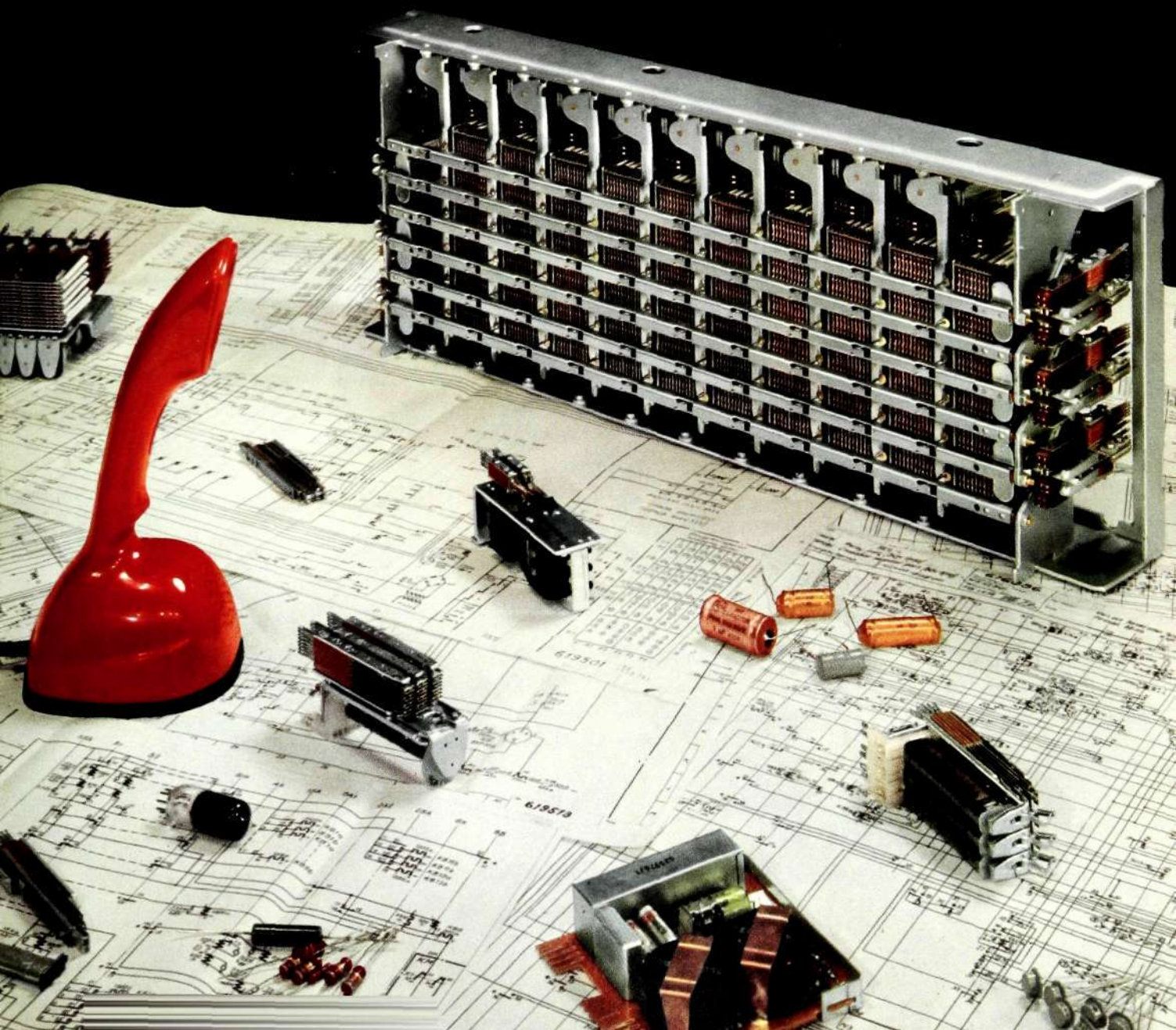


# ERICSSON

## *Review*

1  
1960





# ERICSSON REVIEW

Vol. XXXVII

1960

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On cover: Crossbar switch, Ericofon and some of the most important components in an L M Ericsson crossbar exchange of today.

# Electronic Exchanges — What can we Expect from them?

C J A C O B Æ U S, T E L E F O N A K T I E B Ö L A G E T L M E R I C S S O N, S T O C K H O L M

UDC 621.395.345  
LME 83023, 83024

*Though the leading telephone manufacturers have been working on the development of electronic telephone exchanges for the past ten years or more, no such exchange is yet operating in a public telephone network. Nevertheless, sufficient is known of the electronic systems and of their possibilities to form a reasonable opinion about their prospects. This article is based on a paper read at "7° Convegno internazionale delle comunicazioni" in Genoa in October 1959. It is published with the kind permission of The Civic Committee of Columbus Celebrations.*

The idea of all-electronic switching probably arose during the years between the world wars. That period saw the development of electron tube technology and its use in various circuit applications. Among other devices the amplifier with negative feed-back was developed and the theory of its operation was put forward, thus laying the foundations of analogue techniques which are now employed in the majority of telecommunication transmission systems. Similarly, the design of the bi-stable circuits constituted the first stages in the development of digital techniques. Yet before the second world war, probably no one took the idea of an all-electronic exchange really seriously. Both theoretical and practical circuit problems appeared to be too diffuse. Furthermore, the components did not have the requisite service reliability. During the second world war, however, certain new and significant advances were made. Electronic computers for scientific and military applications were designed and constructed during this period. Concurrently new theoretical advances were made — for instance the use of Boolean Algebra for logic circuits, and the application of information theory to the design of memories and to the representation of analogue functions by means of pulses.

During the forties and fifties, furthermore, progress had been made in methods of switch computation, whereby economical solutions of the switching networks could be found. Finally, in the fifties, new components — germanium or silicon semiconductors — made entirely new solutions practically possible.

During the last decade all the large telephone manufacturers have devoted a great deal of effort to the development of electronic exchanges. In the course of the sixties, therefore, we may be sure to see a number of electronic exchanges put into operation, first on an experimental basis and probably later as fully commercial propositions. The first will probably be the exchange at Morris in Illinois developed by the Bell System in the USA. Later on, the British are to open up a series of exchanges, one every year, representing different stages of development. At about the same time other manufacturers will undoubtedly be making similar trials.

The field trials will furnish answers to a number of questions which cannot be answered in any other way. But our knowledge of electronic systems is now sufficient for a reasonably accurate analysis to be made of what we may expect from them. Some of their salient points will now be considered in greater detail.

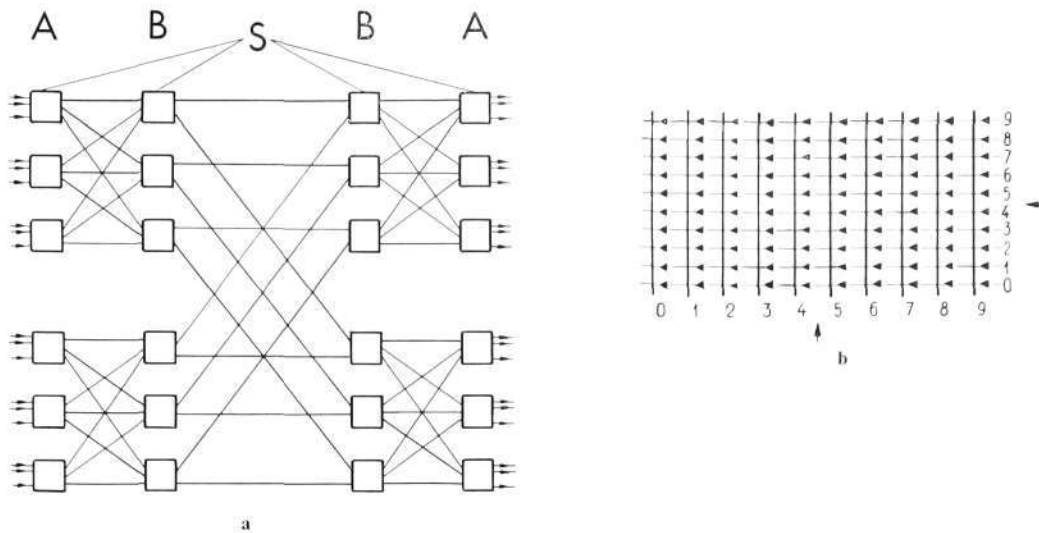


Fig. 1 X 2477 X 2478

### Space division systems

In a space division system the speech paths are physically separated. This is the method employed in all conventional switching systems. An electronic space division system is built up on conventional grouping principles, but the mechanical contacts are replaced by electronic (cold cathode tubes, semiconductors). As a rule the switching network is built up of several stages on the same principles as for crossbar and relay systems (link systems).

- a Normal grouping in a space division system ( $S =$  switching unit)
- b Contact arrangement in each switching unit ( $S$ ) in 1a

## Switching Network

In the traditional switching systems the design of the switching network is inevitably hampered by the lack of flexibility of the switches themselves, which sets a practical limit on the grouping and circuit arrangements. This is especially so in the decadic systems, while the register and marker systems allow a greater degree of freedom in this respect.

In space division systems the contacts are grouped in a manner similar to crossbar switches, in other words so as to form link systems comprising several stages. Since there is no restriction to a given selector capacity, the links can be designed for optimum capacity in each specific case. Moreover, owing to the speed at which the contacts may be made to operate, economies can be effected by arranging for a large number of cooperating switching stages, controlled by common equipment. It should perhaps be pointed out, however, that too many variants of switching and trunking routes will in the long run be uneconomical in electronic just as in traditional switching systems.

In the time division systems one of the parameters is given, namely, the number of pulse positions, which is equivalent in certain respects to the switch capacity. For this reason time division systems are rather less flexible with regard to grouping facilities than are space division systems. But, compared with a crossbar system with a switch capacity equal to the number of pulse positions, they offer greater flexibility since they can be combined in many more ways.

The flexibility of both types of electronic system is such as to make economic switching networks possible. The methods of computation are sufficiently well known, moreover, to enable a designer to choose the optimal solution, though, so far as is known, no such computations have been published.

Fig. 2 X 2479 X 2480

### Time division systems

In a time division system the speech paths are separated in time. Time division is only possible by means of electronics. Transmission of speech is effected on the pulse amplitude modulation principle (PAM).

- a A simple one-step time division system constitutes a full availability system in which the number of connecting circuits is equal to the number of time positions. Instead of having  $m \cdot n$  contacts ( $m$  being the number of lines and  $n$  the number of speech paths), only  $m$  contacts are needed, which can be made to function at different instants of time so as to set up any desired connection. The figure shows an arrangement consisting of  $n$  time division pulses. Memory equipment must be provided to operate the proper contacts at the proper moment. This memory function also exists in a space division system, but is there built into the actual switching network, which is only natural since the contacts are in principle bistable devices.
- b Systems with greater traffic handling capacity can be obtained by means of highway switching. The lines are in such case grouped together and connected to highways ( $H$ ), which are interconnected either direct or via intermediate highway contacts ( $C$ ). The resulting grouping system may be regarded from the traffic point of view as a multi-stage link system.

