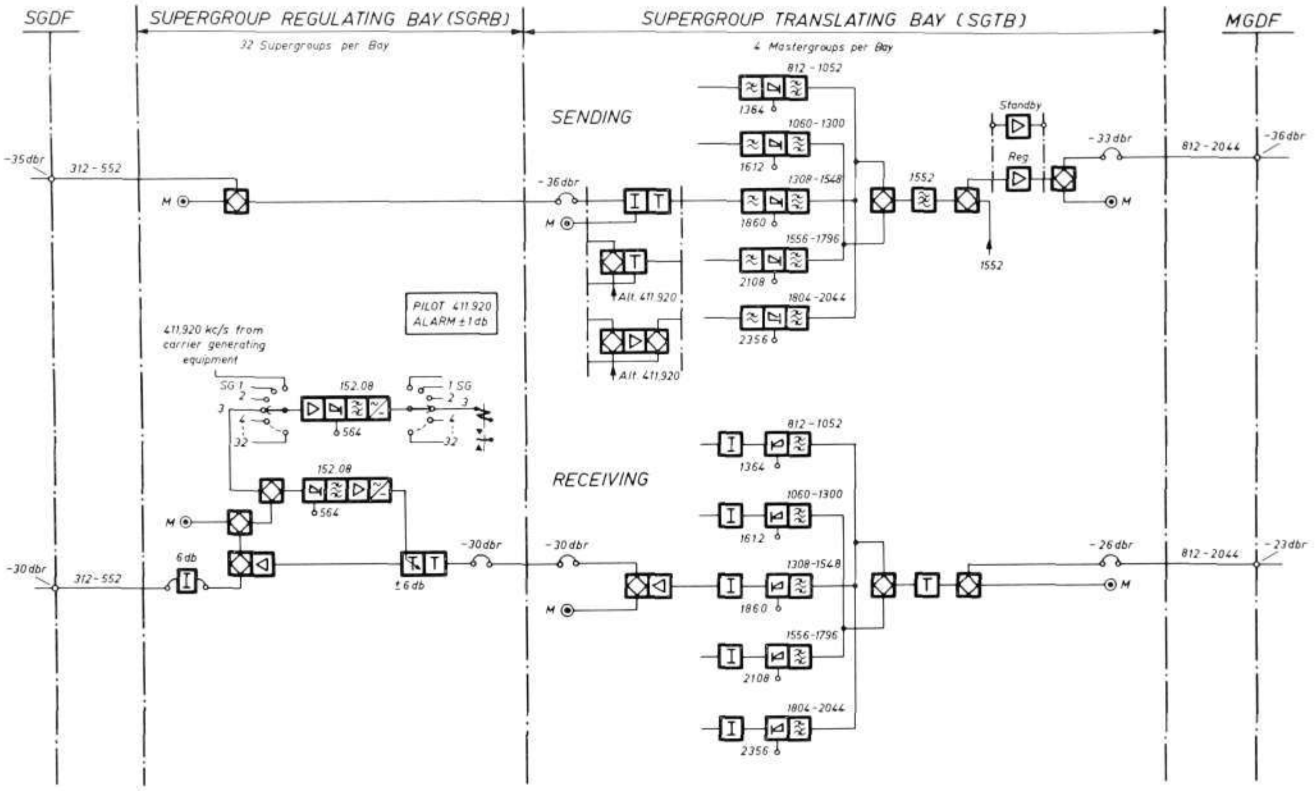


Fig. 2 X 7872

Block schematic for supergroup translating equipment and supergroup regulating equipment

All frequencies are in kc/s

Modulation Equipment

Figs. 2, 3 and 4 show the h.f. block schematics for the different equipment parts, with nominal signal levels given. It will be seen that each modulation stage is in principle built up in the same manner.

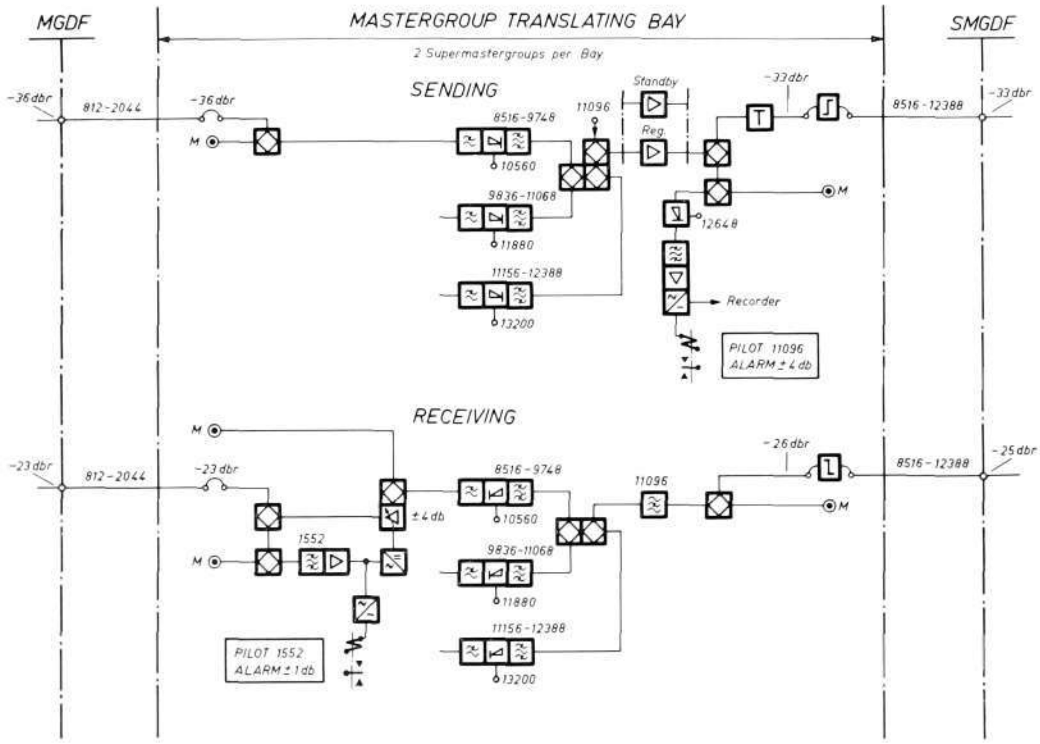


Fig. 3 X 7873

Block schematic for mastergroup translating equipment

All frequencies are in kc/s.

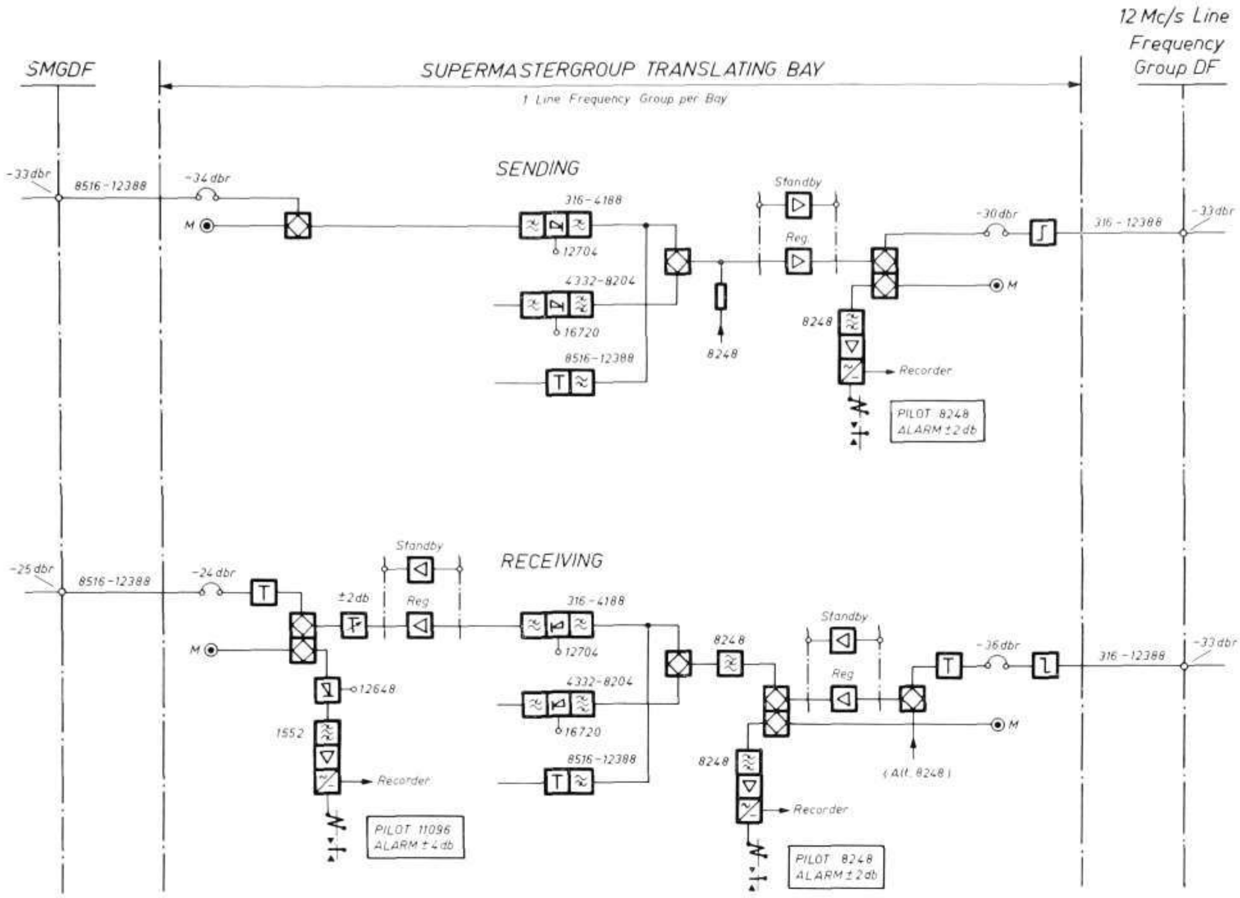


Fig 4 a X 7874

Block schematic for supermastergroup translating equipment for line frequency band alternative 1

All frequencies are in kc/s.

On the sending side, the signal is connected direct to the modulator units, and is then amplified after combination of the signals from the sideband filters, the combination being made in the conventional manner with a hybrid (differential transformer).

On the receiving side, the incoming signal goes direct to a hybrid connexion where it is split up and after demodulation is amplified. This division of the amplification gives good level conditions resulting in good noise characteristics. In addition the modulators and demodulators have approximately the same levels which has enabled these units to be made identical in most cases.

The attenuation at the high frequencies which occurs in transmission over the station cabling can no longer be neglected and to be able to maintain the fixed levels in the distribution frames, the modulation equipment has been designed to permit a certain amount of level adjustment. A cable attenuation of up to 3 db can be allowed for on the terminal side of the distribution frames for the mastergroups, supermastergroups and 12 Mc/s line groups. A cable attenuation of 1 db is permitted between the supermastergroup distribution and the supermastergroup translating equipment.

Due to the frequency dependence of the attenuation, a certain amount of equalization must be carried out, and the mastergroup translating and supermastergroup translating equipment has therefore been provided with plug-in type equalizing networks on the supermastergroup and 12 Mc/s line group sides. Equalization for the mastergroup is not necessary.

Modulators

Conventional ring modulators have been used in the supergroup and mastergroup translating equipment. These modulators are simple and good linearity has been obtained with reasonable carrier power.

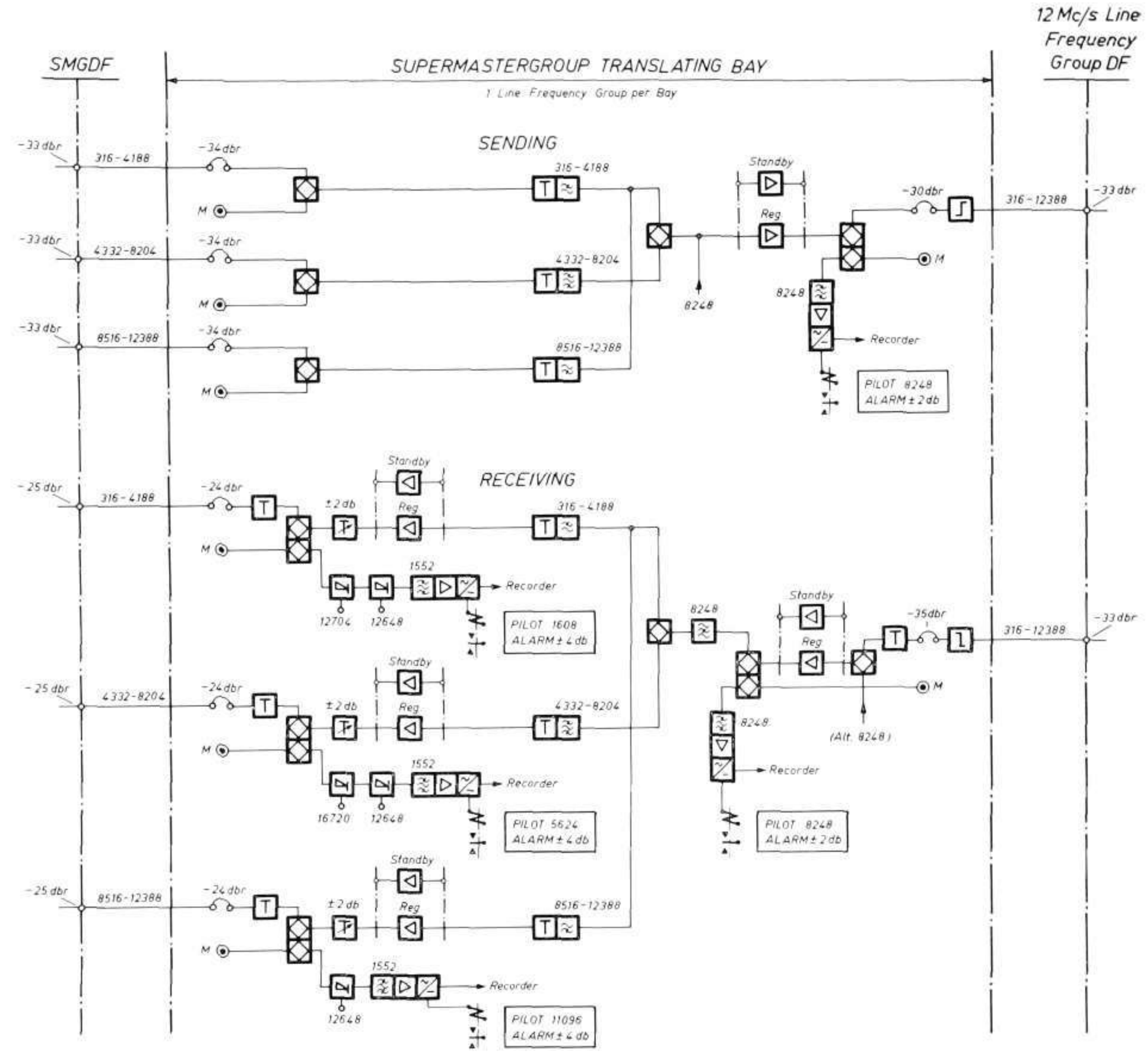


Fig. 4 b X 7875

Block schematic for supermastergroup translating equipment for through routing of supermastergroups in the line frequency band
All frequencies are in kc/s.

A circuit patented by L M Ericsson is used in the supermastergroup translating equipment. The circuit is characterized by the reverse voltage which is available for the non-conducting diodes not being limited to the voltage drop across the conducting diodes. Better linearity with the same carrier power is obtained in this way.

In this way the great linearity required for the supermastergroup can be obtained with reasonable carrier power.

High grade diodes are used to ensure extreme stability and long length of life. The filters are calculated and manufactured using the most modern principles. High quality ferrite cored coils and capacitors give low losses and great stability.

Amplifiers

The amplifiers in the equipment are transistorized as far up as the basic supergroup (upper frequency 552 kc/s). As there is insufficient operational experience of the length of life of high frequency transistors, the wide-band amplifiers in the h.f. range are designed using tubes, even if transistorization is theoretically possible. Uncertainties must be reduced to a minimum when dealing with amplifiers for such a large number of channels. Tube technique is nowadays completely mastered and for the tubes of L M Ericsson's manufacture, an average length of life of 30 000 hours has been guaranteed, although in practice this figure is 40 to 50 000 hours i.e. about 5 years. To obtain increased reliability the tube amplifiers have been designed with two amplifying loops across a feedback network, which means that a fault in one loop does not appreciably affect the transmission. It is not possible to use this principle in the case of transistorized amplifiers. Each tube current is continuously supervised and an alarm is given when the limits of tolerance are exceeded.

Owing to the relatively small number of amplifiers in the equipment the power consumption is not of great importance.

The two amplifying loops in the supermastergroup and 12 Mc/s line group amplifiers are fed from separate mains supply units which also further contributes to operational reliability.

Stand-by amplifiers placed in the respective equipment may be connected practically without causing interference in operation (interruption time is less than 2 ms). This is important as certain checks can only be made with great difficulty on amplifiers in traffic (e.g. linearity test).

Test Points

Even if all precautions have been taken to obtain the highest possible operational reliability, a certain amount of preventive maintenance is required. To ease this work, special test points for maintenance have been arranged. These are denoted by *M* on the block schematics.

The test points which are connected to the transmission path by means of hybrids are not affected by short-circuits and are not affected by poor impedance matching in the transmission path which could otherwise give rise to incorrect results. Maintenance measurements can therefore be made without the risk of causing interruptions to operation caused by faulty measuring equipment. As the test points have been placed so as to be directly accessible in the sides of the bay front, the gangways are not blocked by doors which would have to be opened to carry out measurements. To permit the rapid localization of a unit when it becomes faulty, fault finding test points have been provided at strategic points in the equipment. These test points are placed at the front ends of the plug-in units and are normally covered by the bay dust covers. The fault-finding test points are as a rule pure parallel test points. For fault-finding and commissioning purposes all inputs and outputs to and from the bay have been provided with coaxial break-type U-links.

The modulator filter units and amplifiers have been designed as plug-in type units. Rapid exchange of any possible faulty unit can easily be made. The manufacturing tolerances on each unit are very close and no readjustments are necessary in the system after an exchange has been made. The high stability and close manufacturing tolerances have made it possible to reduce the number of adjusting points in the system to a minimum thereby eliminating a very important fault source.

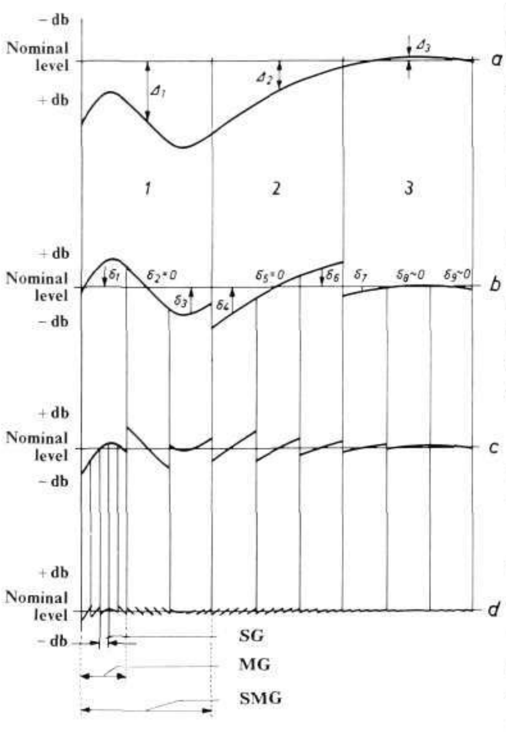


Fig. 5 X 2380

Example of level regulation

a) incoming line frequency band, level deviation from nominal value
b) level deviation from nominal value in the supermastergroups after supermastergroup regulation
c) level deviation in the mastergroups after mastergroup regulation
d) level deviation in the supergroups after supergroup regulation

Equipment for Level Supervision and Regulation

When sending over long distances it is not possible to avoid a certain variation of equivalent over the transmitted band. This so-called attenuation distortion can vary depending, for example, on rearrangement of traffic on other routes, through connexions, temperature variations of cable routes, aging of amplifying elements, etc. Even if certain variations are automatically compensated, residual errors still occur which are not constant over the transmitted band and which can add up to give excessive values. When it is impossible to predict how this loss will vary with frequency, regulation after the line band has been divided up into groups is the most suitable: such regulation can then be independent of frequency (linear).

These groups are in turn divided into smaller groups which can also be provided with linear level regulation, and by going down sufficiently far in the size of the group, variations in the nominal level can be made smaller–see fig. 5.

Pilots

To be able to check the equivalent in a group while in traffic and to be able to arrange its automatic level regulation, each group has been allocated a reference pilot frequency. This pilot follows with its group through the transmission network from the point where the group is formed until it is split up into smaller groups.

It will be seen in the block schematics figs. 2, 3 and 4 how the injection of the reference pilot is arranged immediately after the combination of the groups on the sending side. The pilot therefore passes through the sending amplifiers.

The reference frequencies are as follows:

		injected in:	
supergroup	411.92 kc/s	group	translating equipment
mastergroup	1 552 kc/s	supergroup	" "
supermastergroup	11 096 kc/s	mastergroup	" "
12 Mc/s line group	8 248 kc/s	supermastergroup	" "

The CCITT have not made any recommendation for the 12 Mc/s line group pilot. The equipment has been provided with the possibility of injecting the frequency 8 248 kc/s as the 12 Mc/s line group reference pilot. 8 248 kc/s has actually been allocated for use as an additional measuring frequency for the h.f. line, but CCITT have recommended two frequencies in the same interstice, 8 248 and 8 472 kc/s, and the 8 248 kc/s pilot can therefore in most cases be used as a reference pilot without causing inconvenience.

Level Supervision

Level supervision with alarm facility can be arranged by means of selective pilot receivers for the reference pilots in accordance with the following.

At the end of the supergroup translating equipment, receiving side (fig. 2).

At the output of the receiving side of the mastergroup translating and supermastergroup translating equipment. See figs. 3 and 4.

It has been considered suitable to provide the possibility of supervising each amplifier individually in equipment for supermastergroups and upward. Pilot receivers can therefore be fitted after the sending amplifiers in the mastergroup translating and supermastergroup translating equipment and after the 12 Mc/s line group amplifier, receiving. See figs. 3 and 4.

The pilot receivers for supervision of the supermastergroups and the 12 Mc/s line groups have been provided with outputs for recorders in addition to the alarm facility. In the case where the 8 248 kc/s pilot cannot be sent to the receiving station, for example due to branching, a point for injection of 8 248 kc/s has been provided at the input of the supermastergroup translating equipment on the receiving side.

The alarm limits can be chosen so that selective alarm is obtained.

The frequency 1 552 kc/s is obtained by modulation of the 11 096 kc/s pilot with 12 648 kc/s, and the same pilot receiver can therefore be used for the supermastergroup and mastergroup reference pilots.

Level Regulation

The supergroups and mastergroups can be provided with automatic or manual level regulation. As the supermastergroup constitutes such a large part of the line frequency band, automatic regulation is not warranted and only manual level regulation has been anticipated. The regulation is smooth and cannot cause interruptions. The equipment for regulation and supervision of the supergroups is placed in a special bay, whereas that for the mastergroup and supermastergroup regulation is built together with the respective translating equipment.

The automatic level regulating equipment is of the continuous type; the pilot current from the pilot receiver controls the gain in the signal path via a reference circuit and a thermistor network.

To allow the functioning of the level regulation to be checked, a maintenance test point is brought out at the input of the level regulating equipment. Measurement of the unregulated level and the output level (regulated) provides information about the regulation state and whether there is a fault in the equipment.

Owing to the large number of supergroups in a 12 Mc/s station, the supergroup control functions have been made automatic. A separate pilot receiver carries out the level regulation for each supergroup. A common pilot receiver for supervision investigates the regulated supergroup levels in turn. At each cycle the pilot receiver is connected to the local supergroup pilot from the carrier and pilot generating equipment and checks itself in this manner. See the block schematic, fig. 2.

The pilot level and thermistor heater current can also be measured on an instrument built into the bay.

Suppression of Reference Pilots

When a group is split up at the end of a group link, the reference pilot of the group must be suppressed as otherwise it would be demodulated and could pass through to another system via through connexion of smaller groups.

Suppression must be made on the terminal side of the respective group distribution frame, and can be realized either on the receiving side of the translating equipment, in the through connexion filter or in the sending side of the translating equipment before the point where the pilot is injected.

The 1 552 kc/s mastergroup reference pilot, which lies in the centre of an 8 kc/s interstice between two supergroups, will be stopped automatically in the supergroup through connexion filter since CCITT has already recommended stopping the h.f. line intersupergroup pilots for 4 Mc/s systems in this manner and these lie at 4 kc/s from the supergroup bands. The suppression is, however, not sufficient if there is through connexion from a 4 Mc/s system to a 12 Mc/s system, as the difference in level between the reference and intersupergroup pilots is 10 db. Extra attenuation at the supergroup reference pilot frequency is provided on the sending side in the supergroup translating equipment, see fig. 2.

The 11 096 kc/s supermastergroup reference pilot is stopped on the receiving side in the translating equipment, fig. 3. The pilot does not lie symmetrically in the interstice and it is therefore not suitable to stop it in the mastergroup through connexion filter. In addition, the stopping should not be carried out in the sending side of the translating equipment as it would result in a somewhat lower input level for the sending amplifier, resulting in an increased noise contribution.

The same argument applies for the siting of the stop filter for the 12 Mc/s line reference pilot, fig. 4.

Power Supply and Alarm

All equipment normally receives its operating voltages from separate mains supply units in each bay. The advantages of this principle are that the currents in the power cabling of the station are smaller and the operational reliability increases as the mains supply units supply a smaller part of the equipment. The mains supply units have been mounted at the top of the bay so as to avoid heating up the rest of the equipment by dissipation. The fusing of the bays is carried out in such a way that there is the least possible interference to operation in the event of a fuse blowing. As an example, each "half" of an amplifier is individually fused. The fuses are provided with alarm contacts combined with a visual signal and are placed so as to be easily seen, at the sides of the bay beside the respective equipment.

Alarm Unit

Alarms from the level supervision equipment and alarms for blown fuses, etc. are combined in a central alarm unit in each bay. In this unit there are also relays for supervision of the operating voltages. Two types of alarm are sent out from the alarm unit to the station alarm system. These are for so-called urgent alarm (A-alarm) and for non-urgent alarm (B-alarm) depending on whether the fault causes an interruption to traffic or not. At the same time clearly visible bay alarm lamps placed at the top left of the bay front are lit; one lamp for the A-alarm and one for the B-alarm. In addition, secondary alarm lamps are lit which give more detailed information of where the fault occurs. These lamps are located at the sides of the bay front beside the respective equipment.

To ensure the reliability of functioning of the alarm system when the bay supply voltages fail, provision has been made for connexion of an auxiliary voltage.

Through Connexion Filter Equipment

It is not usual that all carrier circuits coming into a station are terminated there. In most cases, a large number of circuits are through connected to other stations.

It would be particularly uneconomic to demodulate these channels to the voice frequency band 300–3 400 c/s and then after through connexion to remodulate these channels to their position in the transmission band. An unnecessarily large amount of equipment would be required and furthermore an unnecessary reduction in quality would be obtained. Each stage of modulation gives for example an unavoidable contribution to noise.

Whole groups are instead routed to other group sections. When this is arranged in the basic frequency range of the groups, the procedure is called through connexion and because each group has its particular standardized basic frequency range, as given in Section 2, very great flexibility in connections is obtained.

By using standardized groups, through connexion can be arranged between different types of system. All groups of the same type in a station are brought to a central distribution frame and can here be connected for termination or for through connexion. Through connexion can be arranged for basic groups, supergroups, mastergroups or supermastergroups.

For practical reasons the h.f. modulating equipment is not so selective that through connexion can be made without providing extra protection from filters. The through connected group must be passed through a filter to remove certain modulation products and remnants from neighbouring groups which would otherwise give excessive crosstalk between the two systems which are concerned in the through connexion.

The through connexion filter equipment is placed in special bays and is connected to the respective distribution frame of the station. Fig. 6 shows a bay layout diagram for a 12 Mc/s station with two systems where one supermastergroup and two mastergroups are through connected.

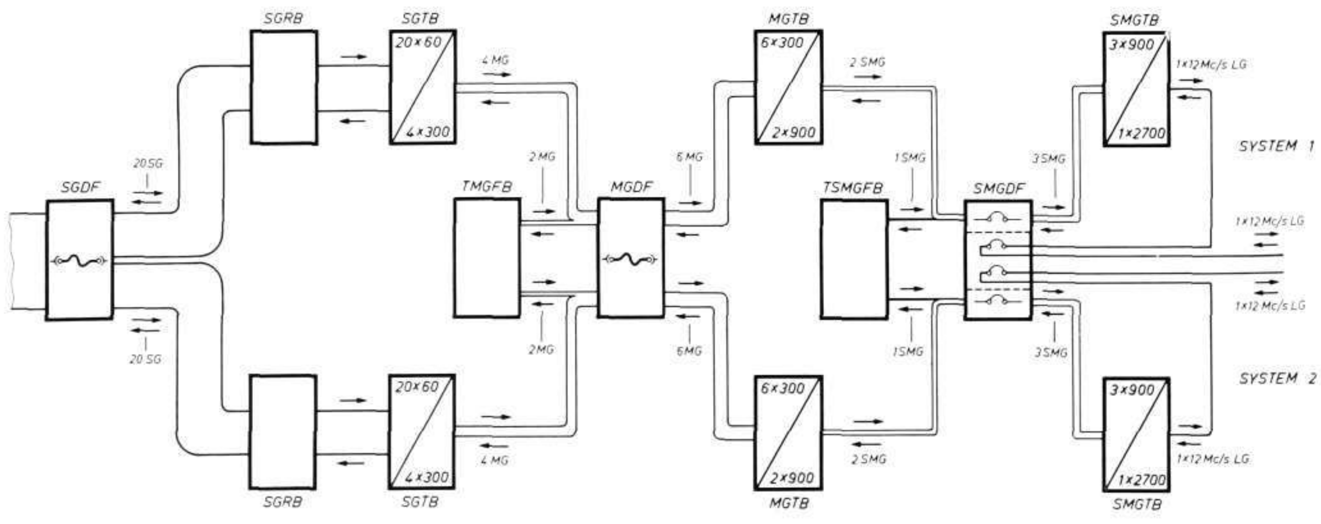


Fig. 6 X 7876

Bay arrangement fo a 12 Mc/s terminal station with two fully loaded systems. One supermastergroup and two mastergroups are through connected.
For abbreviations see next page.

By employing refined calculating methods and the highest quality ferrite coils and capacitors, it has been possible to avoid using amplifiers in all through connexion filter equipment. This has resulted in a cheaper equipment which is more operationally reliable.

There is a special type of filter for the supermastergroups which permits direct through connexion in their respective positions in the line frequency band. The reduced flexibility which is thereby obtained is sufficient in many cases. The method has the advantage of not requiring any modulation and thus involves a slightly smaller noise contribution. An extra filter is not required for supermastergroup 1 as the supermastergroup translating equipment provides sufficient protection. The filters are placed in the same bay that is used for the normal through connexion filters.

For reasons of stability, the through connexion filters have been mounted in hermetically sealed boxes. All through connexion equipment has been designed so that the transmission of radio programs is possible without having to state restrictions on the position of the program channels in the frequency band.

Distribution frames also belong to the through connexion equipment. In these frames there are jacks for the modulation equipment and the through connexion filters. Connexions for termination or through connexion and the routing of traffic can easily and quickly be made in a clear manner by means of locking patch cords for the distribution frames for groups, supergroups and mastergroups and by U-links for the distribution frames for supermastergroups and 12 Mc/s line groups.

The reference pilot can be injected into possible spare group sections to permit their supervision.

Bays

The equipment consists of modulators, filters and amplifiers which are designed as plug-in type electrical and mechanical units placed in the bays.