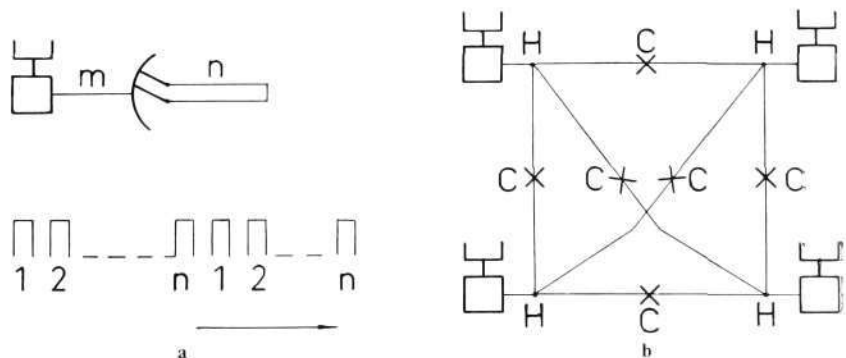
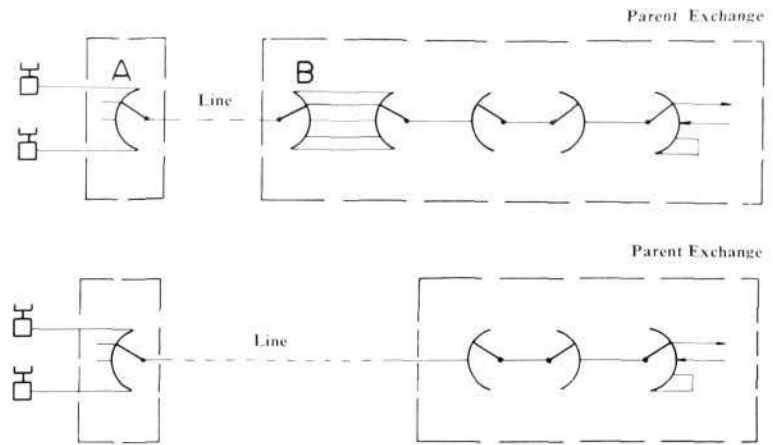


Fig. 3

X 8183  
X 8184

**Line concentrators**

- a In the classical systems the line concentrator is entirely auxiliary to the normal exchange equipment.
- b Electronic line concentrators, with part of the switching equipment transferred from the parent exchange to the centre of gravity of the subscriber group.



## Line Concentrators

Line concentrators have a certain bearing on the construction of the switching network. In conventional systems line concentrators have not yet proved economical except in special circumstances. This is because they have been used purely for auxiliary purposes without reducing the amount of equipment in the main exchange. In electronic systems certain equipment can be separated from the main exchange from the outset and placed in the centre of gravity of the group of subscribers to be served in each particular case, so reducing expenditure on line plant.

The integrated transmission and switching system designed by Bell Telephone Laboratories and known as ESSEX is a further step in this direction. In this system the traffic is concentrated in line concentrators, using the pulse amplitude modulation (PAM) principle, and is then transmitted in pulse code modulated (PCM) form to district or regional centres which are also switched on a time division basis. A system of this kind should probably involve certain savings. But many problems still remain to be solved before a definite opinion can be formed. At present, however, it may be said that a system of this kind poses many problems as regards interworking with existing types of equipment. It can hardly be used to full advantage unless it is introduced on a wide basis.

## Transmission

In the classical systems the fulfilment of the transmission specifications presents no particular problem. The only point which designers usually need to consider is crosstalk, which may make it necessary to pay special attention to the wiring. In some systems contact faults may occur in the speech paths, sometimes accompanied by noise. In the electronic systems, on the other hand, all transmission magnitudes must be taken into account. The space division systems are subject to a certain attenuation, since electronic contacts have a less marked on-off relationship than mechanical contacts. The maximum power transmissible is usually sufficiently high (though not for normal ringing current). Crosstalk attenuation can be kept at a satisfactory level by the choice of appropriate impedances for the operation and holding of the contacts. The contacts are noiseless and are unaffected by vibration. In the time division systems the transmission problems are even more intricate. On account of the introduction of so-called resonant transfer, however, it has been possible to keep the attenuation even lower than in many space division systems. Crosstalk, which initially was expected to be a serious problem, has been reduced to an acceptable level by the addition of capacitances at certain points in the system.

In this system the maximum transmissible power may not always be fully sufficient. In addition the minimum band width is fixed, though it may be increased to any desired extent. If more stringent requirements were to be placed on the system, such as facilities for high speed data transmission, it would probably be necessary to increase the complexity of the line filters in order to minimize phase distortion.

The first time-division concepts were on a 4-wire basis. With semiconductors as speech contacts it has been possible to arrange for bilateral transmission on a 2-wire basis.

The extra attenuation of 1-2 db occurring in electronic exchanges is a disadvantage. For subscribers with poor reference equivalent this attenuation must be compensated by amplification or reduced attenuation in other parts of the network. The added amplification is usually obtainable by means of amplifiers in the subscribers' instruments - which must in any case be re-designed. In practice, therefore, the transmission properties of electronic exchanges should be acceptable and in certain cases even superior to those of conventional systems, owing to the freedom from noise in the transmission path.

## Logic Circuits and Memories

To borrow a term from the computer field, one may say that the relay sets, registers, markers etc. of the classical systems are circuit units in which the system operation is determined by routines and sub-routines. At the same time they serve as memories for dialled numerical information, selected traffic routes etc., as well as information pertaining to the different stages in the routines. Cross-connecting fields may be regarded as semipermanent memories. In the conventional systems there is a greater tendency to concentrate the routines to centralized units. The advent of register systems was probably the first step in this direction, centralized translators and time-zone metering equipment are now currently used, and in crossbar systems a considerable measure of concentration has been made possible through the use of markers.

Electronic systems permit a very much more radical arrangement of logic circuits and memories. In large exchanges it is possible to concentrate the logic circuits to a single functional unit (naturally with a stand-by). Similarly the memory functions can be centralized, though this does not lead to any significant economy in the number of bits. Nevertheless reading, writing and erasing will be simplified by the use of devices which will be common to large memory complexes. The concentration of the logic circuits and memories allows greater flexibility in the exchange functions. Any alteration required in the mode of operation of the exchange should therefore be a simple matter. Interworking with other exchanges could be easily "programmed" into the system. There has been discussion of the relative merits of "logic in circuits" versus "logic in memory". The latter implies that all routines and sub-routines are programmed and written into a memory, possibly by means of remote control. This would give a very high degree of flexibility in operating facilities. On the other hand the cost of the memory in a full "logic in memory" system would be fairly high and the speed of the marker would have to be increased. In practice, therefore, it would be necessary to compromise and allow a good deal of the logic to be built into the circuits. But the larger the exchange, the more logic may be placed in the memories.

One of the great advantages of electronic exchanges lies in the fact that they can be cheaply supplied with a large memory capacity. This makes it possible to introduce new traffic facilities for subscribers. Unfortunately, however, no satisfactory solution has yet been produced for a semipermanent memory, that is, a memory in which the contents need to be changed comparatively seldom. A memory of this kind should preferably be programmed electrically, and read-out should be "non-destructive".

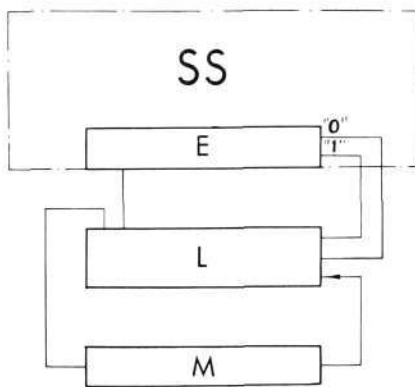


Fig. 4 X 2481

### Logic arrangement

- SS Switching system
- E Executive unit
- L Logic equipment
- M State memory

The figure shows the principle on which an electronic exchange may be built. The executive unit receives and transmits signals to the switching system and to circuits connected to it. The memory records the states of the various circuits, speech paths etc. On receipt of a signal from the executive unit, the logic equipment can decide what action is required by reference to the memory, i.e. either to send a new signal to the switching network or to record the new state in the memory.

In a logic-in-circuit system the mode of operation is determined by the design of the exchange, being built into the wiring, and can only be changed by changing the wiring.

With logic in memory the mode of operation is not determined in advance. It can be changed by remote control by reprogramming the logic memory. This makes it possible to change the rules for clearing, accounting, signalling, etc.

## Telephone Instruments

Electronic exchanges require a new type of telephone instrument. The chief reason for this is that low frequency a.c. ringing is not possible. The switching networks in the exchanges do not permit transmission of the requisite power. The tone ringer system, with which it is necessary to operate, requires amplification in the instrument and also an acoustic generator in lieu of a bell. Naturally a keyset should be provided instead of a dial. The digits would be produced by combinations of v.f. currents. The keying device and amplifier would require a few transistors, which, in the latter case, could be used both for incoming and outgoing speech. This would bring two advantages: the amplification could be used to compensate the greater attenuation in exchanges and especially in line plant; and a better transmitter than the carbon granule type could be used, for instance an electrodynamic transmitter. The new telephone set would naturally be a good deal more expensive than the present one. This is a factor which must be taken into account when considering the introduction of electronic exchanges, as also that all existing telephones would have to be replaced.

## New Traffic Facilities

It has already been said that electronic exchanges offer new and improved traffic facilities at a fairly small additional cost. A few examples are given below:

On encountering an engaged signal, the subscriber can take action which will cause him to be rung back as soon as the number becomes free.

Subscribers can be offered a special facility enabling them to call certain of their most regular contacts by means of single code digits.

Automatic interception facilities, etc.

Electronic metering which may be differentiated for different types of call and classes of subscriber. For example, accounts may be made up on a lump sum basis or with long distance calls specified separately, whichever is desired. The metering equipment will permit complete mechanization of the accounting system (electronic data processing).

These facilities can probably be introduced into existing systems by the addition of auxiliary electronic equipment, though some additional cost would be involved in the necessary coordination between the electronic and relay equipment.

The inclusion of PABX facilities in the main exchange is yet another feature. Subscribers' lines may be grouped together so as to operate as though they were connected to a PABX. This facility is known to have been incorporated in certain conventional systems to meet special requirements. But in electronic exchanges it will be a standard feature which will be especially attractive if combined with the line concentrator principle.