From the description of the through connecting equipment, it will be seen that all groups of the same type in a station are assembled at the central distribution frame for reasons of flexibility. A natural corollary of this is that each bay should only contain one type of modulation equipment. Thus one bay only contains equipment for modulation of supergroups to mastergroups, another bay only contains equipment for modulation of mastergroups to supermastergroups etc. In this way the bay and station layout is surveyable and easily managed by the operation and maintenance staff. This principle has produced the following types of bay.

Designation	Abbreviation	Capacity
Channel translating bay	CTB	5 basic groups
Group distribution frame	GDF	360 jacks (90 groups)
Through group filter bay	TGFB	16 pairs through connexion filters
Group translating bay	GTB	6 basic supergroups
Supergroup distribution frame	SGDF	360 coaxial jacks (90 groups)
Through supergroup filter bay	TSGFB	26 pairs through connexion filters
Supergroup regulation bay	SGRB	32 supergroups
Supergroup translating bay	SGTB	4 mastergroups
Mastergroup distribution frame	MGDF	360 coaxial jacks (90 groups)
Through mastergroup filter bay	TMGFB	16 pairs through connexion filters
Mastergroup translating bay	MGTB	2 supermastergroups
Supermastergroup and 12 Mc/s line group distribution frame	SMGDF	
Through supermastergroup filter bay	TSMGFB	16 pairs through connexion filters
Supermastergroup translating bay	SMGTB	1 line group

It will be seen above that the 12 Mc/s line group distribution frame has been placed in the supermastergroup distribution frame as the number of 12 Mc/s line groups is as a rule low and does not warrant a special bay.

The group, supergroup and mastergroup distribution frames are identical in construction. The same design of through connexion filter bay is used for all types of through connexion filter.

Fig. 6 shows the arrangement of the different bays in a 12 Mc/s terminal.

Flexibility

As the work of standardization by CCITT could progress with the development of the 12 Mc/s system, the equipment has been well defined and interworking with equipment of other manufacturers is made possible in most cases without extra measures being necessary. However, problems can arise regarding the levels of the group and basic supergroup. The levels at the distribution frames are for example not standardized and many different variants are in service today. L M Ericsson's channel, group and supergroup translating bays have therefore been designed so that matching of levels can easily be made.

On the supergroup side of the supergroup translating equipment the following levels can be accepted:

Sending side, minimum	– 47 dbr
Receiving side, maximum	– 34 dbr

The block schematic, fig. 2, shows the amplifier which in these cases replaces the maintenance test unit on the sending side.

Earlier group translating equipment often had no facility for injection of the supergroup reference pilot and it has therefore been considered suitable to be able to provide this facility in the supergroup translating equipment. Only one pilot distribution unit and a variant of the maintenance test unit is necessary at the supergroup input; see the block schematic, fig. 2.

As mentioned earlier under the heading "Through connexion filter equipment" a facility is provided for through routing the supermastergroups in their position in the line frequency band. To be able to realize this it is necessary to modify the supermastergroup translating equipment to function as shown in the block schematic, fig. 4b. The only thing that needs to be done is to make some rearrangement of U-link connexions in the bay. The modulators are disconnected from the signal path and in the pilot receiving equipment thereby avoiding variants of the pilot receivers which would otherwise need to be matched to the pilots in their modulated positions in the line frequency band.

A third operational case for the supermastergroup translating equipment is obtained if a restricted 4 Mc/s frequency band is used instead of the first

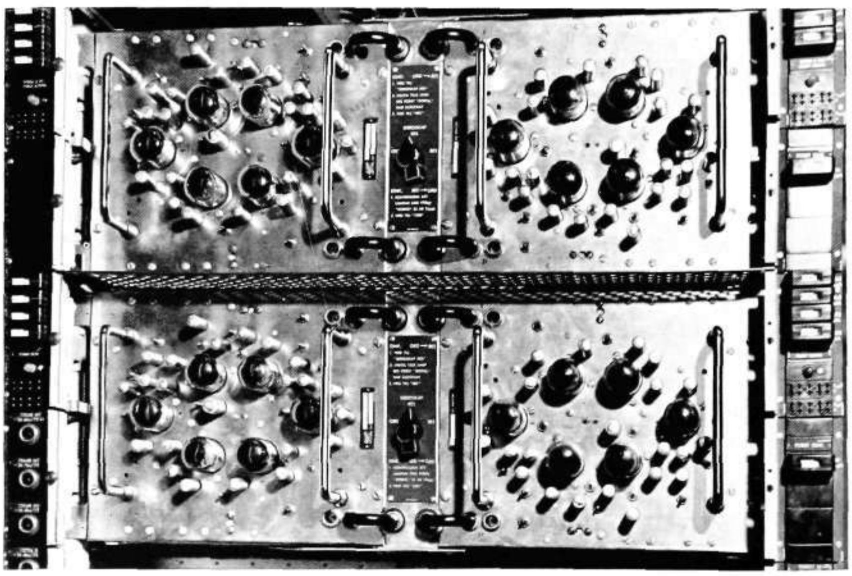


Fig. 7 X 8402

Detail from a supermastergroup translating bay

Top, sending amplifier with standby; bottom, receiving amplifier with standby. Note the connexion of the amplifiers to the changeover unit in the middle.

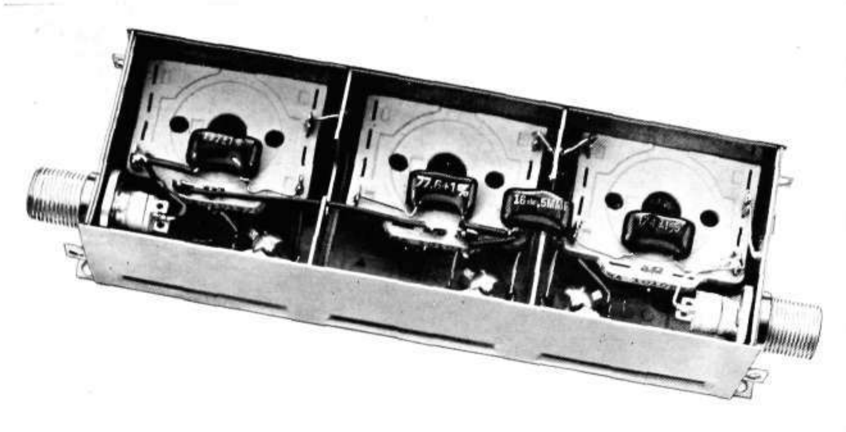


Fig. 8 X 8403

Part of a filter using the high frequency method of construction. Cover plate removed.

supermastergroup (see the chapter entitled Modulation Plan). Rearrangements are also made here by means of U-links. If supervision is required for the 4 Mc/s band, this can be arranged by using the 1 552 kc/s pilot. CCITT has not made any recommendation regarding a pilot for a 4 Mc/s band, but 1 552 kc/s, which in this case is an intersupergroup pilot, can in most cases be used for this purpose without inconvenience.

When an Administration is faced with the problem of converting its 4 Mc/s coaxial network to 12 Mc/s, it can in certain cases be desirable to retain the existing terminal equipment for a further period. This is made possible by means of a special modulator equipment, designed by L M Ericsson, which modulates a restricted 4 Mc/s band consisting of supergroups 2–16 to the frequency band of a supermastergroup. Modulation is made using the carrier 12 648 kc/s and the lower sideband 8 620–12 336 kc/s is used. The bay contains equipment for two 4 Mc/s bands, sending and receiving.

Mechanical Design

L M Ericsson's method of construction for the low frequency range, used for frequencies up to 600 kc/s, is described in Ericsson Review No. 4, 1960.

For higher frequencies the method of construction must be modified for natural reasons. Vacuum tube amplifiers are used in the region around 600 kc/s and above, and to provide cooling for the units with tubes, all units have been set back from the front so as to form a cooling chimney between the dust covers and the units in the bay. The amplifiers are built on vertical chassis with the tubes horizontal to obtain the most effective cooling, see fig. 7. It is very important to try to reduce the temperature rise of the units as this very much affects the length of life of components. For the same reason, the cooling chimney is brought out and a new air inlet is provided for the places in the bay containing modulators and filters.

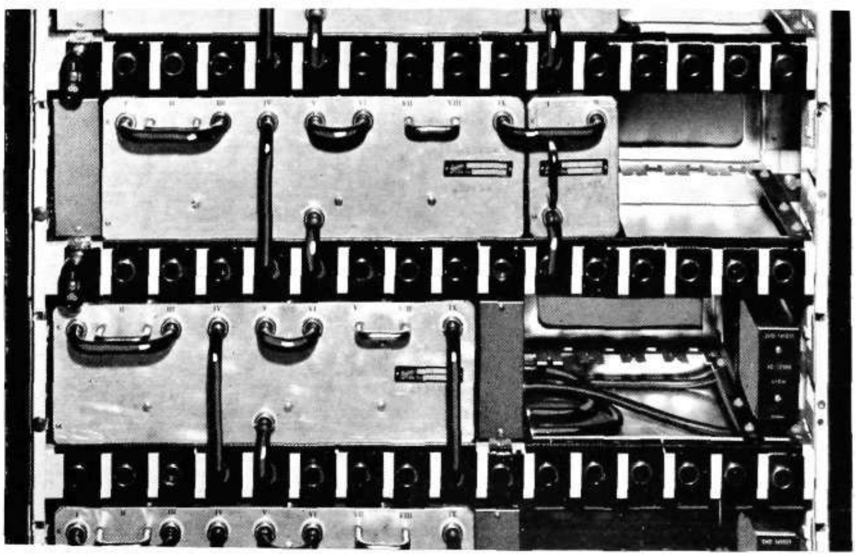


Fig. 9 X 8404

Part of supermastergroup translating bay showing the construction of the modulator filter units and their connexion (high frequency method of construction)

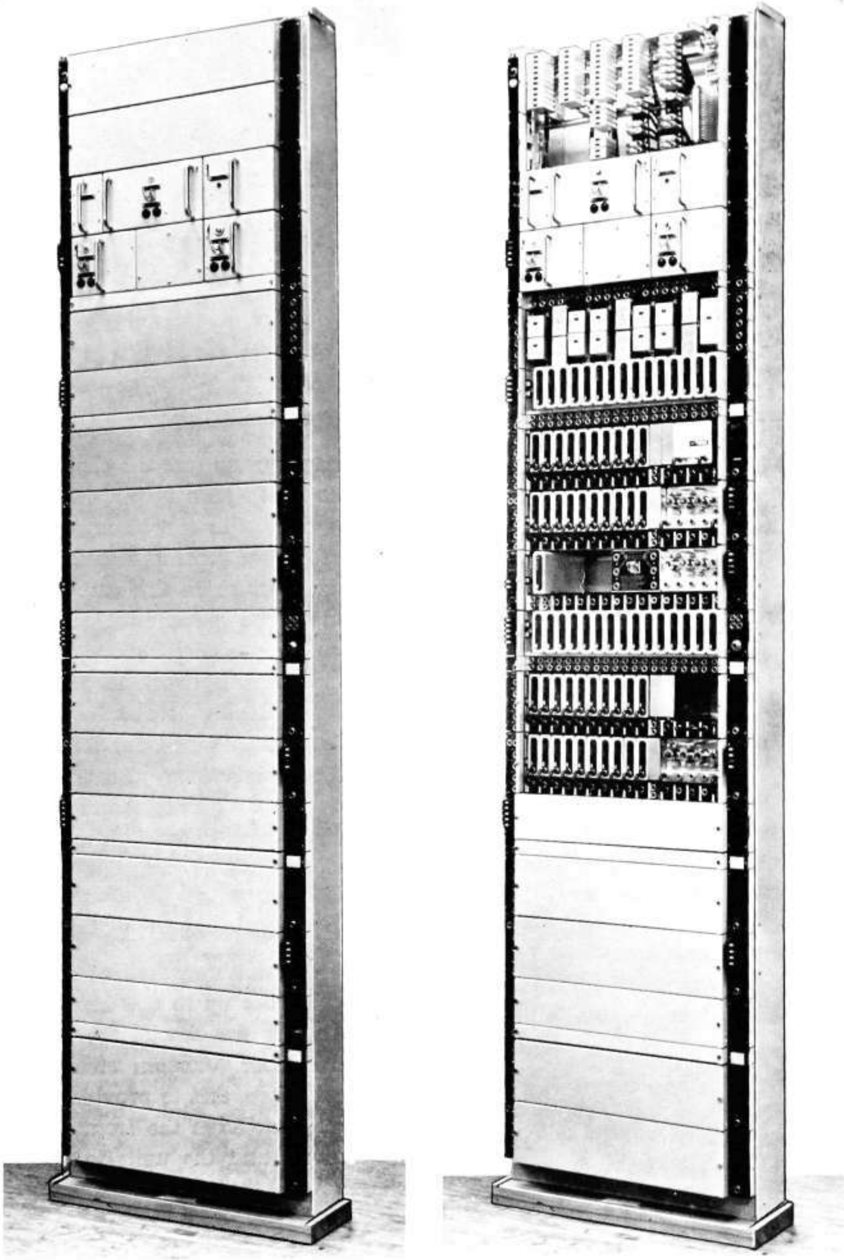


Fig. 10 X 2682 X 2683

Supergroup translating bay

The right hand figure shows the bay with some of the dust covers removed.

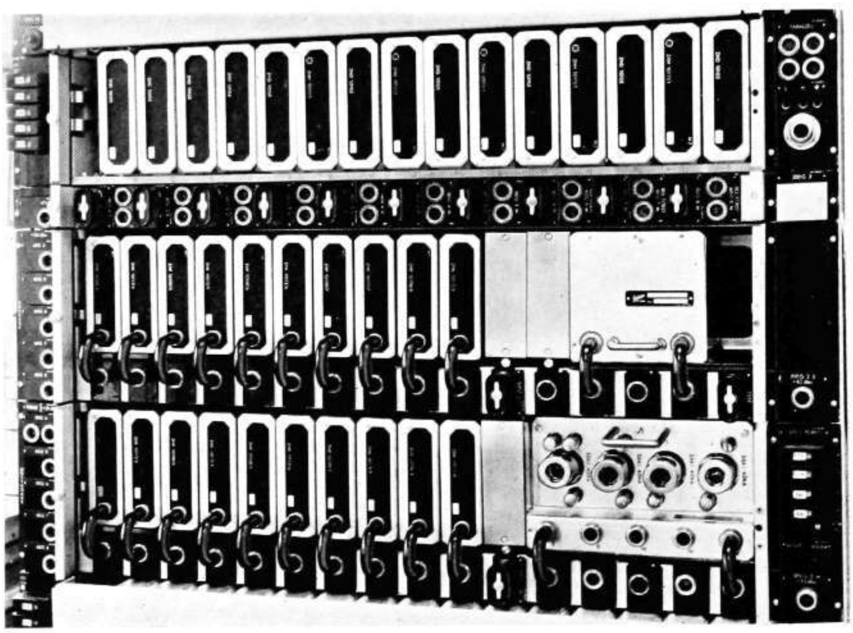


Fig. 11 X 8405

Detail of the supergroup translating bay. Equipment for one mastergroup.

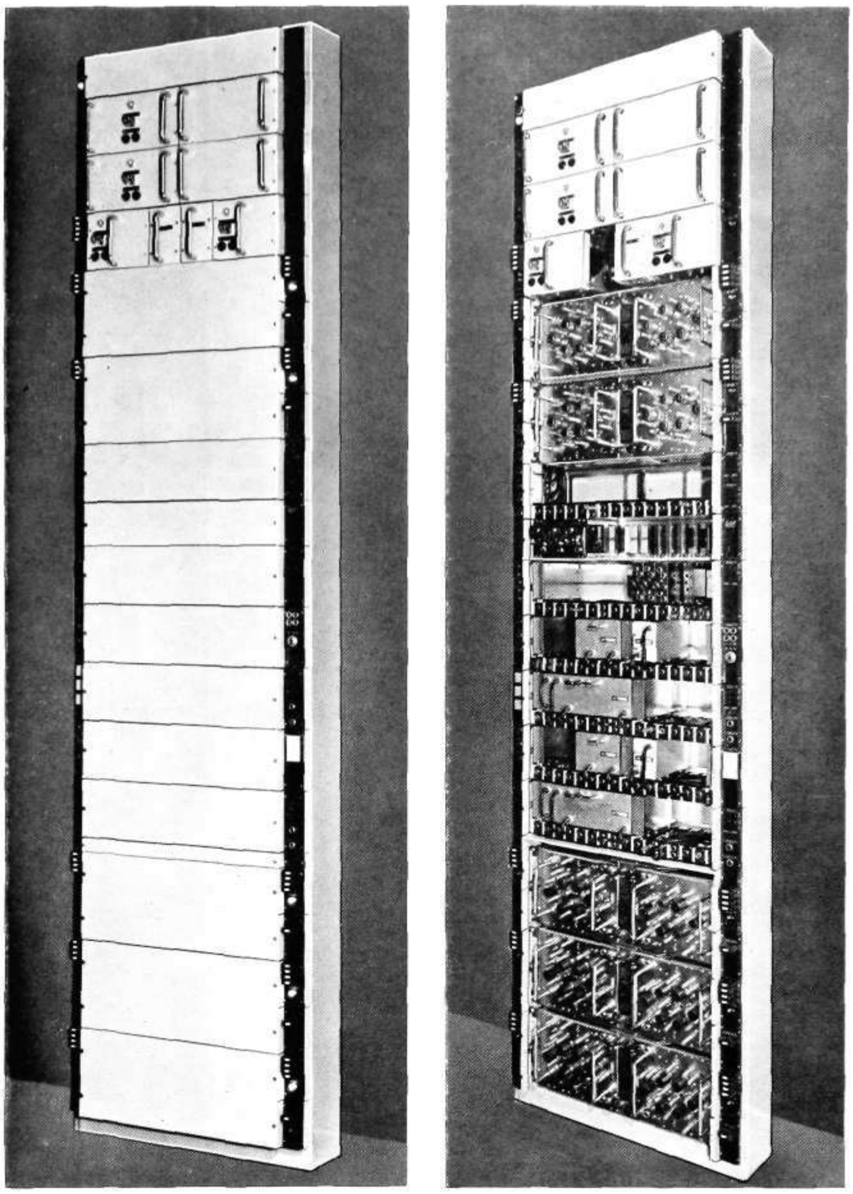


Fig. 12 X 2384 X 2685

Supermastergroup translating bay

The right hand figure shows the bay with the dust covers removed.

The units must be designed so that they are completely screened, and in certain cases it is also necessary to have separate screening between each filter circuit. These special requirements have resulted in a filter construction shown in figs. 8–9 and can be used in the h.f. range up to about 40 Mc/s. All units such as modulators, filters and amplifiers can be replaced directly and are plugged into the bay. All low frequency connexions are made automatically with plug and jack at the rear of the unit. All h.f. connexions are made at the front of the units by means of coaxial U-links to an associated underlying field which at the same time permits easy storage for the bulky coaxial cabling to the respective shelf (fig. 9). Exceptions to this are the supermastergroup and 12 Mc/s line group amplifiers which are connected to a change-over unit, fig. 7. The technique of using coaxial U-links also permits easy connexions in the h.f. path. An example of this is the connexion of the supermastergroup translating equipment for direct through connexion of a supermastergroup in the line frequency band.

Figs. 10 and 11 show the supergroup translating equipment, which is an example of bay for the intermediate frequency range. A number of units on the supergroup side which use the low frequency method of construction are included in the bay. The coaxial connexion of modulator filter units, mastergroup amplifiers and the natural way in which the two methods of construction is brought together are shown in the figures.

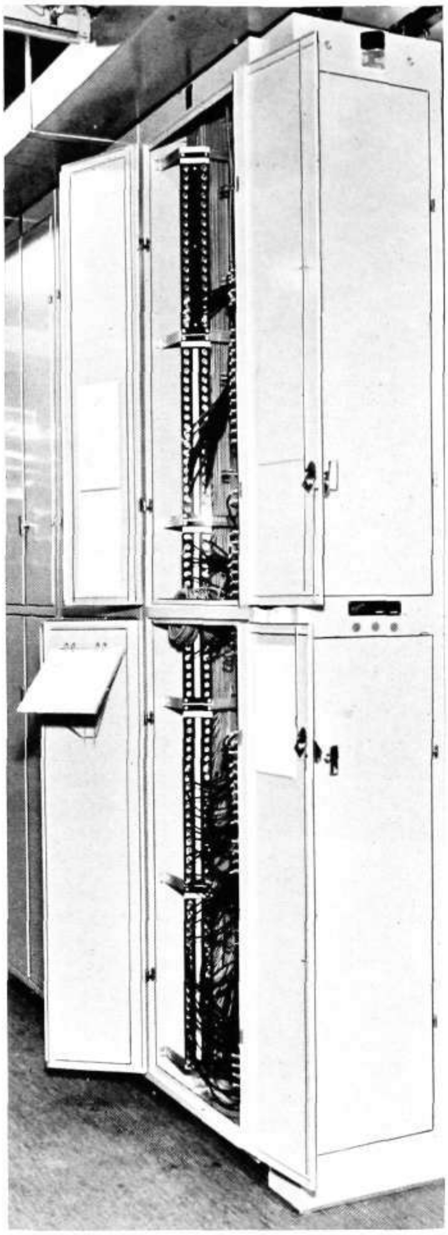


Fig. 13
Distribution frame

X 2386

Figs. 12, 7 and 9 show the supermastergroup translating equipment which are examples of a bay using pure h.f. method of construction. Note the coaxial U-links for the filters and amplifiers, the placing of the maintenance measuring points, fuses and the alarm lamps at the sides of the bay front. The mains supply unit and the bay connexion panel are seen at the top of the bay.

Fig. 13 shows the design of the group distribution frame.

Technical Data

General

Power supply, a.c.

Nominal voltage 110, 127 or 220 V ± 10 %

Variation of nominal voltage ± 2 %

Frequency 50 c/s ± 10 c/s

Ambient temperature max. 40° C

Relative humidity max. 90 % at 20° C
max. 70 % at 40° C

Bay dimensions

Height 2 743 mm

Width 670 mm

Depth 236 mm

(The group distribution frame has twice the above depth)

Weight per fully equipped bay approx. 300 kg

Other data are given in the following table.

	Supergroup translating bay + regulating bay	Mastergroup translating bay	Supermaster-group translating bay
Variation of equivalent within the respective group relative to its reference pilot, sending or receiving, not greater than	± 0.5 db relative to 411.92 kc/s	± 0.5 db relative to 1 552 kc/s	± 0.5 db relative to 11 096 kc/s
All combinations of near-end and far-end crosstalk, not less than	85 db	85 db	85 db
Noise in a loaded system. Psophometrically weighted value measured at a point of zero relative level for the worst channel (sending + receiving), not greater than	50 pW	50 pW	50 pW
Carrier leak on the sending side, not greater than	— 40 dbmO	— 40 dbmO	— 30 dbmO
Regulating range for the respective group receiving side	± 6 db	± 4 db	± 2 db

A typical graph of equivalent for the supergroup through connexion filter is shown in fig. 14.

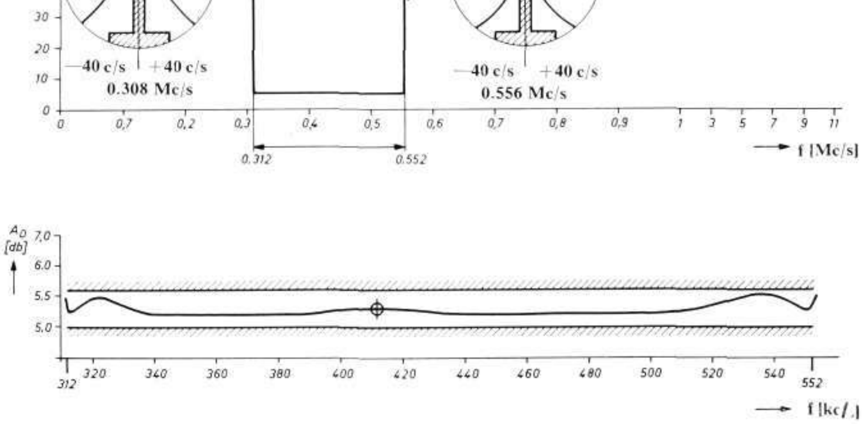


Fig. 14 X 7861

Typical graph of the equivalent for a supergroup through connexion filter

The New Telephone Exchanges in Tunis

HABIB BEN CHEIKH, CHIEF ENGINEER, TUNISIAN PTT

UDC 621.395.722
621.395.344.6
LME 8344

The cut-over on November 30, 1962, of the new L M Ericsson crossbar exchanges in Tunis and its northern suburbs brought to an end the previously difficult, and sometimes dramatic, state of telecommunications in the country. The new exchanges, which represent the first step in the conversion of the entire Tunisian network to automatic operation, are described in this article.

The importance of the new crossbar installations in Tunis will be best realized if I say a few words about the old equipment and about the development of the telephone traffic in general.

The Public Telephone Network before 1957

Most of the older automatic exchanges and the trunk exchange in Tunis were installed in 1928. The former were chiefly Strowger and R-6 equipments. The R-6 system, developed by Thomson-Houston in France, was built up of decadically grouped 51-line rotary step-by-step switches under the control of marker devices. When the replacement of these old equipments was under consideration after the war, the authorities at that time decided to expand and successively replace the existing equipments by a new system called L43 which had only just then been developed in France by CIT. L43 was a register-controlled system, also with rotary step-by-step 51-line switches in decadic grouping. Some 5 000 lines of L43 equipment were installed in the three automatic exchanges in Tunis, viz.

Central Angleterre (8 000 lines Strowger, 2 000 lines L43, and manual trunk equipment)

Central Kasbah (2 000 lines L43)

Central Belvédère (1 300 lines R-6, 1 000 lines L43, 500 lines manual Ericsson equipment)

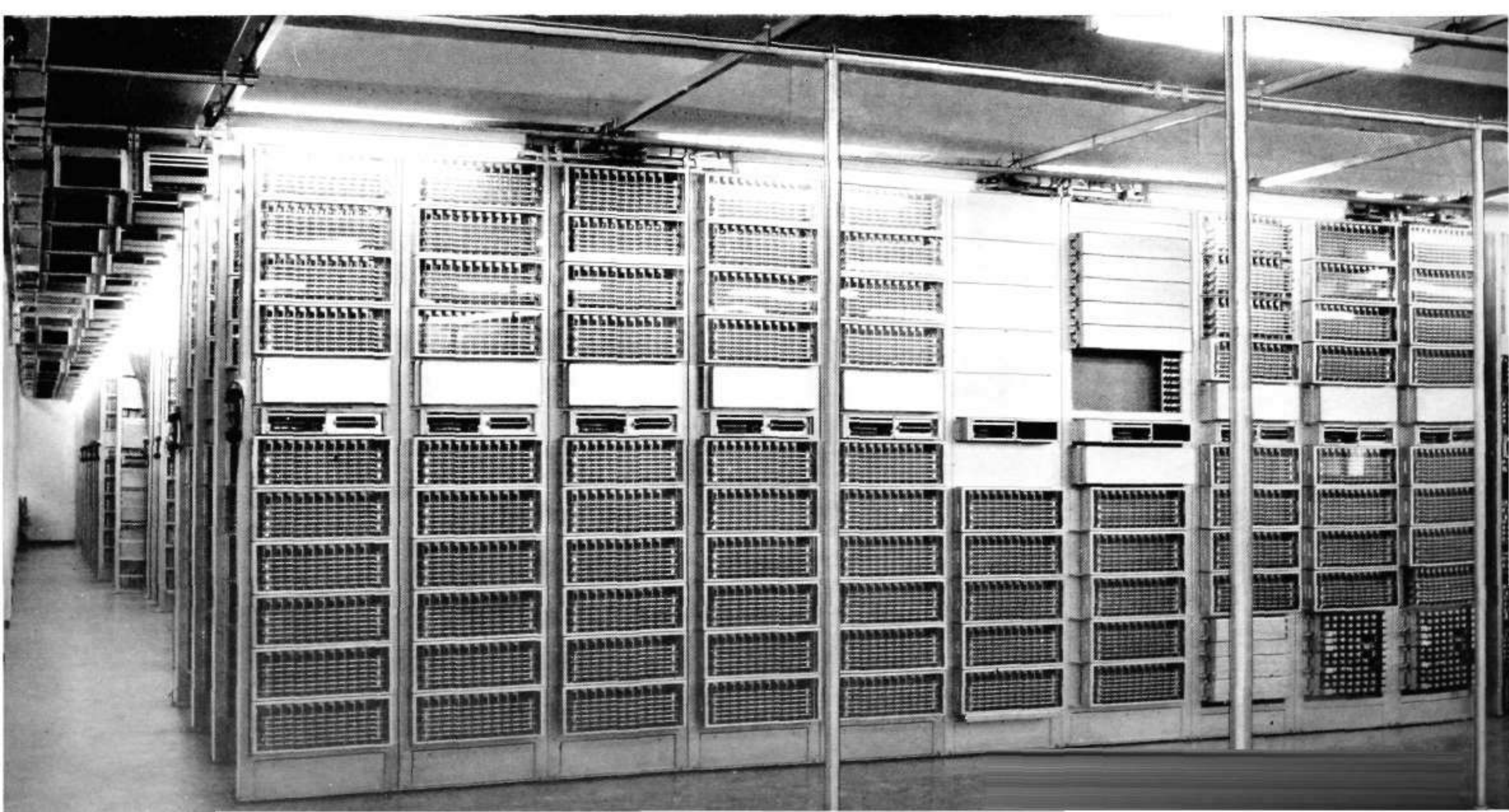


Fig. 1 X 7867
The automatic switchroom in the Carthage exchange

The suburbs were served by manual C.B. systems. The junctions from the suburban exchanges ran to the Angleterre trunk exchange, which handled outgoing inland traffic as well as the traffic to the Tunis suburbs.

The L43 system did not come up to expectations. The PTT thus had two main worries: in addition to the exacting maintenance of the Strowger equipment, the L43 equipment called for frequent adjustment, while the already high traffic continued to rise.

The reason for the large increase in traffic deserves special mention.

With the attainment of independence a number of services, which had earlier been supervised by the French administration, acquired a new importance. New foreign embassies, press and news agencies, economic, social and cultural organizations—all with a large need for telephones—brought an immediate and sharp increase in the already high telephone traffic, which thereby rose considerably above the capacity of the existing installations.

At certain exchanges the number of busy hour calls sometimes amounted to one-quarter or one-third of the total 24-hour rate, whereas normally it is not above one-sixth or one-seventh. At the same time the waiting list numbered several thousand would-be subscribers.

The PTT Decision in 1957

In 1957 the PTT under President Habib Bourguiba's first government decided to adopt radical measures and to replace all telephone exchanges in the capital and its surroundings.

By introducing a fully modern system and building up the network on rational lines, it was desired to create the conditions necessary to meet the present and future needs of the country within so important a sector as telecommunications. This decision opened the way for future full automatization of the Tunisian telephone network.

Tenders were called for and submitted by nine manufacturers from different countries. After thorough study of the various proposals the PTT decided to accept L M Ericsson's crossbar system. The first contract was signed in 1959 and since then seven *ARF* exchanges totalling 26 000 lines have been put in service in Tunisia. *ARF* equipments for an additional 14 400 lines and *ARK* and *ARM* equipments for, respectively, 2 990 and 1 380 lines have been ordered.

Interim Measures

While waiting for the first crossbar exchanges to be put in service, which was expected to take three and a half years, it was necessary to adopt various measures without delay, the most important being:

Extension of the Belvédère exchange by manual positions.

Installation of a switching point (Kasbah G) to handle the traffic of the government departments independently of the city network.

Extension of the Belvédère Exchange

The Belvédère exchange serves the residential area, where the foreign embassies are also located. It was therefore necessary to find a quick and effective solution to the already fully utilized capacity of the exchange. A 500-line manual C.B. exchange with four positions was ordered from L M Ericsson and installed by the PTT in the Belvédère exchange building.

Connection of the manual equipment to the automatic network was effected on a group of a dozen circuits with PBX calling of the manual positions. The positions were equipped with automatic circuits for outgoing calls to the automatic exchange in Tunis. Trunk and international traffic was passed through direct junctions to the Tunis trunk exchange.