The value of the new facilities will not be obvious until they have been tried out in practice. Some subscribers will probably be greatly appreciative, while perhaps the majority will be indifferent. The electronic exchanges will, in these respects, have certain advantages over conventional equipment.

## Some Characteristic Properties

Electronic exchanges will operate more rapidly than conventional ones. This will be of some significance in the case of traffic which is routed through several switching stages. It will become profitable to develop high-speed signalling systems. But the extreme rapidity of switching which is now within our reach cannot be put to its full use since dialling cannot be done more quickly than is possible with a keyset.

Electronic equipment is lighter in weight and will take up much less space than the present exchange equipment. Normally, since housing costs are low compared with equipment costs, this factor will have little economic significance. But in large cities, where sites are expensive and space is at a premium, this may often be the determining factor; also in military applications, especially for mobile units. In the latter instance insensitivity to vibration is also important.

As regards power consumption electronic exchanges will have a clear advantage, though counterbalanced to some extent by the fact that the voltage limits must be more stringent.

Electromechanical systems possess two features which are impossible to attain with electronics. One is the reversal of polarity on subscribers' lines, which is now employed for special signalling purposes, for example in connection with coin boxes. The other is the ability to make resistance and insulation measurements of subscribers' lines. In electronic switching there is no d.c. connection to the line network.

## Maintenance and Quality of Service

The questions of perhaps greatest importance to the telephone administration – apart from first cost – are quality of service and cost of maintenance. There has been some scepticism about the quality of service attainable with electronic equipment. For an electronic exchange to be on a par with present types of equipment, very stringent requirements must be fulfilled with regard both to components and to the system as a whole. To illustrate this it may be mentioned that, if one transistor fault per week is to be tolerated in a 10,000-line exchange, the transistors must have a mean life of  $20 \cdot 10^6$  hours (or over 2,000 years). Even if not impossible, it would be difficult to decide in advance whether a life of this magnitude is attainable. The requirements could be modified to the extent of allowing a fault rate of 0.005 per cent per 1,000 hours during the first 40 years. After 40 years, which is the maximum life of an exchange from the point of view of technical modernity, the semiconductors may be allowed to degenerate more rapidly. It is thought by the component manufacturers that these life requirements are within the bounds of possibility. The mechanism involved in the degeneration of transistors is now becoming better understood, so that accelerated life tests can be evolved. With the advent of improved transistors greater insight has also been gained into methods of circuit design which do not overrate the components. The influence of ambient temperature has also been made clear.

Part of the hesitation felt with regard to electronic systems stems from the very inferior performance of carrier systems compared with automatic exchange equipment. This is probably due to a large extent to inefficient contacts in soldered joints and jacks. Electronic systems are vulnerable to this type of fault owing to the low power levels passing the contacts. An intensive study of these phenomena is being carried out, however, and it may be expected that the problems will be solved without undue increase of cost. In carrier systems, moreover, some of the faults have clearly been caused by the maintenance work itself, since breaks in transmission have been more frequent during the daytime.

A fault in an electronic system may have serious consequences in view of the concentration of functions to single units. The designers must guard against this by employing the principle of redundancy. This can be done in two ways, either by duplicating the more critical component aggregates or by including self-checking circuits. Electronic computer design has given a pointer in this respect. Some increase of cost will be involved, but not of a significant nature.

As far as maintenance is concerned, the electronic exchanges will, of course, create an entirely new situation. Maintenance will be concerned almost

exclusively with electrical phenomena. Up to now the main faults in exchanges have been mechanical, even if the crossbar systems have brought electrical faults into greater prominence. It may be said that electrical faults are difficult to detect and to locate, but easy to repair, while the converse is true of mechanical faults. In electronic systems the attempt is made to incorporate fault finding circuits as an aid to maintenance. The equipment will check its own functions, say once a day, and report type and location of fault to the maintenance staff. At unattended exchanges these reports will decide whether a repairman must be sent out immediately or not. But it can hardly be expected that all faults will be traceable in this way. Maintenance staffs must under all circumstances be trained on entirely different lines from those now employed. And maintenance work should prove more attractive to young people than before, since they will be dealing with more modern techniques.

## The Price Question

The cost of an electronic exchange is determined by the price of the individual components and by the quantities required. The general design of the systems can be foreseen fairly clearly, so that the number of components is at least approximately known. The price question will therefore depend almost entirely on component prices. At the present prices of semiconductors, which are the main cost item, it will not be possible to build electronic exchanges on a competitive basis. Semiconductor prices must be reduced, but this can only be done if the production methods become cheaper. The diffusion process seems to offer promise of reducing production costs, given sufficient output. It is therefore essential that the equipment be designed so as to make use of components from other fields such as industrial electronics.

The two other main production costs are assembly and testing. Probably only the very largest producers will be able to afford automatic assembly. Testing, on the other hand, will be largely automatic.

It may be assumed that it will be in the large local or trunk switching centres that electronic systems prove most competitive. It is there that the concentration of functions to centralized units shows up to best advantage. Small units are likely to be less profitable. There is an obvious parallel in the computer field. No attractive electronic solution has yet been found for small machines.

## Summary

This comparison between electronic and conventional types of exchanges has hardly resulted in a unified picture. In some respects electronic exchanges have the advantage, as for instance in traffic facilities, volume, weight, and perhaps maintenance costs. But these benefits are counterbalanced to some extent by inferior transmission properties, the necessity for a new telephone instrument, and new and unaccustomed techniques. Apart from specialized applications, therefore, for which electronic equipment is manifestly preferable (military installations, where weight, volume and vibration stability are essential), the price question will probably be the decisive factor in the long run. In this connection it must be remembered that the production costs for conventional systems have not yet reached rock bottom. The impact of a new technique always has a stimulating influence on the upholders of the old order. As already stated, semiconductors hold the key position in the price question. If electronic exchanges are to have any future on a broad front, the liberal promises of price reductions made by the semiconductor manufacturers must be fulfilled.

# Relay Interlocking Plant at Copenhagen Main Station

W WESSEL HANSEN, DANISH STATE RAILWAYS, COPENHAGEN

UDC 656.257  
LME 86, 87

*The Danish State Railways (DSB) have recently installed a relay interlocking plant for the suburban lines terminating at the main Copenhagen railway station. The plant is designed on the most modern principles with relay groups for control of shunting movements. The shunting route circuits were designed by DSB, and relay groups, relays, control machine and other equipment were supplied by LM Ericsson's Danish Company, Dansk Signal Industri A/S. The head of the Signalling and Telecommunications Department of the Danish State Railways, Mr. W. Wessel Hansen, describes the new relay interlocking plant, starting with a few words about modern signalling techniques as employed by DSB.*

## The New Interlocking Technique

The introduction of track circuits, track diagrams and automatic block systems has provided the basis for all-relay-controlled signalling systems. Railway companies all over the world have shown a great interest in relay systems in preference to the earlier mechanical and electromechanical interlockings. An important factor was the saving in operating costs expected with relay operation for, since the outbreak of the last war, practically all railways have run at a loss.

But the prices of relays were still too high to warrant a general change-over to relay interlockings. It was only in the USA that such systems had been installed in fairly large numbers before the war. Efforts to reduce the cost of relays were essential; and so successful were they that the first three relay interlocking plants, the components of which were designed by Dansk Signal Industri A/S, Copenhagen, could be introduced on trial around 1950.

Fig. 1 X 7769  
The new control machine and the telephone switchboard, Copenhagen



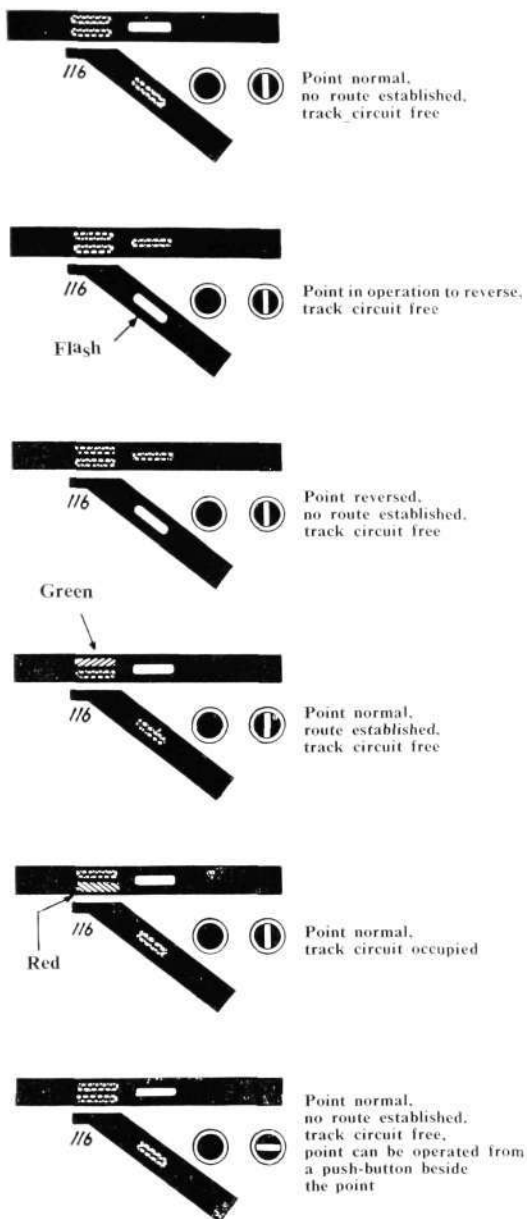


Fig. 2 X 2485  
 Indication lamps and control buttons for centrally controlled points with local switching facilities

The three trial installations proved satisfactory, and a number of both small and, by Danish standards, large relay interlocking plants were installed in the following years at Esbjerg, Glostrup, Odense, Hobro, Kolding, Lunderskov, Nyborg and Helsingør—the two latter on a purely provisional basis during reconstruction of the track layout; for investigations showed that the installation of temporary relay interlockings was preferable to the costly and hazardous practice previously employed of cutting out the signalling while reconstruction was in progress. The basic principles of these relay interlockings are as follows.

The *centralized switching of points* is effected by brief depression of an individual button beside the point symbol (fig. 2) and of a common button. This two-button operation eliminates the risk of points being switched by accidental pressing of a button. The start of point operation is indicated by darkening of the lamp marking the initial position of the point and by ringing of a bell. In addition, the lamp for the new position of the point flashes white during the switch-over. The completion of switching is indicated by a new bell signal, and the lamp for the new position of the point now shows a steady white light. The same button is used for the two directions of operation of the point.

Should the common button be kept depressed by mistake for more than about 10 seconds, a bell rings.

Each point on the track diagram has its own lamp combination which can show red or green. The lamps are normally dark, but red light is shown when the track circuit at the point is occupied. The green light is shown when the track circuit forms part of an established route; the light indicates that the point cannot be switched but that the track circuit at the point is unoccupied.

To facilitate lubrication of the points, snow clearance etc., the points can be equipped with control buttons for local operation (fig. 3). All points are now provided with roller bearings which are fitted direct to the stock rail (fig. 4).

At large installations the staff are unlikely to notice a failure of point operation owing to a *fault*. Every point is therefore provided with a time relay which automatically stops the switching operation, if not completed within 15—20 seconds, and issues an alarm.

At the plants installed hitherto there has been no need for automatic switching of points simultaneously with the establishment of routes (except at C.T.C. installations).

*Routes are established and signals operated* by the simultaneous depression of a signal button and a route button on the track diagram. The establishment of a route is indicated by the lamps for the track circuits in the route showing green if the track is unoccupied (occupied track circuits show red). The relay system associated with the keys checks that the track is unoccupied and, if so, operates the signals. The establishment of a route is also indicated by the lighting of two arrow-shaped lamps on the track diagram; white light beside the route button and yellow light beside the signal button.

The system has now been developed a step further in that relay-controlled shunting routes have been introduced at Copenhagen, i.e. routes which are intended for normal shunting movements. The economic prerequisite for the

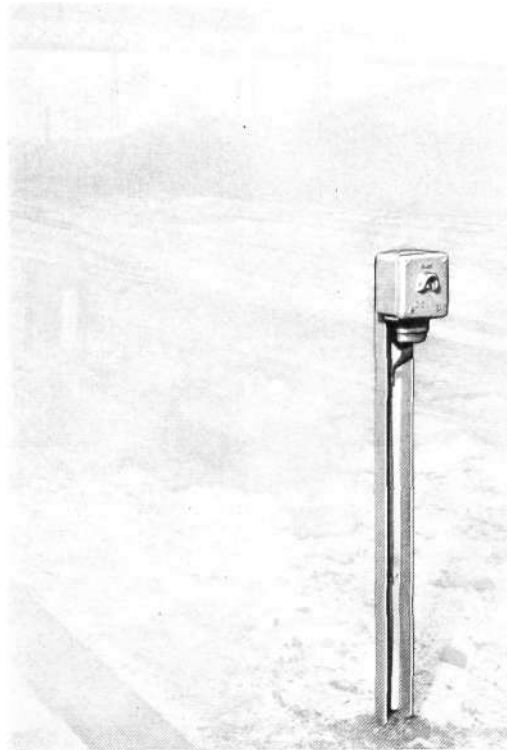


Fig. 3 X 2499  
Control button for local point operation

introduction of this system was the design of a small, cheap and reliable relay (fig. 5), since shunting routes require a comparatively large number of relays. A considerable amount of additional development work was necessary, for DSB required that the relays for shunting routes should be assembled in the form of relay groups (fig. 6).

Fig. 7 gives an idea of the *control of shunting routes*. The release of a shunting route is effected sectionally. The points at the approach end of the route are released first, so that they may be used for other shunting movements. The points at the exit end of the route are released when the cut has passed the entire route. No manual operation is required for release of a route. A dwarf signal can be set to "No entry" by simultaneous operation of the signal key and of a common key. A dwarf signal can be set to "Signal cancelled" by simultaneous operation of the signal key and another common key.

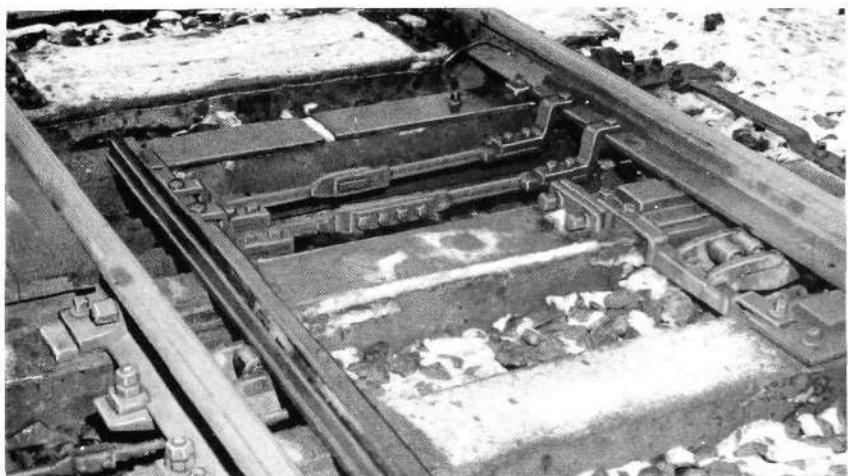


Fig. 4 X 8186  
Roller bearings attached to the stock rails reduce the likelihood of faults in point operation

Fig. 5

X 8194

Relays for relay group  
8-contact size: 59 × 40 × 81 mm

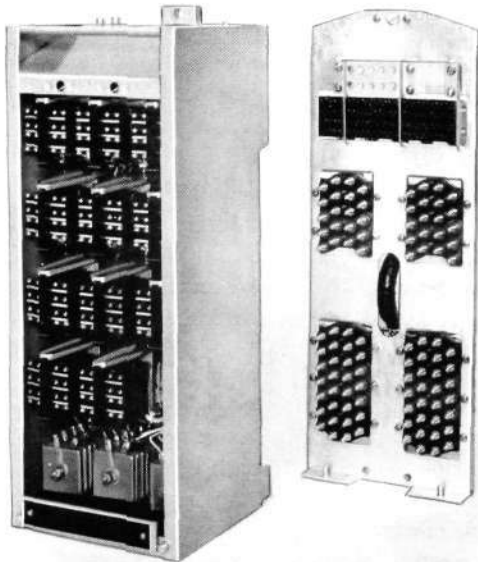
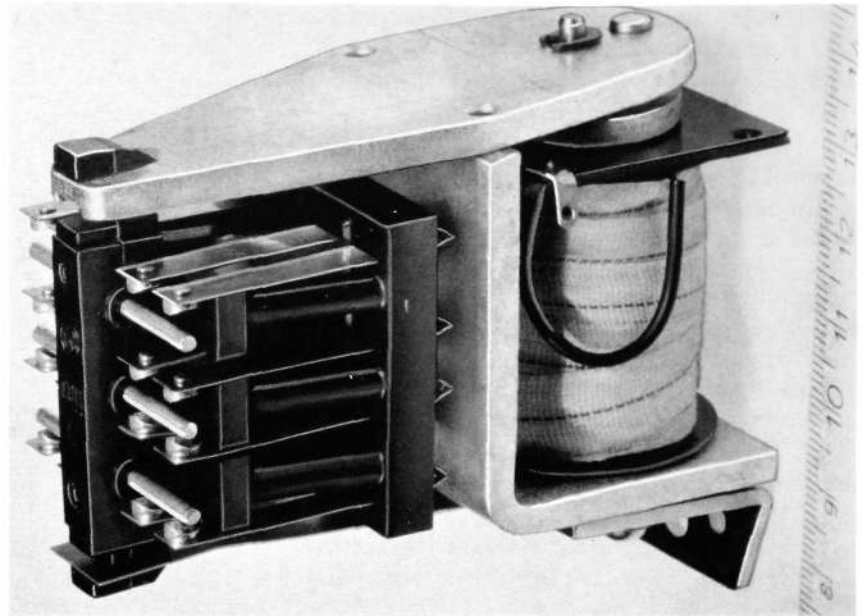


Fig. 6

X 2488

Relay group containing relays and rectifiers.  
Max. 15 relays type RF.

On the right is the mounting plate which is attached to the relay rack and on which the wiring terminates.

Dimensions 140 × 160 × 370 mm

Fig. 7

X 8187  
X 9149

Control of shunting route

If a route is to be established, say, from dwarf 129 to dwarf 125, the points must first be operated, after which the yellow button at 129 and green button at 125 are depressed simultaneously. "Cancellation" of a signal is effected by simultaneous operation of the yellow signal button and the A button. The "No entry" aspect is set by simultaneous operation of the yellow signal button and the F button. Manual release of a route from, say, dwarf 129 to dwarf 125, is effected by simultaneous operation of the F button and (successively) of the green button at 129 and green button at 125.

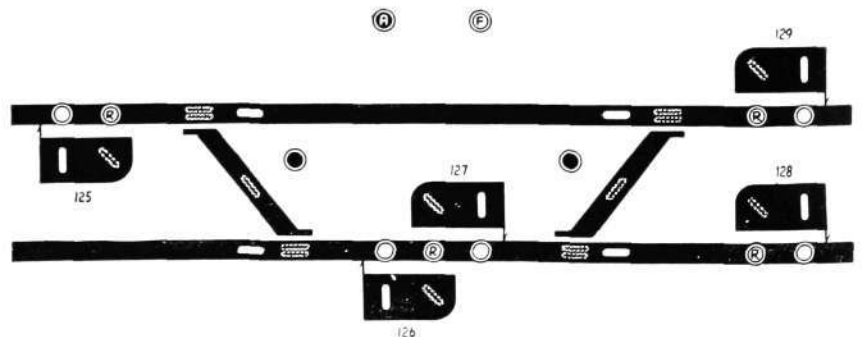
## Interlocking Plant for Copenhagen Main Station

When the railways were electrified in 1933, there was considerable doubt whether the electrical interlocking at Copenhagen could be used in conjunction with an electrified railway in view of the risk of faulty point operation due to heavy "stray" currents. Investigations showed, however, that the plant could be retained provided that the equipment and the cables were kept in the best possible condition.

It was nevertheless decided that the interlocking plant, which had been installed in 1911 and was already approaching the end of its life, should be replaced by a new one. This proved no easy task, however. Not only was interlocking technique still in the melting pot, but it was difficult to design an efficient new plant which would comply with the signalling regulations.

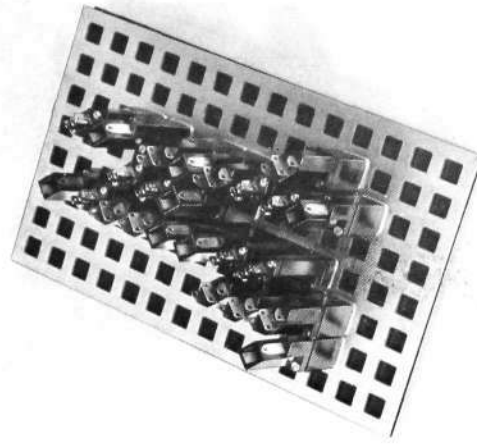
The main features of the new plant are the following.