Fig. 2 X 2396
The Carthage exchange

Kasbah G

The administrative services in Tunis were affected more than other subscribers by the increasingly serious telephone situation. A quick solution had to be found at a reasonable cost, which would retain its value even after the new L M Ericsson equipment had been installed.

To find a quick remedy for the insufficient capacity of the public exchanges it seemed natural to combine all administrative service switchboards into a single unit. This solution would bring two advantages: satisfactory handling of the government telephone traffic, and so relief of the overloaded public network. It would not be too expensive, and it would require a limited cable network since the departments concerned are concentrated in the Kasbah area. To utilize this new switching point to the maximum, the intention was to connect to it various other subscribers such as official or semi-official organizations of vital importance to the country—public undertakings, banks, newspapers, schools, hospitals etc.

On June 22, 1961, therefore, a 2 000-line *ARF 101* system with high traffic capacity to serve the "government departments" was installed in the Kasbah exchange building under the name Kasbah G. The traffic with city subscribers is handled at 14 operators' positions.

The result was excellent. The government departments did not need to wait till the end of 1962 to have a telephone which works.

The New Equipments in Tunis

Buildings

Two of the three Tunis exchanges have been placed in new premises. For the two 10 000-line groups in the largest exchange, Angleterre, a new building has been erected at Avenue de Carthage for equipments with ultimate capacity of 40 000 lines. Another new building for 20 000-line ultimate capacity has been erected in Belvédère. In the Kasbah area the new crossbar equipments, the new trunk exchange (the old one was located in the Angleterre), and the Kasbah G have all been accommodated in the old building erected in 1952.

Capacity of the New Exchanges

The number of already installed lines is at present 12 000 in Carthage, 5 000 lines in Belvédère, 4 000 in Kasbah, 1 000 in La Marsa, and 1 000 in Le Kram. The two latter exchanges are in the northern suburbs of Tunis.

Characteristics of the Crossbar System

The large local exchanges have been equipped with the Ericsson crossbar system *ARF 10*. The system is well known, and this account will be restricted to a few of its prominent features, which are also characteristic of the other Ericsson systems for rural automatization (*ARK*) and transit exchanges (*ARM*).

The crossbar switch possesses excellent contact properties, which has been an important factor in the quality of transmission on long distance subscriber dialled calls, which often pass through many switching stages. Another characteristic of the crossbar switch is its very short switching time, which has been put to the best use through the design of the systems as register-controlled bypath systems with markers. Register control also permits great flexibility in the direction of traffic. These properties ensure the best utilization both of the exchange equipments and of the cable network. The structure of the system in the form of small plug-in units allows flexibility in adaptation to actual traffic requirements. The high reliability of the systems, moreover, results in low maintenance costs.

Trunk and International Traffic

The 500-line trunk exchange contains 82 operators' positions divided into four independent groups for outgoing demand service, outgoing delay service, incoming and transit calls, and concentration positions.

Thirty-two demand positions, called on code 15, handle traffic to the majority of exchanges in the country. Thanks to the adequate supply of circuits between the capital and the various transit exchanges, calls are set up while the caller remains on the line. The operator starts automatic metering by pressing a button corresponding to the relevant unit tariff. All new installations are equipped for time-zone metering, based on conversation time and

Fig. 3 X 7868
The Kasbah trunk exchange

distance between the subscribers: pulses are sent to the calling subscriber's meter at intervals inversely proportional to the distance.

Fourteen code 10 positions handle traffic to the southern suburbs, the number of circuits to which is insufficient to permit demand working. These operators can also take over calls from the demand positions when the latter cannot obtain access to a free circuit on a particular route.

Incoming and transit calls are handled at 20 positions at which all incoming circuits are multiplied and indicated by call lamps.

The trunk exchange also comprises 16 concentration positions equipped for handling all the aforementioned types of traffic. The number of operators can thus be reduced considerably during low traffic periods.

Then there are 16 international operators' positions, called on code 16. This traffic is handled on a call-back basis. All trunk circuits in Tunis are multiplied over these positions for the extension of incoming international calls.

Special Services

Apart from the usual special services for fault reporting (code 11), complaints and claims (code 13), telephoning of telegrams (code 14), police (code 197), fire alarm (code 198), time announcements in Arabic (code 199), and in French (code 191), there are also information and interception services.

The information service is called by dialling 12. If the operator can give an immediate reply, the charge is recorded by a pulse on the subscriber's meter. If the information required takes time to procure or concerns questions of telegraphy or other services, the operator can automatically switch the subscriber to the proper special service.

The interception service on code 195 is centrally located in the Kasbah exchange and serves all subscribers in Tunis with suburbs. An intercepted subscriber's line is marked by the insertion of a plug. A subscriber whose subscription has been terminated or whose number has been changed can be marked in the same way. A subscriber whose line is intercepted can use his telephone for outgoing calls without hindrance. Incoming calls to his number are answered by an operator and put through to the subscriber if he so desires.

New Exchanges in Tunis Suburbs

The southern and northern suburbs of Tunis extend over quite a wide area. We nevertheless considered it sufficient to provide two exchanges for the northern suburbs, La Marsa and Le Kram, and two for the southern, Hammam-Lif and Mégrine. So far only the La Marsa and Le Kram exchanges have been opened for service, at the same time as the Tunis exchanges on November 30, 1962. The Hammam-Lif and Mégrine exchanges are expected to be opened at the beginning of the summer of 1963.

The conversion of the north suburban network to automatic operation posed several problems in respect of the number of exchanges, their locations and their connection to the Tunis exchanges. In view of the distances and of the existence of a well developed underground cable network, we decided to combine the four existing small manual exchanges into two larger units of 1 000 lines each, one at La Marsa, the other at Le Kram.

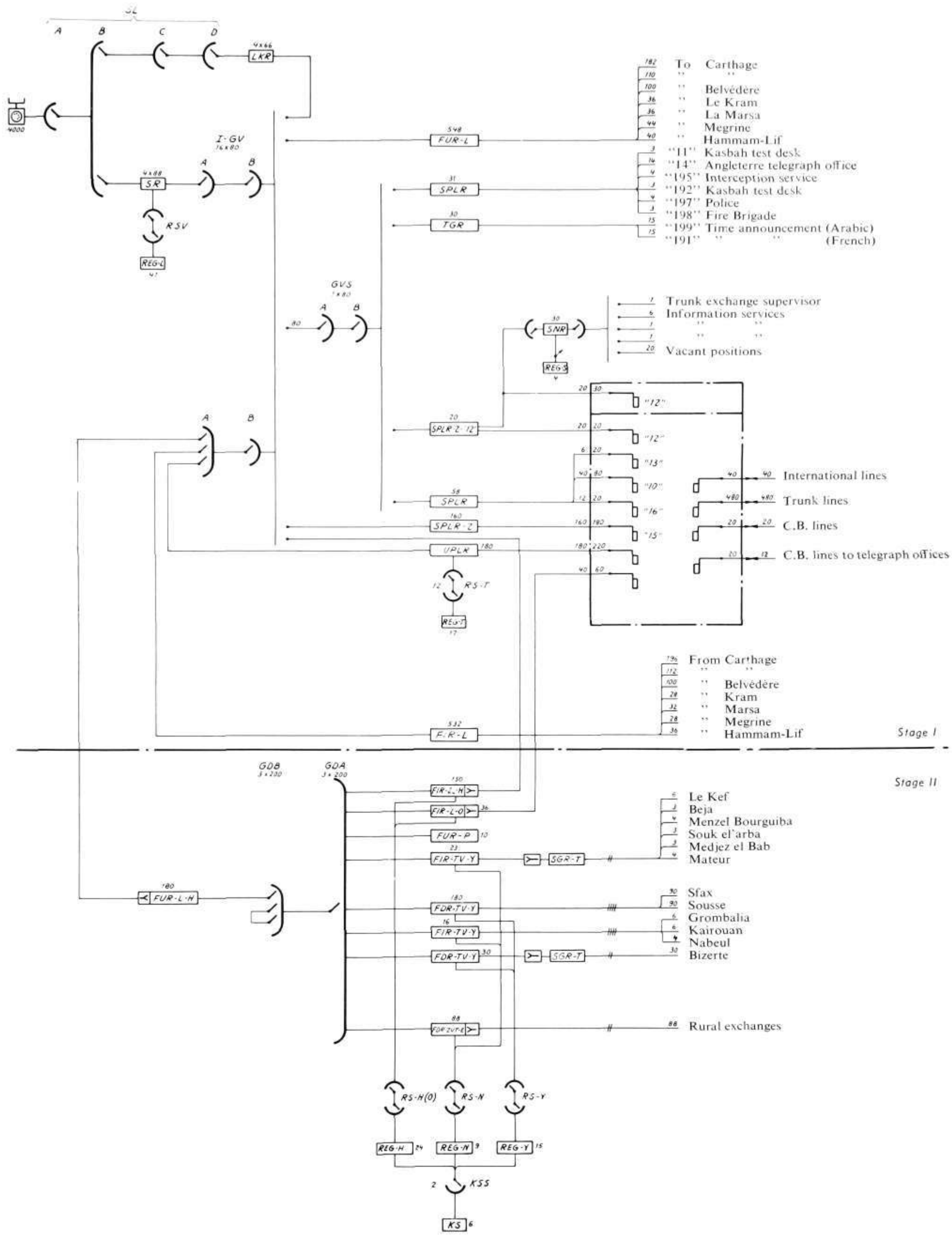


Fig. 4 X 7871

Trunking scheme of the Kasbah exchange

After a comparative study of different signalling systems, a d.c. code system was chosen. Later, when the La Marsa and Le Kram exchanges have been extended, they can be connected to the *ARM 20* transit stages in Tunis, which are expected to be in service in 1964. At the present state of affairs it has proved most economical to deal with the suburbs in the same way as the Tunis exchanges. Thus La Marsa and Le Kram have been connected to the *I-GV* stage of the Kasbah exchange via *FUR* and *FIR* equipments of the same type as have been used for the junctions between the Tunis exchanges. The Kasbah exchange accordingly acts as a transit centre for all traffic between Tunis and its suburbs. Through the d.c. code signalling the subscribers in the northern suburbs have access to the trunk demand service by dialling 15 and thus have the same service as the Tunis subscribers.

General Automatization of Tunisian Telephone Network

The opening of the Ericsson exchanges in Tunis with suburbs, and of the earlier exchange at Bizerte (November 1960), is the first step in a vast programme, the ultimate aim of which is the automatization of the entire Tunisian network.

The first stage of the project will embrace Sousse and Sfax in addition to Tunis and Bizerte. The local exchanges *(ARF 101)* at Sousse and Sfax, with manual trunk sections, are expected to be ready for service at the end of 1963. The conversion of these four areas to fully automatic operation within and between the areas should be completed in 1964.

This programme forms part of the government's three year plan 1961–1964 for the economic and social development of the country. The automatization of the Cap Bon area in the north-east, Le Kef in the west, and Gafsa, Gabès, Medenine in the south, will come in the latter part of a ten year plan (1961—1972).

Automatic Trunk Circuits

Conversion of the entire network to automatic operation requires a large number of trunk circuits with very good transmission characteristics. Our Transmission Division under Chief Engineer Brahim Khouadja has worked out a plan adapted to the growth of the switching system. Thus a carrier link between Tunis and Sfax, with final capacity of 600 channels, is to be opened at the beginning of March 1963. The initial capacity will be 148 telephony and 2 radio channels. The frequency band will be 2 000 Mc/s, and the distance between the relay stations will vary between 45 and 70 kilometres. The radio system will have standby equipment and the power supply will come from the electricity undertakings. An extension of this link from Sfax to Tripoli within the next three years is at present being planned.

For automatization of the Sousse area (Sahel) a loaded cable will be laid within two years. Its capacity is expected to cover the requirements for the next 40—50 years. The cable will contain six carrier quads which will permit an increase of its capacity if required.

In the north-western area (Le Kef) the North African cable connecting Tunis, Constantine, Algiers, Oran, Fez and Rabat is to be deloaded to increase its capacity. This cable at present allows international 4-wire and local 2-wire connections.

Open wire carrier circuits are to be installed in the southern areas in March 1967, 6 channels for Gafsa—Gabès, 12 for Sfax—Gabès, and 12 for Sfax—Gafsa.

Underground Cable Networks in the Cities

Simultaneously with the aforementioned projects the Lines Department under Chief Engineer Souhir Ben Lakhal has started an extensive programme of construction of underground cables in cities in which subscriber-dialling has been or is to be introduced. Thus, following on the major operation of transferring the Tunis subscribers from the old to the new exchanges, the Lines Department has already started to plan considerable extensions in the Sousse and Sfax areas.

These projects have been worked out in close cooperation with the planners of the general switching programme, and rational and modern solutions have been adopted. To take one example, the cables have been pressurized, which is expected to eliminate the disturbances that have occurred all too often as a result of rain.

Numbering Scheme

The conversion of a telephone network to automatic operation necessitates a numbering scheme covering the entire country. There are several factors to be considered, the most important being the division of the country into zones, the extent of the traffic, and the numbers of subscribers within zones and group areas.

The Tunisian numbering scheme is based on the following seven considerations:

a. The country to be divided into seven zones.

b. Each zone to be divided into a number of group areas.

c. The switching points for zones and group areas to be located usually in the zone and group centres.

d. Linked numbering scheme within each zone, i.e. the zone code will not be used on calls between subscribers within the same zone.

e. Zone numbering schemes will vary between 4, 5 and 6 digit subscriber numbers. Tunis with northern and southern suburbs will have 6-digit subscriber numbers.

f. For interzone traffic digit 0 will be dialled followed by the code of the called zone.

g. The zone codes will be:

1 — Tunis city and suburbs

2 — Tunis—Bizerte—Cap Bon zone with zone centre in Tunis

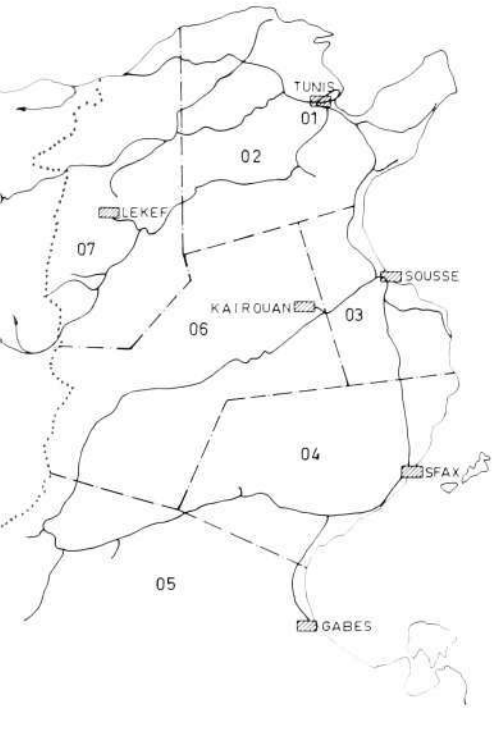
3 — Sousse

4 — Sfax

5 — South with zone centre at Gabès

6 — Centre with zone centre at Kairouan

7 — North-west with zone centre at Kef



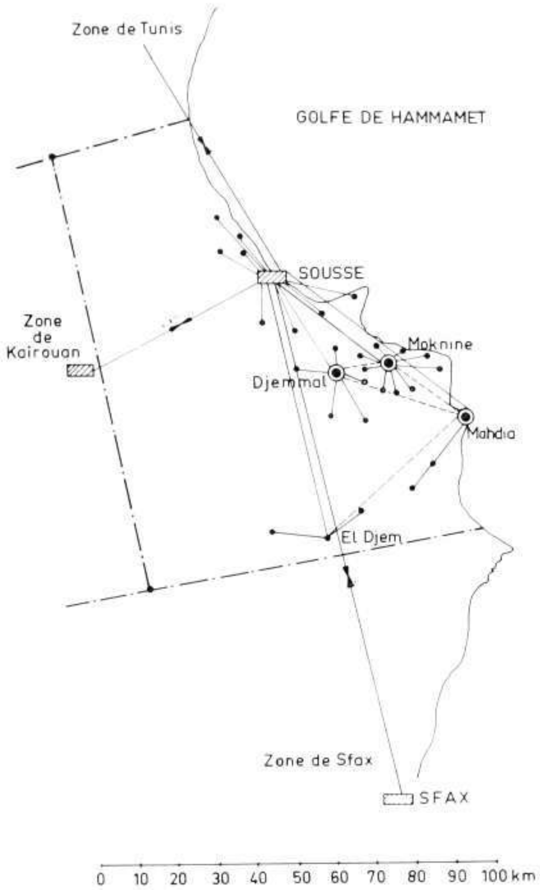
X 2697
X 9158

Fig. 5

Map of the northern Tunisia with zone boundaries

Zone centre

In some zones the subscriber density would not require 4-digit numbers. One might, therefore, consider increasing the geographical areas to be served by these zone centres. But such a course would involve an undue increase in the number and length of circuits in the zone which would not be justified by the traffic. On the other hand an increase in the number of zones with consequent reduction in the number of subscriber digits would not lead to a reduction in switching equipment. It was therefore considered best, from the start of automatization, to divide the country into zones adapted to the geography and to the communities of interest, and to determine the optimal number of subscriber digits accordingly. A 6-digit numbering scheme has



X 2698
X 9159

Fig. 6

The Sahel zone with zone centre at Sousse

- Zone centre
- Group centre
- Terminal exchange

thus been introduced in the most populated parts of Tunis with suburbs, a 5-digit scheme for less densely populated areas, and a 4-digit scheme for the sparsely populated areas in the south where the group centres lie far apart. If, at some future point of time, the number of digits in a zone proves to be insufficient, the zone will be subdivided and an extra digit added to subscribers' numbers.