The basic element of the control panel is a perforated plate (fig. 8) on which buttons and lamps are mounted. The buttons, with their dust-tight con-



Colours of buttons

- ⓐ green
- ⓕ red
- Ⓨ yellow



**Fig. 8**  
Perforated plate

X 2489

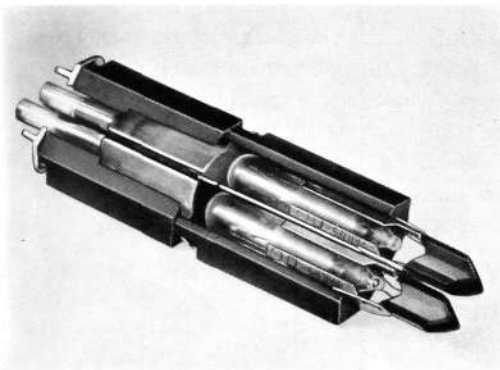
tact system, have one transfer contact (fig. 10). Some buttons are of the locking and others of the non-locking type, and they are differently coloured and engraved according to their usage.

One type of panel socket has two lamps (fig. 9), each with its colour filter or lamp profile corresponding to the function it is to indicate.

For indication of digits 01-99, which are used, among other purposes, for indicating the positions of route signs, there is a separate panel system with 20 lamps which project their light through a lens system on to a matt glass plate (fig. 11).

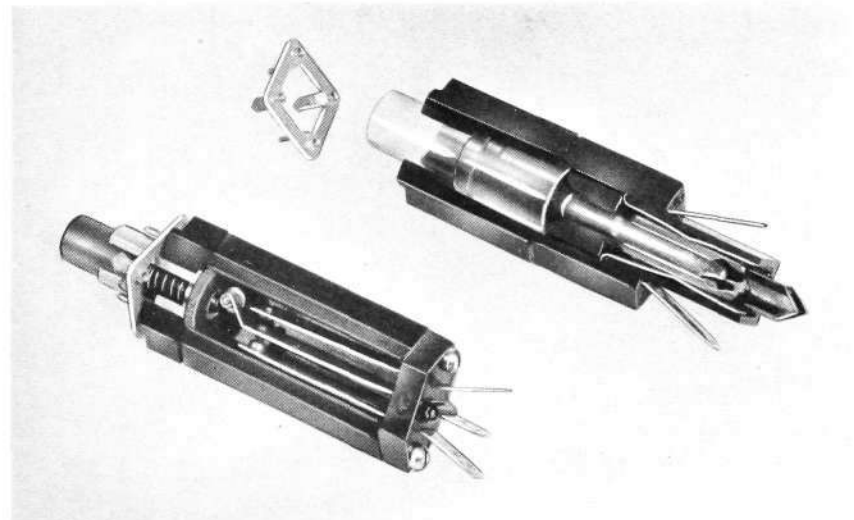
The perforated plate is covered by a plastic plate on which are engraved the schematic track system, signals etc., the tracks being white against a dark background.

The cabling of the control machine is divided into separate sections, each of which accommodates a maximum of about 200 wires. The individual wires are taken to a distribution frame and to cable sealing ends at the bottom of the control machine and thence to the relay racks.



**Fig. 9**  
Twin-lamp panel socket  
Dimensions: 16 · 16 · 58 mm

X 2490



**Fig. 10**  
Control button and single-lamp panel socket  
Dimensions: 16 · 16 · 65 mm

X 8188

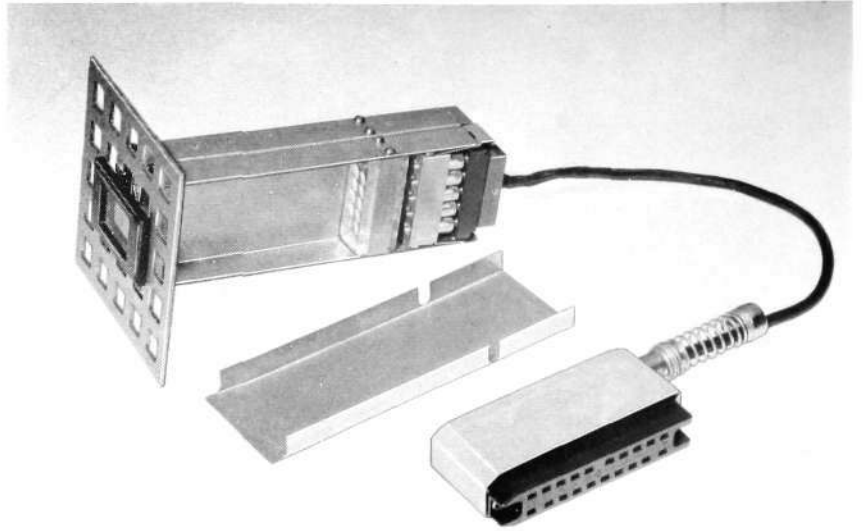


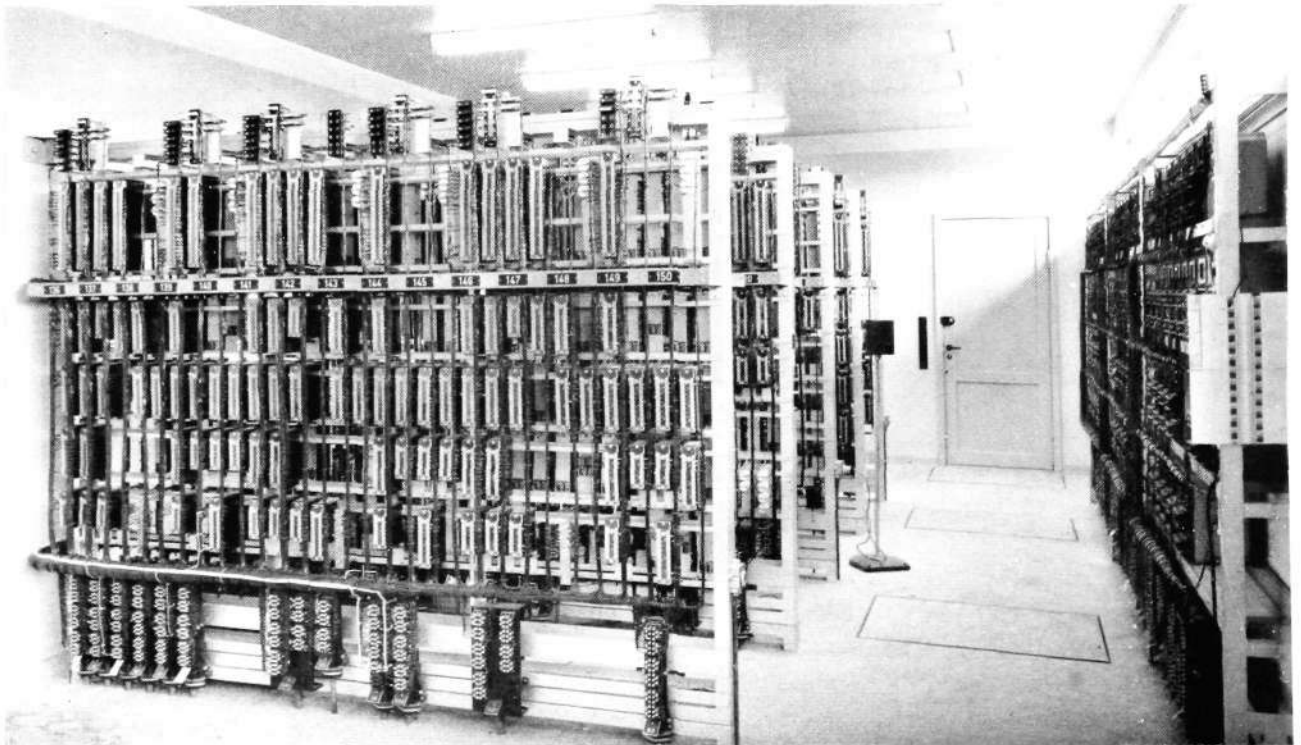
Fig. 11 X 8189  
 Panel units for  $2 \times 10$  digits or letters  
 Dimensions: 32 - 48 - 155 mm

The relays are placed on racks which are divided into sections. Thus all relays involved in the operation and control of a point are placed in the same section (fig. 12). Fig. 13 shows the circuit diagram for point operation. Fig. 14 shows an example of how a station area is divided into signalling areas for shunting movements. There are 22 routes solely for the track area delimited by signals *D 133*, *134a*, *134b*, *D 135*, *D 146*, *D 147* and *D 148*. The circuits for the shunting routes are made up on the geographical circuit principle (fig. 15). By this means the number of relays and contacts can be greatly reduced.

The new interlocking plant covers:

- 20 main routes
- 102 shunting routes
- 53 signals
- 64 points
- 85 track circuits

Fig. 12 X 7770  
 Relay racks for interlocking plant



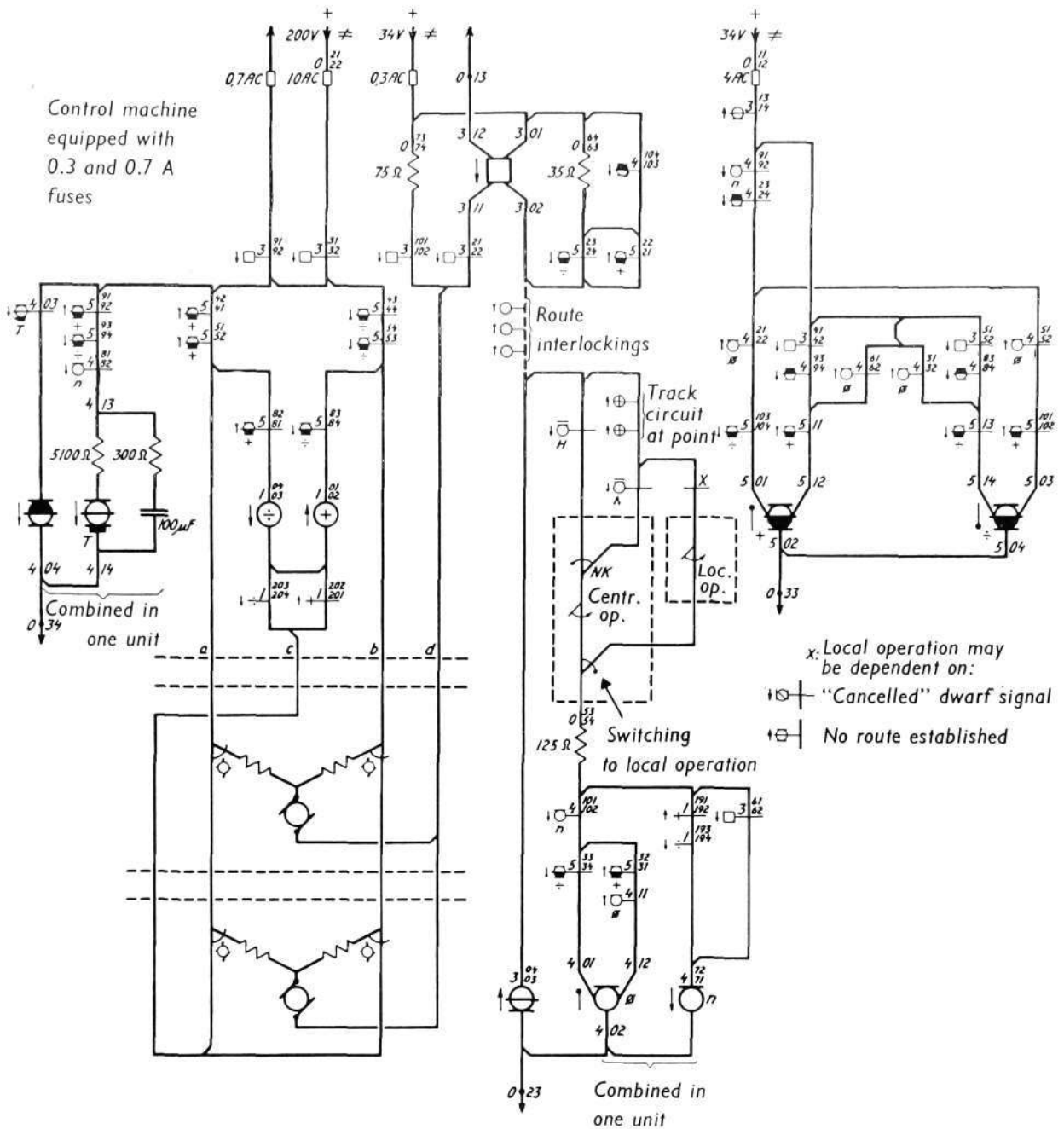


Fig. 13

X 7775

**Circuit diagram for point operation**

Silver contacts only are employed. The points are operated by a 220 volt d.c. motor.

- 1368 relays, of which 451 in 41 relay groups
- approx. 33 miles of cable with overall conductor length of 400 miles
- approx. 20 miles of wiring between relays, cables etc.
- 34000 terminals
- 17 call stations, with 23 loudspeakers
- 47 electrically heated points

The control machine has 260 push buttons and 354 lamps.

An interesting new feature is the automatic self-regulating emergency power plant. This consists of an air-cooled diesel engine, which, through a centrifugal coupling, can be connected to a shaft carrying a heavy flywheel. The other end of the shaft is coupled both to a self-regulating, self-magnetizing a.c. generator and, via an elastic coupling, to an electric motor.

Under normal supply conditions the electric motor is coupled to the shaft, so that the generator and flywheel are rotated at about 1,500 r.p.m. while the diesel is at a standstill.

If the supply fails, the load is automatically switched over to the generator and flywheel, and at the same time the diesel is started. It takes about 15 seconds, however, for the diesel to attain the speed at which it can take over the production of alternating current of the required frequency and voltage. In the meantime the supply is maintained by means of the flywheel which can deliver 5 kW. As soon as the diesel has attained the necessary revolutions, the centrifugal coupling connects the diesel to the flywheel shaft (and to the generator).

When the main supply returns to normal, a relay system "senses" whether the supply is stable and, if so, the load is switched back to the mains and the diesel stops.

The relay system also contains a frequency-sensitive element which starts the diesel if the mains frequency drops below a given limit. This brings the flywheel up to normal revolutions so that its full energy is available to meet any fluctuations from the mains. The load thus remains on the mains. The relay system likewise contains a voltage-sensitive element which starts the standby unit if the mains voltage falls below 25 % of normal.

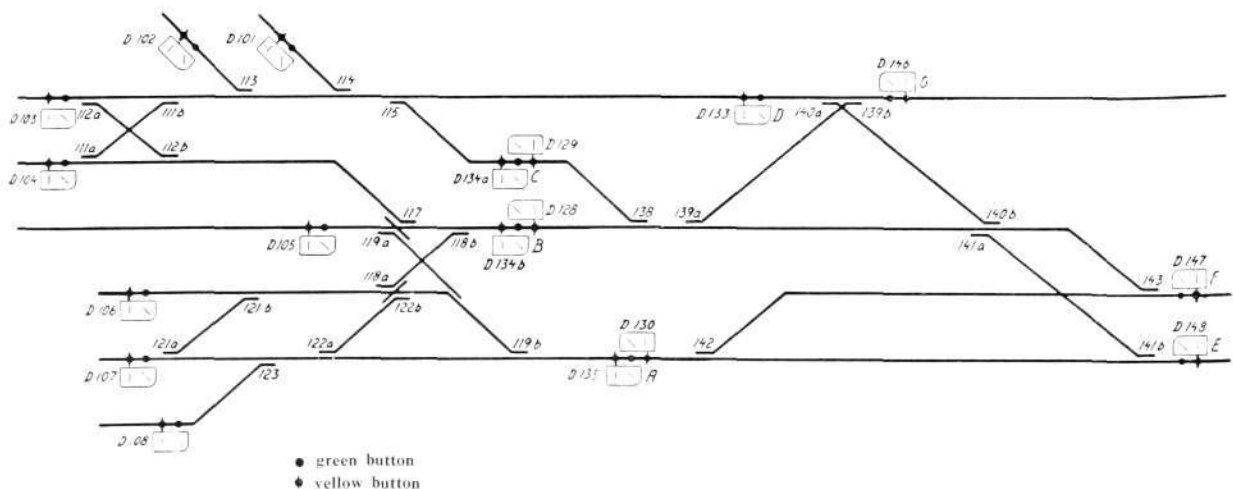
The diesel engine has an all-automatic lubricating system and stops if the oil pressure sinks or the oil temperature rises above a given level.

The diesel engine has built-in thermostat-controlled heaters in the sump which keep the lubricating oil at the proper starting temperature.

## Traffic Conditions at Copenhagen Main Station

The area served by the new interlocking plant covers 4 platform tracks, 13 storage tracks, 9 shunting tracks and 6 dead-end tracks. Adjoining the area is a machine depot equipped with 5 overhaul tracks for suburban trains and 7 depot tracks on the west of the depot. The fourth main track connects the station area with the goods yard (where the machine depot is situated). Over the third main track there are two crossing tracks leading to the long-distance tracks.

Fig. 14  
Shunting area





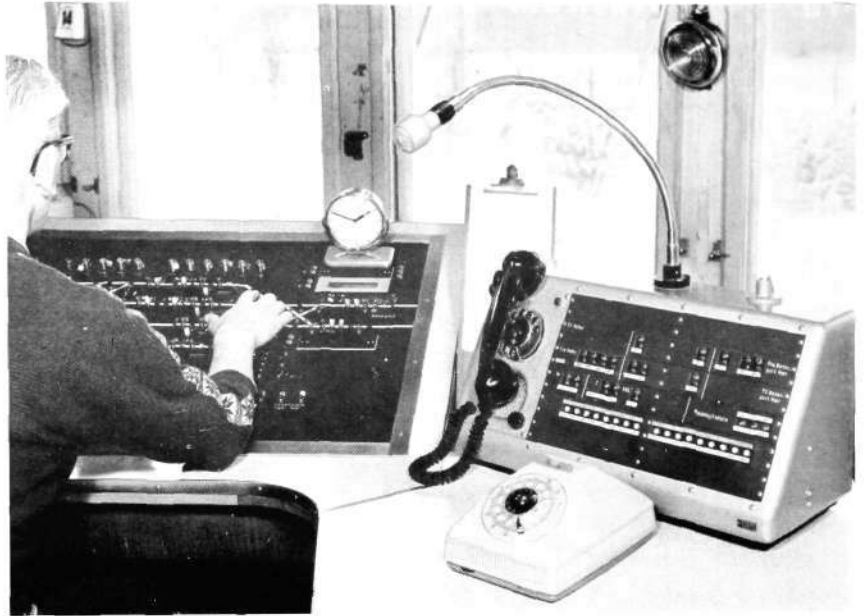


Fig. 16

X 8190

Control machine and telephone equipment including L M Ericsson's loudspeaking telephone, Ericovox

### Cut-over of Plant

The cut-over was started on November 10, 1959, when 32 points were connected up to the new plant. Connection to main and platform tracks was done on Sunday, November 15, and by 5.15 a.m. the entire installation was in operation—with certain minor exceptions—without any interruption to service.

# LM Ericsson's Automatic Fire Alarm System HAA 100 with Control Board KBA 410

G BERGH, LM ERICSSONS SVENSKA FÖRSÄLJNINGSAKTIEBOLAG, STOCKHOLM

UDC 654.924.5  
LME 861

*LM Ericsson has brought out a new and improved fire alarm system in which the signal is produced by short-circuiting of the two line wires. The system, known as HAA 100, obviates any possibility of a false alarm being issued to the fire brigade headquarters as a result of a line fault. The article describes the new system and its principal advantages.*

Automatic fire alarm installations have been used in Sweden, to a far greater extent than in other countries, for giving an immediate warning to the municipal fire brigade. Earlier systems have employed two-wire loops in which the thermal detectors were connected. The detectors were of the temperature-limit type and had twin break contacts. A rise of temperature caused by a fire caused the two contact points to fuse and open the two-wire loop, whereupon an alarm signal was given at the control board and, in most installations, was automatically passed to the fire brigade headquarters.

The original reason for making use of two-wire loops was the desire for separate alarm and fault signals. If a fault were to result in an alarm signal, the fire brigade would be summoned without cause, which would naturally be unsatisfactory.

The chief reason for false signals being transmitted from automatic fire alarm installations has been that the wires have been damaged or torn away in the course of building repairs, so that a two-wire disconnection arose in the loop. The trouble caused by broken wires became growingly serious as the number of installations connected to municipal fire brigades increased. LM Ericsson has therefore been working on the development of a system in which broken wires would not cause an alarm but only a fault signal.

A study of the problem showed that a short-circuit between the two wires of a loop was very rare. Why, then, should not a system be employed in which the alarm signal resulted from closure instead of opening of the two-wire circuit? And this was the principle adopted in the new system.

A thermal detector with absolutely reliable make action proved a difficult design problem, but the unit finally evolved, and used in the new system HAA 100, is a make-contact thermal detector with as reliable an action as the previous type with twin break contacts.