Zone Centre and Group Centre Equipments

Zone centres will soon be equipped with Ericsson's *ARM* system—*ARM 20* in Tunis, Sousse and Sfax, and *ARM 503* in Bizerte. These systems are well-known and need no further presentation. An example of an *ARM* network is illustrated in fig. 6, showing the Sahel zone with zone centre at Sousse and its associated group centres and terminal exchanges.

The Cut-over on November 30

This account would be incomplete without a few words about the small problems that arise in all large cut-overs, the present one not excluded.

The work preceding the opening of the new exchanges in Tunis and northern suburbs may be classed under two main headings, the large scale testing of the equipment and the transfer of the subscriber circuits to the new exchanges.

The testing of the switching equipment was done by a team from L M Ericsson assisted by a large number of technicians from the Tunisian PTT, who thereby gained the opportunity of becoming acquainted with the new equipments and at the same time helped to complete the tests in a shorter time. Local traffic was started in the five exchanges concerned and faults encountered were remedied. The junctions between the exchanges were tested in the same effective and methodical manner.

The Lines Branch at the same time put the finishing touch to the work on the underground cable network that had started 18 months earlier.

To check the connection of the altogether 18 000 subscribers to the new exchanges, a first series of tests was made on the M.D.F.'s, with systematic identification of the lines. This was followed by more comprehensive testing of the subscriber lines from test desks.

Finally, after some days of intense work, the line and switching specialists of the PTT and L M Ericsson completed their tests on time at 12 a.m. on November 30.

The actual cut-over could thus take place on schedule at 5 p.m. on the same day. The date of the cut-over was well chosen, for the next two days were public holidays and the work could be finished off without disturbance from too much traffic.

The cut-over comprised four main operations, viz:

Connection of the subscribers to the new equipments

Connection of the junctions between the Tunis exchanges

Connection of the trunks to the new trunk exchange

Connection of the junctions between Tunis and the suburban exchanges

To give an idea of how the problems were solved, we may follow the course of these four main operations.

The entire cut-over was led by a General Staff of engineers from the PTT Engineering Branch and from L M Ericsson. The Staff Headquarters was in the Kasbah exchange, where the main problems of different kinds were most likely to arise.

Twenty-eight teams were formed, 23 Tunisian and 5 Swedish, the leader of each team being directly responsible to the Staff.

The work was divided into six phases. Each team received precise instructions, and a new phase could be started only on the express order of the Staff. The progress of the entire operation could thus be followed from a central point.

The connecting-up of the subscribers had been prepared on the M.D.F.'s by 1 p.m. on November 30. Subscribers had been notified that a test was to be made between 5 and 9 p.m. and had been requested not to use their telephones during those hours. The old equipments were disconnected by removing the M.D.F. fuses. For the subscribers in Tunis and suburbs the telephone was thereafter silent for about one hour, and the old equipments closed down for ever.

Official subscribers and essential services could maintain telephone traffic through Kasbah G. The subscribers were thereafter connected to the new equipments by plugging-in the *LR/BR* relay sets in the racks. This work, which was done by Ericsson engineers, started at 6 p.m. and was carried through in steps to permit a check of faults and to avoid too heavy a rise in the traffic. It was completed at 8 p.m., by which time all subscribers had been connected to the new exchanges.

As regards the junctions between the Tunis exchanges, the spares in the existing underground cables had been sufficient for connection of all circuits on certain routes and for 85 per cent on other routes.

Trunks and junctions to the northern suburbs were established by prolonging the previous trunks between Kasbah and Angleterre.

The trunks from the Melassine repeater station had been branched both to the old Angleterre and to the new Kasbah trunk exchange. The isolation of the trunks at Angleterre started at 5 p.m. and the transfer to Kasbah was completed at 7.30 p.m.

Half of the routes between Tunis and the two north suburban exchanges had already been established. The connection of the remaining circuits between Kasbah and Le Kram required three teams and proceeded between 6.10 and 7 p.m. The subsequent connection of the circuits between Kasbah and La Marsa was completed by 8 p.m.

The work as a whole took 3 hours, and, after its completion, faults were found on only 120 of the 18 000 subscriber circuits involved. On about 4 per cent of the junction circuits to the northern suburbs, some additional adjustment was required on the *FIR* and *FUR* relay sets.

The cut-over of the crossbar exchanges had thereby been completed according to plan.

The cut-over of the new exchanges on November 30 came as a pleasant surprise to subscribers, since the official opening—synonymous with "cut-over" as far as the subscribers are concerned—had been announced in the

Fig. 7 X 8422
The Kasbah information service

press for December 7. In this way the peak traffic which always follows on such occasions could be avoided.

The success of this operation exemplifies in a striking manner the excellent cooperation between the Tunisian PTT and L M Ericsson. A great deal of the initiative and action taken to provide the country with modern and efficient telecommunications is due primarily to the Bourguiba government and its Minister of Communications, Rachid Driss. The latter has shown a great interest in and personally supervised the work of installation and cut-over.

Mention should also be made of the very important contributions made by Chief Engineer Mohammed Mili, who has been responsible for all work on the exchanges, by the heads of the Transmission and Lines Branches, Chief Engineers Brahim Khouadja and Zouhir Ben Lakhal, and by all other members of the various telecommunications departments who have taken an active part in making the operation a success.

L M Ericsson Exchanges Cut into Service 1962

CITY EXCHANGES

Public exchanges with 500-line selectors

Town	Exchange		Number of lines
Bolivia			
La Paz	Centro	(extension)	2000
Brazil			
Curvêlo		(extension)	50
Itabirito			500
Manhuacú			500
Sete Lagoas		(extension)	500
Vitória	Central	(extension)	500
Chile			
Arica		(extension)	1000
Colombia			
Bogotá DE	Centro	(extension)	2000
»	Ciudad Universitaria	(extension)	3000
»	Olaya		5000
»	Ricaurte	(extension)	2000
»	San Fernando	(extension)	3000
Honda		(extension)	200
Medellín area	América	(extension)	2000
» »	Bosque	(extension)	1000
» »	Buenos Aires	(extension)	1000
» »	Centro	(extension)	500
» »	Poblado	(extension)	500
Ecuador			
Guayaquil	Centro	(extension)	500
»	Sur	(extension)	500
Ethiopia			
Addis Ababa	Filwoha	(extension)	1500
Finland			
Karhula		(extension)	500
Karjasilta		(extension)	500
Mariehamn		(extension)	500
Mikkeli/St. Michel		(extension)	500
Pori/Björneborg		(extension)	500
Rauma/Raumo		(extension)	500
Ruosniemi			500
Italy			
North Italy			
Legnago		(extension)	200
Mantova		(extension)	500
Monselice		(extension)	100
S. Bonifacio		(extension)	100
Schio		(extension)	200
Valdagno		(extension)	100
Venezia/Venice	Lido	(extension)	500

Town	Exchange		Number of lines
Verona	Borgo Trento	(extension)	500
»	Centro	(extension)	500
Vicenza		(extension)	1500
South Italy			
Agrigento		(extension)	1000
Barcellona		(extension)	100
Bari		(extension)	3000
Capri		(extension)	500
Caserta		(extension)	500
Milazzo		(extension)	100
Napoli/Naples	Amedeo	(extension)	1000
»	Bagnoli	(extension)	1000
»	Museo	(extension)	2000
»	Posillipo	(extension)	2000
Palermo	Libertà	(extension)	6000
Piano di Sorrento		(extension)	100
Reggio Calabria		(extension)	1500
Sorrento		(extension)	100
Taranto		(extension)	1500
Lebanon			
Beyrouth	Furn-El-Chebak	(extension)	1000
Mexico			
México DF	Apartado	(extension)	500
»	Chapultepec	(extension)	1500
»	Churubusco	(extension)	500
»	Peralvillo	(extension)	1500
»	Piedad	(extension)	2000
»	San Angel	(extension)	1000
»	Saro	(extension)	3000
»	Tacuba	(extension)	1000
Villahermosa		(extension)	500
Netherlands' West Indies			
Curaçao	Brievengat	(extension)	200
Norway			
Fiskå			500
Kristiansand S		(extension)	500
Stavanger		(extension)	2000
Svelgen			360
Panama			
Colón			3000
Panama City	Panama 5	(extension)	500
Peru			
Arequipa		(extension)	500

Town	Exchange	Number of lines
Sweden		
Göteborg/Gothenburg		
Suburban Area	Kortedala (extension)	1000
Hagfors	(extension)	500
Halmstad	(extension)	2500
Hälsingborg	(extension)	500
Kalmar	(extension)	2000
Karlstad	(extension)	2000
Katrineholm	(extension)	500
Kiruna	(extension)	1500
Köping	(extension)	500
Linköping	(extension)	3000
Ludvika	(extension)	1000
Norrtälje	(extension)	500
Skellefteå	(extension)	500
Stockholm		
Centrum Area	Östermalm (extension)	500
Suburban Area	Hanviken (extension)	500
»	Lidingö-Brevik (extension)	1500
»	Storängen (extension)	2000
»	Vendelsö (extension)	1000
Tumba	(extension)	1000
Ulricehamn	(extension)	500
Uppsala	(extension)	2000
Västervik	(extension)	500
Västerås	(extension)	4000
Åmål	(extension)	500
Örebro	(extension)	3000
Turkey		
Adana	(extension)	1000
Antalya	(extension)	500
Kars		500
Tarsus		1000
Uşak	(extension)	500
Venezuela		
San Carlos		500
San Felipe	(extension)	200
	Total	**113110**

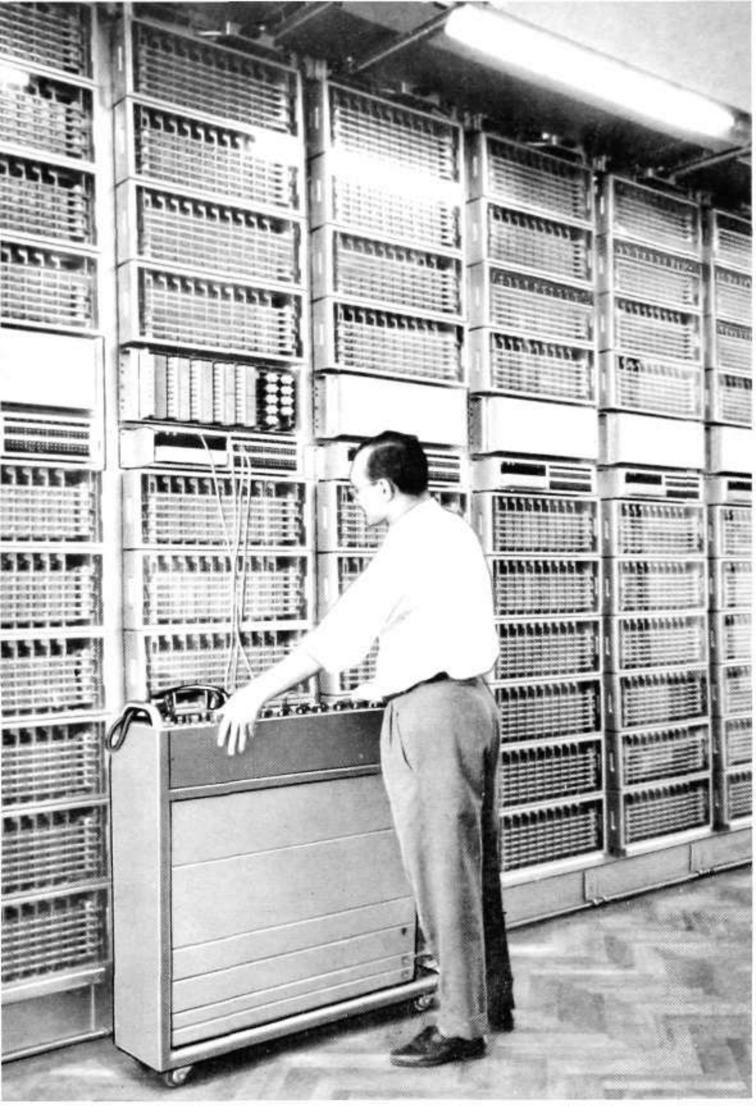
Public exchanges with crossbar switches

Town	Exchange	Number of lines
Brazil		
Brasilia	(extension)	5000
Cubatão		400
Itajubá		1200
Leme		600
Recife area	Boa Viagem	1000
» »	Boa Vista	7000
» »	Santo Antonio	6000
Santo André area	Mauá (extension)	200
» » »	Ribeirão Pires (extension)	200
» » »	Rudge Ramos (extension)	200
» » »	Santo André (extension)	800
» » »	São Bernardo (extension)	200
» » »	São Caetano (extension)	400
São José dos Campos		2000
Sorocaba area	Sorocaba	5000
» »	Votorantim	120
Central-African Republic[1]		
Bangui		800
Chad[1]		
Fort Lamy		1000
Dahomey[1]		
Cotonou		2000
Porto Novo		800
Denmark		
Aalborg	(extension)	2000
Aarhus	Nord	2000
»	Risskov (extension)	1000
»	Skaade (extension)	1000
Esbjerg	(extension)	8000
Frederikshavn	(extension)	1000
Grenaa	(extension)	200
Helsingør/Elsinore	(extension)	1000
Ikast	(extension)	400
København/Copenhagen	Bella (extension)	1000
»	Birkerød (extension)	1000
»	Brøndbyøster (extension)	1000
»	Damsø (extension)	2000
»	Glostrup (extension)	1000
»	Herlev (extension)	3000
»	Hvidovre (extension)	2000
»	Kastrup (extension)	2000
»	Lille Værløse	1800
»	Nora (extension)	5000
»	Rødovre (extension)	2000
»	Sundbyøster (extension)	7000
»	Trørød	1000

[1] These exchanges, system CP 400, were delivered by Société des Téléphones Ericsson, Colombes.