## Thermal Detector KEA 2001

The element which issues an alarm signal on an outbreak of fire is the thermal detector (fig. 1). The new detector consists of a plastic base (fig. 2) carrying two contact springs. On the free ends of the springs there are small discs of fusible alloy. A compressed helical spring is moulded into one of the

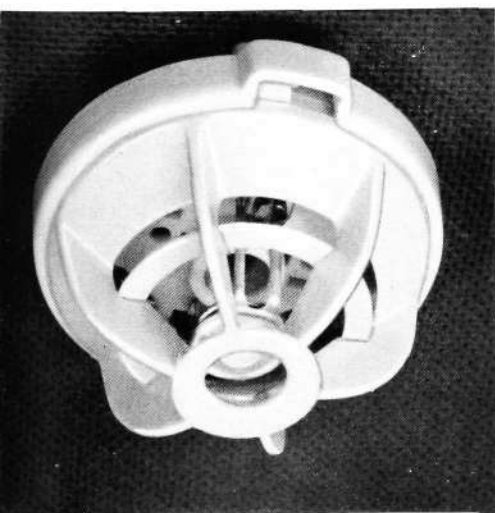
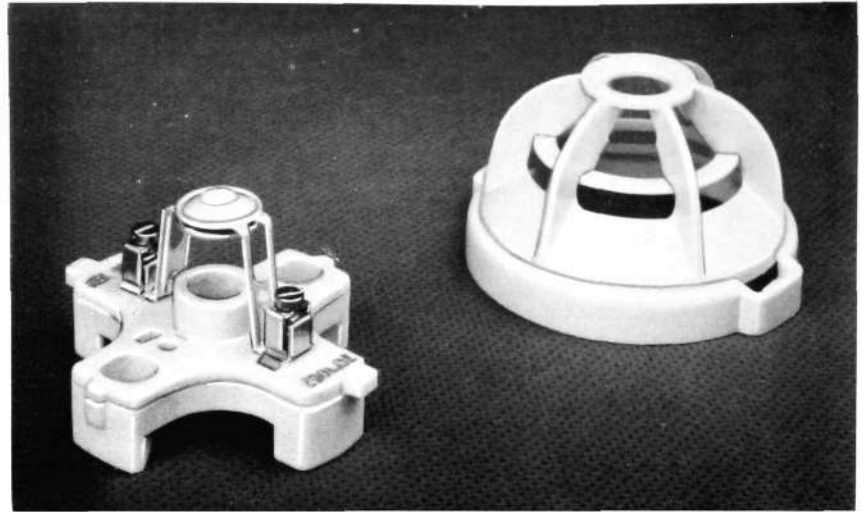


Fig. 1  
Thermal detector KEA 2001

X 2495

Fig. 2  
Thermal detector KEA 2001  
with cover removed

X 8192



discs. The two discs are kept at the proper distance apart by a sleeve of insulating material (fig. 3). When the detector is exposed to heat, the discs melt and the helical spring expands and makes contact with the two contact springs. The helical spring pushes into the melted disc on the opposite contact spring and extremely good contact action is obtained.

To ensure satisfactory heat transfer to the fusible alloy, both contact springs are formed on the upper and lower sides into domed caps so as to have a large area of contact with the air.

The contact springs are protected by a plastic cover which allows free passage of air to the contact springs and so ensures quick heat transfer.

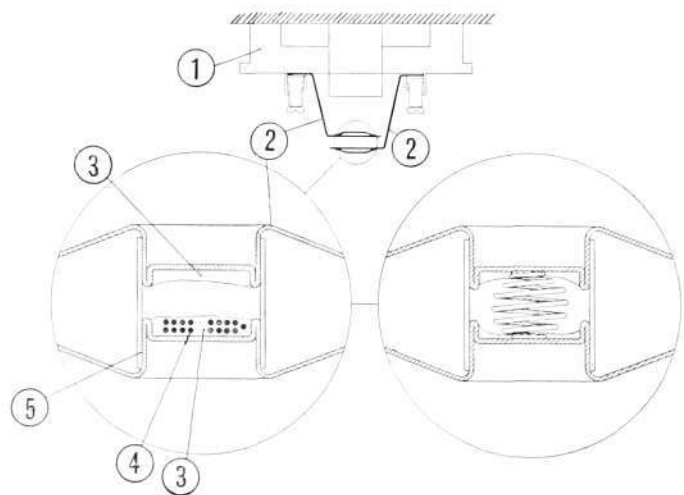
### Principles of Operation

The circuit diagram is shown in fig. 4. Five two-wire loops are connected to a supervisory relay *VR*. The relay and loops are arranged in a closed circuit, with the relay operated. The thermal detectors *TK*, which have the form of make contacts, are arranged in parallel across the loops.

Fig. 3  
Cross-section of thermal detector KEA 2001

X 8196

- 1 plastic base
- 2 contact springs
- 3 fusible alloy
- 4 helical spring
- 5 insulating and spacing sleeve



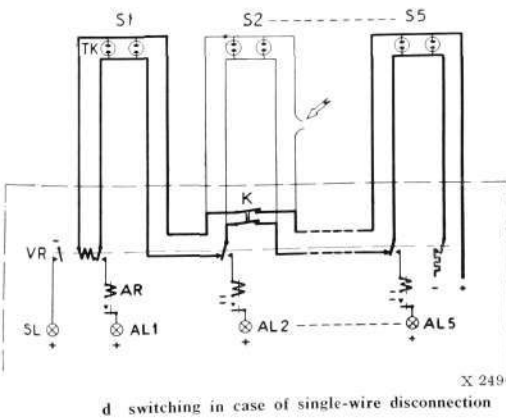
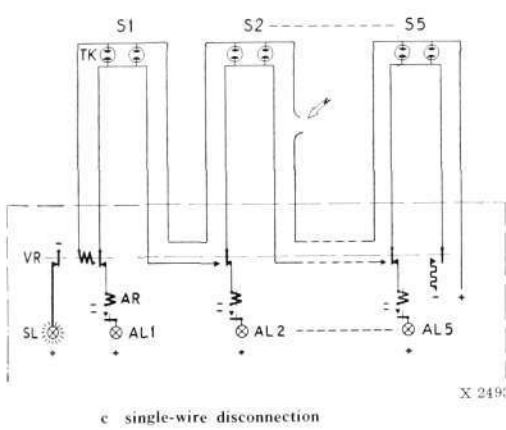
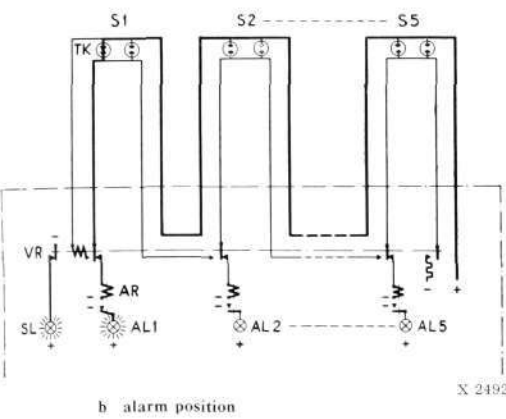
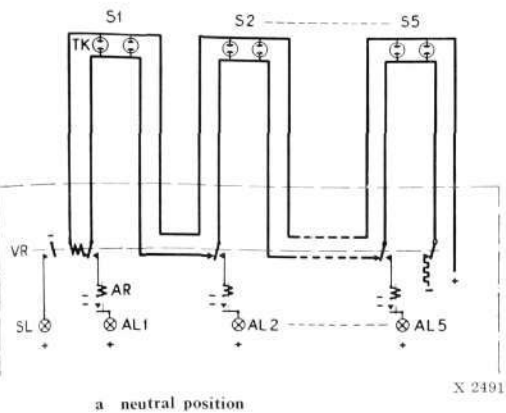


Fig. 4  
Simplified circuit diagram

When a thermal detector fuses in response to a rise in temperature, contact is made between the two wires of the loop. The winding of the supervisory relay is thereby short-circuited and the relay releases. The relay contacts now break up the supervisory circuit into five loops and connect each loop to an alarm relay *AR*, at the same time closing a circuit to a group lamp *SL* common to the five sections of the group. Information as to the section in which a detector has fused is given by the alarm circuit which is established through the detector and the alarm relay *AR*; the alarm relay associated with the section operates and lights its section lamp *AL*. Thus the section containing the fused detector is indicated by two lamps. The supervisory relay lamp *SL* shows to which group of sections the detector belongs, and the alarm relay lamp *AL* indicates the particular section within the group.

If a single-wire or two-wire disconnection occurs in a loop, the supervisory relay is de-energized and releases. This causes the group lamp to light, and also a fault lamp (not shown in the diagram) common to all groups. When the section key for the faulty loop is thrown on the control board, the closed circuit is restored in the remaining four loops and the group lamp goes out. Though no longer closed-circuit controlled, alarm will nevertheless be received from *all* detectors in the faulty loop.

It is possible to connect to each detector a pilot lamp which lights in response to an alarm signal and indicates which detector has fused. On ships, and also in industrial installations and the like, this arrangement will be found of considerable advantage.

On ships pilot lamps can be placed in the corridors and connected to the detectors in the cabins, so that immediate warning will be given of a fire in a cabin. In factories detectors are sometimes placed in concealed positions such as ventilation ducts, and in such case a pilot lamp helps the fire brigade to detect the source of a fire.

The pilot lamp is connected in series with the detector; in parallel with the lamp is a resistor which closes a signal circuit if the lamp fails or if a break occurs in the wiring between the pilot lamp and detector.

### Control Board KBA 410

The control board is made up of a number of panel units which may be combined according to requirements. They are mounted on a hinged frame in a casing which can be recessed or surface-mounted.

The casing carries terminals for the leads from thermal detectors, battery, alarm bells etc. The panel equipment is protected by a glass door with a rubber packing which provides a tight fit with the casing. The door can be locked so as to prevent unwarranted interference with the control board equipment.

A control board consists of the following panel units:

#### Line panel BEL 15001

Five detector sections can be connected to every line panel. Every line panel has five keys, one for each section. The keys have three positions:

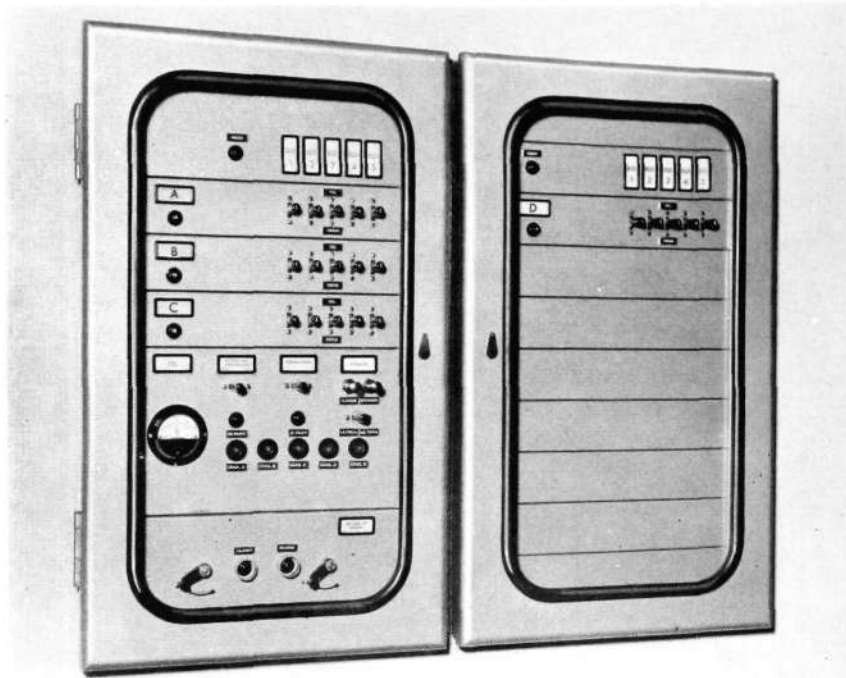


Fig. 5 X 6193  
Control board KBA 41032/301 with extension board KBA 42001/101

FAULT, neutral and OFF. At one end of the line panel is the group lamp, as indicated in the circuit diagram, and below it a restoring button.

#### *Alarm panel BEL 15101*

This panel is common to all line panels of a control board and contains five FIRE lamps numbered 1, 2, 3, 4 and 5. The lamps are placed directly above the section keys on the line panels. To the left of the signal lamps is a test button.

#### *Control panel BEL 15212*

The control panel is common to the entire control board and carries four signal lamps marked FIRE, BATTERY FAULT, EARTH and OFF-NORMAL.

A meter on the control panel shows the closed-circuit current consumption of the system and is used also for measuring battery voltage and insulation resistance to earth. Two switches are provided beside the meter for these purposes.

On the control panel there are two buttons which are actuated by the glass pane of the door and which automatically spring out when the door is opened. The local alarm bells are thereby silenced and the transmission of signals to the fire brigade ceases. These buttons permit regular testing of the system without placing the alarm bells out of action or disturbing the fire brigade. At the bottom of the control panel are five fuses.

There are also two bells on the back of the control panel.

#### *Line panel BEL 15501*

The line panel has two transmitting units which transmit alarm and fault signals to a fire alarm headquarters of the Morse—closed-circuit type.

#### *Line panel BEL 15401*

This is used for transmission of alarm and fault signals to an L M Ericsson type emergency telephone system.

#### *Telephone Instrument DGN 190*

In earlier types of automatic fire alarm equipment, *KBA 14* and *KBA 15*, the telephone used for communication with the fire brigade was placed at the bottom of the control board. In the new system the telephone is placed in the floor-plan cabinet, *KBY 2201*, beside the control board.

Telephone set type *DGN 1901* is used in systems connected to a Morse—fire telegraph centre, and telephone set type *DGN 1902* in systems connected to an L M Ericsson type emergency telephone centre.

#### *Floor-plan Cabinet KBY 2201*

The cabinet beside the control board accommodates floor plans, maintenance and testing instructions, log-book, the telephone set and minor spare parts such as detectors, lamps and fuses.

## Power Plant

At most fire alarm installations an a.c. supply is available. In such case a 24 V storage battery and a voltage-regulated charging unit type *BMM 4111* are provided for standby purposes.

If the battery voltage falls below a given level, or if the battery fuse blows or the battery supply is cut off for any other reason, the BATTERY FAULT lamp lights on the control panel and the fault signal bells ring. If the system is connected to the fire brigade, a fault signal is also transmitted to the latter.

A battery fault does not put the system out of operation, however, since the charging unit in such case takes over the supply.

A mains failure is indicated by a fault signal on the control board and by the ringing of the fault signal bells. Mains failures are not signalled to the fire brigade, but only locally. A fault signal is silenced by means of the switch on the control panel, which at the same time extinguishes the indication lamp. When the mains supply returns, a new signal is given; the latter is cancelled by restoring the switch to neutral.

As long as the mains voltage is cut off, the system is supplied by the battery. The battery is recharged when the mains voltage returns.

Feed cables, section leads, battery leads etc. connect to terminal blocks on the back of the control board. There is also space for additional terminal blocks for cross-connection of the various sections. This is of special value in large plants where building work is constantly going on which may necessitate renumbering of the sections.

Additional bells for alarm and fault signals can be connected to the control board, which may also include arrangements for automatic switching-off of fans.

## Main Advantages of the System

A two-wire disconnection in a section line causes only a fault signal and not a false alarm signal. This is a great advantage in view of the frequency of damage to section lines in factories and similar locations where building repairs are in constant progress. In other systems a line break sends a false alarm to the fire brigade.

Once the control board has been reset after a fault signal caused by a two-wire disconnection, alarm signals will be issued by all thermal detectors in the faulty loop on an outbreak of fire.

A single-wire disconnection in a section line causes a fault signal.

During building repairs one or more detectors can be disconnected in the area concerned without affecting other detectors in the section.

The division of the detectors into groups, with five sections in each group, appreciably reduces the supervisory current consumption, so that the battery and charging unit can be of smaller capacity than in earlier systems.

The control board is very much smaller than previous types, which is an advantage when space is at a premium. The smaller board has been greatly appreciated by architects.

# L M Ericsson Exchanges Cut into Service 1959

## Public exchanges with 500-line selectors

Town	Exchange	Number of lines
<i>Argentine</i>		
San Martín	(extension)	300
San Rafael	(extension)	500
Santiago del Estero	(extension)	2000
<i>Brazil</i>		
Campos do Jordão		1500
Caratinga		500
Caruarú		500
Garanhuns		300
Goiânia	Centro (extension)	2500
»	Campinas (extension)	500
Ituiutaba		500
Itumbiara		500
Ituverava		500
Lavras		1000
Lins		1000
Martinópolis		300
Nova Friburgo	(extension)	1000
Parnaíba	(extension)	300
Pinhal		700
Ponte Nova		500
<i>Chile</i>		
Arica	(extension)	500
<i>Colombia</i>		
Armenia	(extension)	1500
Barranquilla	Principal (extension)	6500
»	Sur (extension)	500
Bogotá DE	Centro (extension)	5000
»	Ciudad Universitaria (extension)	1000
»	Muzu (extension)	1000
»	Ricaurte (extension)	1000
»	San Fernando (extension)	2000
Medellín	America (extension)	2000
»	Bello	1500
»	Envigado	1500
»	Itagüí	1500
Yarumal		500
<i>Ecuador</i>		
Quito	Centro (extension)	3000
»	Iñaquito	500
»	Mariscal Sucre (extension)	3000
<i>Ethiopia</i>		
Addis Ababa	Filwoha (extension)	400
<i>Faroe Islands</i>		
Klakksvik		500
Runavik		280
Torshavn	(extension)	500

Town	Exchange	Number of lines
<i>Finland</i>		
Oulu/Uleåborg	(extension)	500
Pori/Björneborg	(extension)	500
Rauma/Raumo	(extension)	500
Seinäjäoki	(extension)	200
Vasa/Vaasa	(extension)	500
<i>Italy</i>		
<i>North Italy</i>		
Chioggia	(extension)	100
Este	(extension)	200
Iesolo	(extension)	100
Mogliano	(extension)	100
Monselice	(extension)	200
Padova	(extension)	3000
Rovigo	(extension)	200
Thiene	(extension)	300
Treviso	(extension)	1500
Valdagno	(extension)	100
Venezia	Centro (extension)	2500
»	Lido (extension)	400
»	Mestre (extension)	1000
Verona	(extension)	2500
Vicenza	(extension)	900
<i>South Italy</i>		
Avellino	(extension)	1000
Barcellona		800
Bari	(extension)	1500
Battipaglia		800
Caltagirone	(extension)	600
Canicattì		1000
Caserta	(extension)	1000
Catania	(extension)	1000
Catania Ognina		6000
Cava dei Tirreni		800
Formia	(extension)	200
Gaeta		800
Gallipoli	(extension)	100
Milazzo		800
Napoli/Naples	Amedeo (extension)	2500
»	Chiaia (extension)	2000
»	Fuorigrotta (extension)	1500
»	Miano	1500
»	Museo (extension)	6000
»	Nolana (extension)	6500
»	Vomero (extension)	5000
Ostuni		800
Palermo	Libertà (extension)	3000
Sciaccia		1000
Siracusa	(extension)	1000
S. Giuseppe Vesuviano		600
Termini Imerese	(extension)	100
Torre del Greco		1500
Vittoria		1000



X 7774

Switchroom in 500-selector exchange at Campo Grande, Brazil

Town	Exchange	Number of lines
México D.F.	Sabino (extension)	500
»	San Angel	5000
»	Saro (extension)	500
Pachuca		3000
Uruapan		1000
<i>Netherlands</i>		
Rotterdam	Hillegersberg	10000
»	Zuid II (extension)	2500
<i>Netherlands' West Indies</i>		
Curacao	Punda (extension)	500
»	Santa Rosa	300
<i>Norway</i>		
Gjøvik	(extension)	500
Hamar	(extension)	1000
Sarpsborg	(extension)	300
Trondheim	(extension)	1500
<i>Panama</i>		
Panama City	Panama II (extension)	500
<i>Peru</i>		
Arequipa	(extension)	1000
Cuzco	(extension)	500
<i>Sweden</i>		
Borås	(extension)	3000
Eskilstuna	(extension)	1000
Falköping	(extension)	1000
Gävle	(extension)	2000
Göteborg/Gothenburg		
Centre Area	Källtorp (extension)	3000
»	Masthugget (extension)	2000
»	Örgryte (extension)	2000
Göteborg/Gothenburg		
Suburban Area	Biskopsgården (extension)	4000
»	Kortedala (extension)	1000
»	Partille (extension)	1000
Hagfors	(extension)	500
Halmstad	(extension)	1500
Hälsingborg	(extension)	2000
Jakobsberg	(extension)	1000
Jönköping	(extension)	1000
Kalmar	(extension)	1500
Karlstad	(extension)	2000
Kinna	(extension)	500
Kiruna	(extension)	1000
Klippan	(extension)	500
Kristianstad	(extension)	1000
Krylbo	(extension)	500
Lidköping	(extension)	500
Lund	(extension)	1500
Norrköping	(extension)	3000
Skara	(extension)	500
Stockholm,		
Centre Area	Högalid (extension)	3000
»	Södra Vasa (extension)	3000

Town	Exchange	Number of lines
<i>Lebanon</i>		
Beirut	Centre (extension)	8500
»	Dora	2000
»	Chiah	1000
»	Furn el Chebak (extension)	1000
Tripoli	(extension)	2000
<i>Mexico</i>		
México D.F.	Apartado (extension)	500
»	Morales	7000
»	Peravillo (extension)	500
»	Piedad (extension)	500