Town	Exchange	Number of lines
København/Copen-hagen	Valby (extension)	2000
»	Vallensbæk (extension)	1000
Næstved	(extension)	1000
Struer	(extension)	400
Varde		1600
Finland		
Helsinki/Helsingfors	Gräsa	1000
»	Haaga/Haga (extension)	1000
»	Herttoniemi/Hertonäs (extension)	400
»	Kulosaari/Brändö (extension)	400
»	Laajasalo/Degerö	1200
»	Leppävaara/Alberga (extension)	400
»	Oulunkylä/Åggelby	1600
»	Pihlajamäki/ Rönnbacka	1000
»	Sörnäinen/Sörnäs (extension)	2000
Langinkoski	(extension)	400
Niirala	(extension)	1000
Porvoo/Borgå	(extension)	500
France[1]		
Beauvais	(extension)	400
Blois		3200
Haguenau		1600
Saint Vallier		200
Gabon[1]		
Libreville		1000
Port Gentil		600
Iceland		
Hafnarfjördur		2000
Ireland		
Dublin	Dundrum (extension)	1000
»	Palmerstone (extension)	400
Limerick	(extension)	1000
Italy		
North Italy		
Padova	(extension)	4000
Treviso	(extension)	400
Venezia/Venice	Mestre (extension)	2200
South Italy		
Altamura	(extension)	400
Amalfi		600
Augusta	(extension)	200
Avola		1000
Benevento		4000
Caltanissetta		6000
Casalnuovo		400
Casamicciola		800
Castrovillari		800
Corigliano		800
Eboli		800
Fondi		600
Lentini		1000
Marigliano		1000
Napoli/Naples	Fuorigrotta	10000
Noto		1000
Partinico		1000
Paternò		1200
Piazza Armerina		800
Pomigliano		600
Pozzuoli		1600
Ragusa		4000
S. Maria C.V.		1000
Vico Equense		400
Nepal		
Kathmandu		1000
Netherlands		
Gouda		6000
Maassluis		2000
Ridderkerk		2400
Rotterdam	Centrum IV	5000
»	Pernis	4000
New Zealand		
Kensington		1600
Onerahi		1000
Sweden		
Alingsås	(extension)	300
Motala	(extension)	200
Nyköping	(extension)	300
Skövde	(extension)	700
Visby	(extension)	500
Ystad	(extension)	600
Thailand		
Cholburi		1000
Yala		1000
Tunisia		
Tunis	Belvédère	5000
»	Carthage	12000
»	Kasbah	4000
»	La Marsa	1000
»	Le Kram	1000
United Arab Republic		
Cairo	Abbassia	10000
Damanhour		2000
Mansoura		4000

[1] These exchanges, system CP 400 were delivered by Société des Téléphones Ericsson, Colombes.



X 8418

Interior from the new crossbar exchange at Mehalla-El-Kobra, Egypt, United Arab Republic.

Public exchanges with crossbar switches (cont.)

Town	Exchange	Number of lines
Mehalla-El-Kobra		3000
Tanta		4000
USA[1]		
Chillicothe, Ohio		1000
Elkin, North Carolina	(extension)	200
Export, Pennsylvania	(extension)	850
North Madison, Indiana	(extension)	300
Perry, Georgia	(extension)	200
Seymour, Indiana	(extension)	500
Winter Park, Florida	(extension)	1000
Yugo-Slavia[2]		
Beograd	Akademija (extension)	2000
Niš	(extension)	1000
Priština	(extension)	1000
Sarajevo	(extension)	3000
Sisak		1000
Sušak		1000
Zagreb	Cernomerec	2000
»	Pešćenica (extension)	1000
»	Trešnjevka (extension)	1000
	Total	**246870**

[1] These exchanges, system NX-1, were delivered by North Electric Co., Galion, Ohio.
[2] The equipment for these exchanges has been manufactured on L M Ericsson-license by the Yugo-Slavian factory Nikola Tesla, Zagreb.

RURAL EXCHANGES

	Number	Number of lines[3]
Public rural exchanges with crossbar switches, system ARK, ART		
Brazil	1	400
Denmark	3	1850
Ethiopia	—	60
Finland	52	7190
Ireland	5	1140
Italy	22	2640
Lebanon	1	200
Netherlands	—	1600
Sweden	—	1200
USA[4]	34	17610
Yugo-Slavia[5]	15	3700
Total	**133**	**37590**
Rural exchanges with 12-, 25- or 100-line selectors, system OL, XY		
Norway	**69**	**7190**

TRANSIT EXCHANGES

	Number of junctions
Transit exchanges with crossbar switches, system ARK, ARM	
Colombia	800
Denmark	2820
Finland	2340
Italy	2360
Mexico	700
Netherlands	2500
Total	**11520**

[3] The number of lines includes both new exchanges and extensions of existing exchanges.
[4] These exchanges, system NX-2, were delivered by North Electric Co., Galion, Ohio.
[5] The equipment for these exchanges has been manufactured on L M Ericsson-license by the Yugo-Slavian factory Nikola Tesla, Zagreb.

NEWS *from All Quarters of the World*

(Above) Mr. Rachid Driss, Minister of Communications, cuts the symbolical tape in the Tunisian national colours at the opening ceremony. On his right is Foreign Minister Mongi Slim, on his left president Sven T. Åberg and Ambassador Lennart Petri.

L M Ericsson's New Automatic Exchanges Now in Service in Tunis

At President Bourguiba's reception: the President conversing with Messrs. Åberg and Petri.

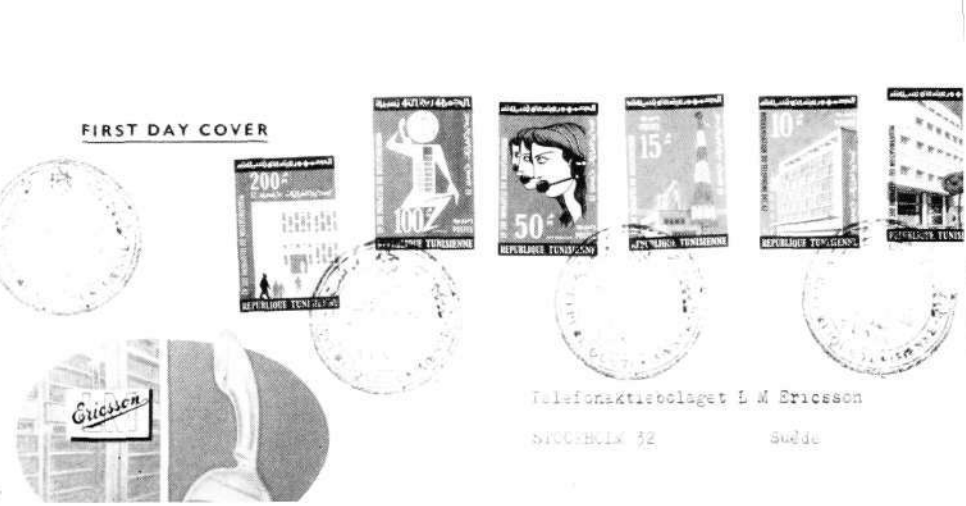
Minister Rachid Driss, Head of the Tunisian P.T.T., presided at the opening of L M Ericsson's automatic telephone exchanges in Tunis on December 7, 1962. The inauguration ceremony took place in the P.T.T. offices in Boulevard Farhat Hached in Tunis. These exchanges are a link in the re-equipping of the entire Tunisian network by L M Ericsson. The whole project is expected to be completed in 1964.

The ceremony was attended by the Foreign Minister, Mongi Slim, the Minister of Health and Social Affairs, Mondher Ben Ammar, and a large number of dignitaries from the Tunisian government administration. Among Swedish participants were Ambassador Lennart Petri, L M Ericsson president Sven T. Åberg, and the president of Stockholms Enskilda Bank, Marc Wallenberg, who were received after the ceremony by Mr. Bourguiba at the palace at La Marsa. Mr. Bourguiba complimented the company with the words: "you have completed your job on time with great precision and with 'brio'."

That the new telephone system has been greatly appreciated by the general public is revealed by the following extract from a letter from Mr. Rachid Driss to the Swedish Department of Trade: "Sweden has been greatly honoured through L M Ericsson, whose name since the beginning of December has been on everybody's lips in Tunis."

The total value of the Tunisian orders to L M Ericsson is 23 million kronor. There are at present some 26,000 Ericsson automatic lines in operation in Tunis and Bizerte.

The stamps on this First Day Cover were issued by the Tunisian P.T.T. in memory of the inauguration. The 200 millimes denomination depicts the Belvédère exchange, the 100 millimes a telephoning figure (the head is a dial and the trunk a crossbar switch), the 50 millimes three operators in profile, the 15 millimes the Sfax exchange and the Tunis-Sfax radio link, the 10 millimes the Carthage exchange, and the 5 millimes the Kasbah exchange.



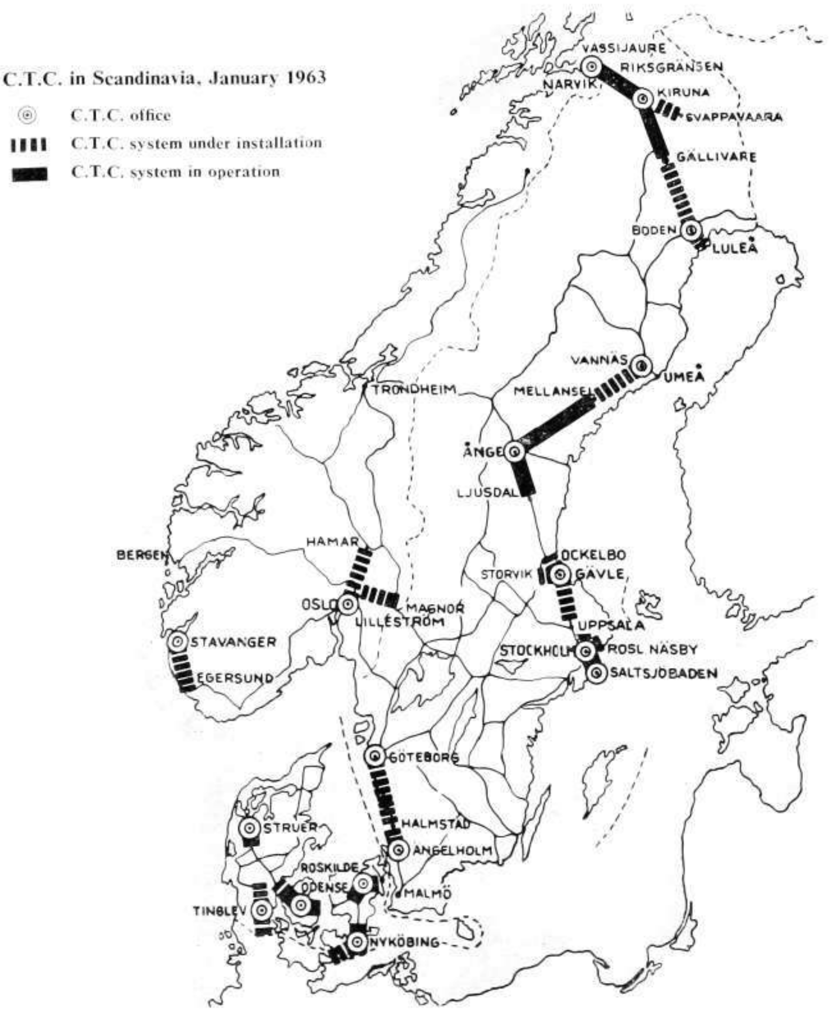
L M Ericsson Continues Expansion of C.T.C. in Scandinavia

In the autumn of 1962 the Swedish State Railways ordered from L M Ericsson C.T.C. Code Control Equipment for 130 stations with five C.T.C. offices. The equipment suffices for a distance of 1,000 kilometres and is to be installed on the Gothenburg—Ängelholm, Uppsala—Gävle—Storvik—Ockelbo, Mellansel—Vännäs, Luleå—Boden—Gällivare and Kiruna—Svappavaara lines. The equipment is to be delivered in the years 1963—1965 and will be of the same kind as earlier installed at three C.T.C. offices and 71 field locations.

The Swedish Railways already have the longest continuous C.T.C. line in Europe, between Ljusdal and Mellansel, 357 km with 44 field locations. After the installation of the new equipment, Sweden will have a considerably greater length of railroad under centralized traffic control than any other country in Europe, altogether some 1,450 km.

As announced in Ericsson Review No. 1, 1962, the Norwegian State Railways are installing C.T.C. on two lines, between Narvik and Riksgränsen on the Swedish boundary in the north, and between Stavanger and Egersund in the south. The equipment is being supplied by L M Ericsson and A/S Norsk Signalindustri. The Norwegian Railways have since purchased equipment for the Lilleström—Hamar and Lilleström—Magnor lines, which will bring up the length of C.T.C. lines in Norway to 370 km with three C.T.C. offices and 61 field locations. The equipment is to be delivered during 1963.

The Danish State Railways are continuing to install C.T.C. on the main lines. According to present plans, before the end of 1963 C.T.C. will be in operation on 305 km of line with five C.T.C. offices and 42 field locations.



Sven Weber in Memoriam

Sven Weber died on January 15 in Helsinki.

At his death Sven Weber was chairman of the board of O/Y L M Ericsson A/B. Originally trained as a naval architect in Dresden and at Chalmers, Gothenburg, he entered the telephony field in 1930 when he accepted an appointment in the South Finnish Trunk Telephone Co. In 1934 he was appointed president of O/Y L M Ericsson A/B, a post to which he brought great ability and in which he remained until 1958 when he became chairman of the board.

During the many years in which Sven Weber presided over O/Y L M Ericsson A/B, telephony in Finland underwent a tremendous development. Under his leadership L M Ericsson established intimate cooperation with the Finnish telephone administrations, to the benefit of all parties. In his work and in his person Sven Weber was a man of stature. Dynamic, rich in initiative, a skilful engineer and businessman, he became in time the symbol of an indomitable spirit that acknowledged no difficulty. These qualities he combined with a kindness and a firmness of friendship, an optimism and infectious good humour which make his loss doubly great. Sven Weber was an important link in the relations between our two countries. In the memory of his colleagues and friends he remains a strong and bright light.

Sven T. Åberg

The work on the new telephone factory at Broadmeadows near Melbourne, Australia, has now started. The factory is being erected by L M Ericsson's Australian subsidiary, L M Ericsson Pty. Ltd. The first stage will comprise about 120,000 sq. ft. of factory and office space to step up the present production of telephone switching and other telecommunications equipment. President Sven T. Åberg is seen throwing up the first sod—or rather shovel-load—for the foundations of the new building.

The Ericofon has found its way far and wide around the globe. It has now reached these Colorado Indians, who have definitely abandoned smoke signals as means of communication. (Left)

Telefones Amazonas S/A has recently put in commission a telephone exchange equipped with one of L M Ericsson's manual C.B. switchboards type ADF for 120 lines. The exchange is situated at Itacoatiara 200 kilometres from the town of Manaus on the river Amazon. The exchange building, situated in one of the most rainy areas in the world, is shown in the photograph below.

The Nigerian Minister of Communications, Mr. Olu Akinfosile, has visited Stockholm and L M Ericsson at Midsommarkransen. (Left) Minister Akinfosile watches with interest the work in one of the Ericsson production shops.

Forty-one nations, including Sweden, were represented at the first international fair in tropical Africa—at Lagos, Nigeria—at the end of last year. The fair was a decided success and was visited by some 1,200,000 people in the three weeks that it was open. L M Ericsson telephones were among the well-known Swedish products in Africa that were exhibited. Nils Eriksson from L M Ericsson demonstrates some LME products to (from left) Tony Maxwell, IPTC, T. O. S. Benson, Nigerian Minister of Information, Governor General Nramdi Azikiwe and Ambassador Love Kellberg.

Carrier Equipment for Liberia

The telecommunication authorities of Liberia have been working for several years on a project covering the main towns of the country. As a result a contract with L M Ericsson was signed in 1961 for the supply and installation of telephone exchanges, pay stations, local cable plant etc.

Recently the Government of Liberia signed an additional contract with L M Ericsson covering the supply and installation of multiplex equipment for telephony and telegraphy. This equipment is of L M Ericsson's latest design and is fully transistorized.

The carrier telephony equipment will be installed at 22 stations, as shown on the map. The voice frequency telegraph equipment will constitute the initial installation for nine of the same stations. The order also includes training of maintenance personnel.

Ericsson Technics No. 2, 1962

Ericsson Technics No. 2, 1962, has now appeared. In the first paper, "Planning of Exchange Locations and Boundaries in Multi-Exchange Networks" by Dr. Yngve Rapp, Telefonaktiebolaget L M Ericsson, methods are presented which are aimed at facilitating the preparation of a fundamental plan for multi-exchange networks, i.e. for determining the number of exchanges, their locations, and the boundaries between the exchange areas. This fundamental plan serves as starting point for the detailed planning of the subscribers' and junction networks. A summarized version of this paper was published in Ericsson Review No. 2, 1962, under the title "Planning of Multi-Exchange Networks with Aid of a Computer».

There follows a paper by Henry Scheftelowitz, Telefonaktiebolaget L M Ericsson, "Study of Sampling Noise, Especially in Reference to Systems for Transmission of Wide Band Signals on Identical Narrow Band Channels in Parallel Connection". In a time multiplex system the band width of the individual channel is determined by the pulse repetition frequency. If this frequency is, for example, 8 000 c/s, the upper cut-off frequency will be 4 000 c/s. For transmission of signals at higher frequencies several channels must be interconnected. Each individual channel may be regarded as a four-terminal network. A study is made of crosstalk as function of the characteristics of the four-terminal networks.

Finally, in "Calculations for the Design of Switching Devices in Automatic Telephone Systems", Karl Lundkvist, Telefonaktiebolaget L M Ericsson, describes a method of calculating the most suitable design of a switching device for automatic telephone exchanges consistent with the traffic per line, the production cost of the switch components, and the number of lines. For every telephone system there is an economic optimum for a given quantity of traffic. The size and arrangement of the corresponding switching group is sought having regard to the effect of different design measures on the price and traffic capacity of the telephone exchange.

New Method for Jointing of Plastic Cables Developed by L M Ericsson

The use of plastic cables instead of paper-lead cables called for a jointing method which was acceptable both technically and economically. L M Ericsson has developed a method essentially fulfilling the requirements for satisfactory jointing of polythene-insulated and polythene-sheathed cables.

As far as the individual conductor splices are concerned, the method basically involves twisting of the conductors under heat without removal of the insulation, and welding of a plastic sleeve, which is sealed at one end, to the conductor insulation so as to insulate the splice.

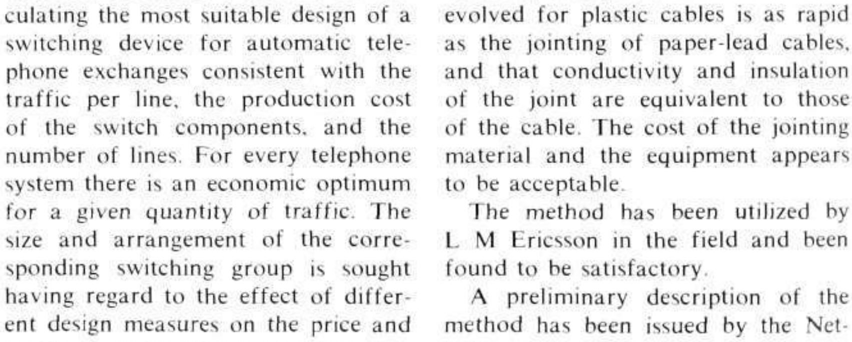
As regards the sheath joint, the method implies a welding process by which the plastic material is heated in a hot gas stream via a heat resistant rubber band. To achieve a pressure-tight joint, sheath and jointing material must be of the same composition.

Far-reaching experiments and laboratory tests prove that the method evolved for plastic cables is as rapid as the jointing of paper-lead cables, and that conductivity and insulation of the joint are equivalent to those of the cable. The cost of the jointing material and the equipment appears to be acceptable.

The method has been utilized by L M Ericsson in the field and been found to be satisfactory.

A preliminary description of the method has been issued by the Network Department under reference N 2822.1—109 Us.

In February L M Ericsson's new factory at Ronneby was opened—the fourth Ericsson factory in the province of Blekinge. It is expected to employ some 400 persons and will operate as a branch of the Karlskrona factory. The production will consist chiefly of the assembly and wiring of racks for automatic switching equipments.



UDC 621.395.44
LME 8424

TRONSLIE, S: *Terminal Equipment for 2700-circuit Carrier System. I. Modulation Equipment.* Ericsson Rev. *40*(1963): 1, pp. 2—17.

The article deals with L M Ericsson's equipment for modulation from the basic supergroup to the line frequency band of the 12 Mc/s system. A brief description of the system is given and the most important technical data are presented.

The associated equipment for carrier frequency generation will be dealt with in an article to be published in a future number of Ericsson Review. The modulation equipment for the formation of the basic supergroup has been described in Ericsson Review, No. 1, 1961 and No. 2, 1962.

UDC 621.395.722
621.395.344.6
LME 8344

BEN CHEIKH, HABIB: *The New Telephone Exchanges in Tunis.* Ericsson Rev. *40*(1963):1, pp. 18—28.

The cut-over on November 30, 1962, of the new L M Ericsson crossbar exchanges in Tunis and its northern suburbs brought to an end the previously serious state of telecommunications in the country. The new exchanges, which represent the first step in the conversion of the entire Tunisian network to automatic operation, are described in this article.

The Ericsson Group

Associated and co-operating enterprises

• EUROPE •

Denmark
L M Ericsson A/S *København F,* Finsensvej 78, tel: Fa 6868, tgm: ericssons

Telefon Fabrik Automatic A/S *København K,* Amaliegade 7, tel: C 5188, tgm: automatic

Dansk Signal Industri A/S *København F,* Finsensvej 78, tel: Fa 6767, tgm: signaler

Finland
O/Y L M Ericsson A/B *Helsinki,* Fabianinkatu 6, tel: A8282, tgm: ericssons, telex: 57-12546

France
Société des Téléphones Ericsson *Colombes (Seine),* Boulevard de la Finlande, tel: CHArlebourg 35-00, tgm: ericsson

Paris 17e, 147 Rue de Courcelles, tel: CARnot 95-30, tgm: eric

Ateliers Vaucanson, *Paris XX,* B. P. 28.20, tel: MENilmontant 83-40, tgm: atelcanson

Great Britain
Swedish Ericsson Company Ltd. *London, W. C. 1,* 329 High Holborn, tel: HOLborn 1092, tgm: teleric

Production Control (Ericsson) Ltd. *London, W. C. 1,* 329 High Holborn, tel: HOLborn 1092, tgm: productrol holb

Italy
SETEMER, Soc. per Az. *Roma,* Via G. Paisiello 43, tel: 868.854, 868.855, tgm: setemer

SIELTE, Soc. per Az. *Roma,* C. P. 4024 Appio, tel: 780221, tgm: sielte

FATME, Soc. per Az. *Roma,* C.P. 4025 Appio, tel: 780021, tgm: fatme

Netherlands
Ericsson Telefoon-Maatschappij, N.V. *Rijen (N.Br.),* tel: 01692-555, tgm: erictel, telex: 44-14354

den Haag—Scheveningen, 10, Palacestraat, tel: 55 55 00, tgm: erictel-haag, telex: 44-31109

Norway
A/S Elektrisk Bureau *Oslo NV,* P.B. 5055, tel: Centralbord 46 18 20, tgm: elektriken, telex: 56-1723

A/S Industrikontroll *Oslo,* Teatergaten 12, tel: Centralbord 335085, tgm: indtroll

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

A/S Norsk Signalindustri *Oslo,* Bygdø allé 12, tel: Centralbord 56 54 94, tgm: signalindustri

Portugal
Sociedade Ericsson de Portugal, Lda. *Lisboa,* 7, Rua Filipe Folque, tel: 57193, tgm: ericsson

Spain
Cía Española Ericsson, S. A. *Madrid 13,* Torre de Madrid 3er piso, oficina 9, Plaza de España, tel: 241 1400, tgm: ericsson

Sweden
Telefonaktiebolaget L M Ericsson *Stockholm 32,* tel: 19 00 00, tgm: telefonbolaget, telex: 19910

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

AB Ermi, *Karlskrona 1,* tel: 23010, tgm: ermibolag-karlskrona

AB Rifa *Bromma 11,* tel: 26 26 10, tgm: elrifa-stockholm

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

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

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

L M Ericssons Svenska Försäljningsaktiebolag *Stockholm 1,* Box 877, tel: 22 31 00, tgm: ellem

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

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

Svenska Radioaktiebolaget *Stockholm 12,* Alströmergatan 14, tel: 22 31 40, tgm: svenskradio

Switzerland
Ericsson Telephone Sales Corp. AB, Stockholm, Zweigniederlassung *Zürich,* Postfach *Zürich 32,* tel: 325184, tgm: telericsson

West Germany
Ericsson Verkaufsgesellschaft m. b. H. *Düsseldorf,* Postfach 2925, tel: 844 61, tgm: erictel, telex: 41-8587979

• ASIA •

India
Ericsson Telephone Sales Corporation AB *New Delhi 1,* P.O.B. 669, reg.mail: 1/3 Asaf Ali Road (Delhi Estate Building), tel: 272312, tgm: inderic

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

Indonesia
Ericsson Telephone Sales Corporation AB *Bandung,* Djalan Dago 151, tel: 8294, tgm: javeric

Djakarta, Djalan Gunung Sahari 26, tel: Kota 22255, tgm: javeric

Lebanon
Telefonaktiebolaget L M Ericsson, Technical Office *Beyrouth,* Rue du Parlement, Immeuble Bisharat, tel: 252627, tgm: ellem

Turkey
Ericsson Türk Ticaret Ltd. Şirketi *Ankara,* Rumeli Han, Ziya Gökalp Cad., tel: 23170, tgm: ellem

Istanbul, Istanbul Bürosu, Liman Han, Kat 5, No. 75, Bahçekapi, tel: 22 81 02, tgm: ellemist

• A

Egypt (UAR)
Telefonaktiebolaget LM Ericsson, Egypt Branch *Cairo,* P. O. B. 2084, tel: 497 77, tgm: elleme

Northern and Southern Rhodesia, Nyasaland
LM Ericsson Telephone Co. (Pty.) Ltd. (Branch Office of LM Ericsson Telephone Co. Pty. Ltd. in Johannesburg) *Bulawayo, Southern Rhodesia,* P.O.B. 1974, tel: 64 704, tgm: ericsson

South Africa, South-West Africa
L M Ericsson Telephone Co. Pty. Ltd. *Johannesburg, Transvaal,* P. O. B. 2440, tel: 33-2742, tgm: ericofon

Tunisia
Telefonaktiebolaget LM Ericsson, Technical Office *Tunis,* Boîte Postale 780, tel: 240520, tgm: ericsson

• AMERICA •

Argentine
Cía Ericsson S. A. C. I. *Buenos Aires,* Casilla de correo 3550, tel: 33 20 71, tgm: ericsson

Cía Argentina de Teléfonos S. A. *Buenos Aires,* Perú 263, tel: 30 50 11, tgm: catel

Cía Entrerriana de Teléfonos S. A. *Buenos Aires,* Perú 263, tel: 30 50 11, tgm: catel

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

Brazil
Ericsson do Brasil Comércio e Indústria S. A. *Rio de Janeiro,* C. P. 3601, tel: 43-0990, tgm: ericsson, telex: Rio 155

Canada
LM Ericsson Ltd. *Montreal 9, P.Q.,* 2300 Laurentian Boulevard, City of St. Laurent, tel: 331—3310, tgm: caneric, telex: 1-2307

Chile
Cía Ericsson de Chile, S. A. *Santiago,* Casilla 10143, tel: 825 55, tgm: ericsson-santiagodechile

ar- … 00, tgm: ericsson

Ecuador
Teléfonos Ericsson C. A. *Quito,* Casilla 2138, tel: 16100, tgm: ericsson

Guayaquil, Casilla 376, tel: 16892, tgm: ericsson

Mexico
Teléfonos Ericsson S. A. *México D.F.,* Apartado 9958, tel: 464640, tgm: coeric

Industria de Telecomunicación S.A. de C.V. *México 6, D.F.,* Londres No. 47, tel: 250405, tgm: industel

Peru
Cía Ericsson S. A. *Lima,* Apartado 2982, tel: 34941, tgm: ericsson

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

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

USA
The Ericsson Corporation *New York 17, N. Y.,* 100 Park Avenue, tel: Murray Hill 5-4030, tgm: erictel, telex: NY 224135

North Electric Co. *Galion, Ohio,* P. O. B. 417, tel: Howard 8-2420, tgm: northphone-galionohio, telex: 470-U

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

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

• AUSTRALIA & OCEANIA •

Australia
L M Ericsson Pty. Ltd. *Melbourne C 1 (Victoria),* 20 Collins Street, tel: 635646, tgm: ericmel

North Sydney (NSW), 182 Blue's Point Road, tel: 92—1147, tgm: ericsyd

Teleric Pty. Ltd. *Melbourne C 1 (Victoria),* 20 Collins Street, tel: 635646, tgm: teleric

North Sydney (NSW), 182 Blue's Point Road, tel: 92—1147, tgm: teleric

Agencies

• EUROPE •

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

Greece
"ETEP" S. A. Commerciale & Technique *Athens 143,* 57, Akadimias Street, tel: 629.971, tgm: aeter-athinai

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

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

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

• ASIA •

Burma
Burma Asiatic Co. Ltd., Ericsson Department *Rangoon,* P.O.B. 1008, tel: 10999, tgm: ericsson

Cambodia
The East Asiatic Company Ltd. *Phnom-penh,* P.O.B. 129, tel: 762-1070-1071, tgm: pyramide

Ceylon
Vulcan Trading Co. (Private) Ltd. *Colombo 1,* New Caffoor Building, 40, Church Street, tel: 36-36, tgm: vultra

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

Hong Kong
The Swedish Trading Co. Ltd. *Hongkong,* P. O. B. 108, tel: 35521-5, tgm: swedetrade

Iran
Irano Swedish Company AB, *Teheran,* Khiabane Sevom Esfand 28, tel: 367 61, tgm: iranoswede

Iraq
Usam Sharif Company W.L.L. *Baghdad,* Sinak-Rashid Street, tel: 870 31, tgm: alhamra

Japan
Gadelius & Co. Ltd. *Tokyo C,* P. O. B. 1284, tel: 408-2131, tgm: goticus, telex: 19079

Jordan
The Arab Trading & Development Co., Ltd. *Amman,* P. O. B. 1, tel: 25 931, tgm: aradeve

Korea
Gadelius & Co. Ltd. *Seoul,* I. P. O. Box 1421, tel: 2—9866, tgm: gadeliusco

Kuwait
Latiff Supplies Ltd. *Kuwait,* P. O. B. 67, tel: 2404, tgm: latisup

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

Pakistan
Vulcan Industries Ltd. *Karachi City,* P. O. B. 4776, tel: 325 06, tgm: vulcan

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

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

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

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

Thailand
Ericsson Agency Office, Telephone Organization of Thailand *Bangkok,* Ploenchitr Road, tel: 55183, tgm: telthai

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

• AFRICA •

Ethiopia
Swedish Ethiopian Company *Addis Ababa,* P. O. B. 264, tel: 11447, tgm: etiocomp

Ghana
The Standard Electric Company *Accrá,* P.O.B. 17, tel: 627 85, tgm: standard

Kenya, Tanganyika, Uganda, Zanzibar
Transcandia Ltd. *Nairobi, Kenya,* P. O. B. 5933, tel: 219 31, tgm: transcanda

Liberia
Swedish Agencies Liberia Co. *Monrovia,* P.O.B. 506, tel: 745, tgm: salco (Except sales to public institutions)

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

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

Morocco
Elmar S. A. — SEYRE *Tangier,* Francisco Vitoria, 4, tel: 122-20, tgm: elmar

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

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

Sudan
TECOMA Technical Consulting and Machinery Co. Ltd. *Khartoum,* P.O.B. 866, tel: 2224, ext. 35, tgm: sutecoma

• AMERICA •

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

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

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

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

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

Honduras
Quinchón León y Cía *Tegucigalpa,* Apartado 85, tel: 1229, tgm: quinchon

Jam
Morr
354,

Nicaragua
Edmundo Tefel *Managua, D.N.,* Apartado Postal 24, tel: 3401, tgm: edfelco

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

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

Puerto Rico
Splendid Inc. *San Juan,* P. O. B. 4568, tel: 3-4095, tgm: splendid

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

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

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

USA
Clark Walter Corporation *Newark 2, N. J.,* 744 Broad Street, tel: Mitchell 3-7333, tgm: wirewalter-newarknj. (For intercom)

State Labs. Inc. *New York 3, N. Y.,* 215 Park Avenue South, tel: Oregon 7-8400, tgm: statelabs (For electron tubes)

• AUSTRALIA & OCEANIA •

New Zealand
ASEA Electric (N.Z.) Ltd. *Welling-*
uild-
tel: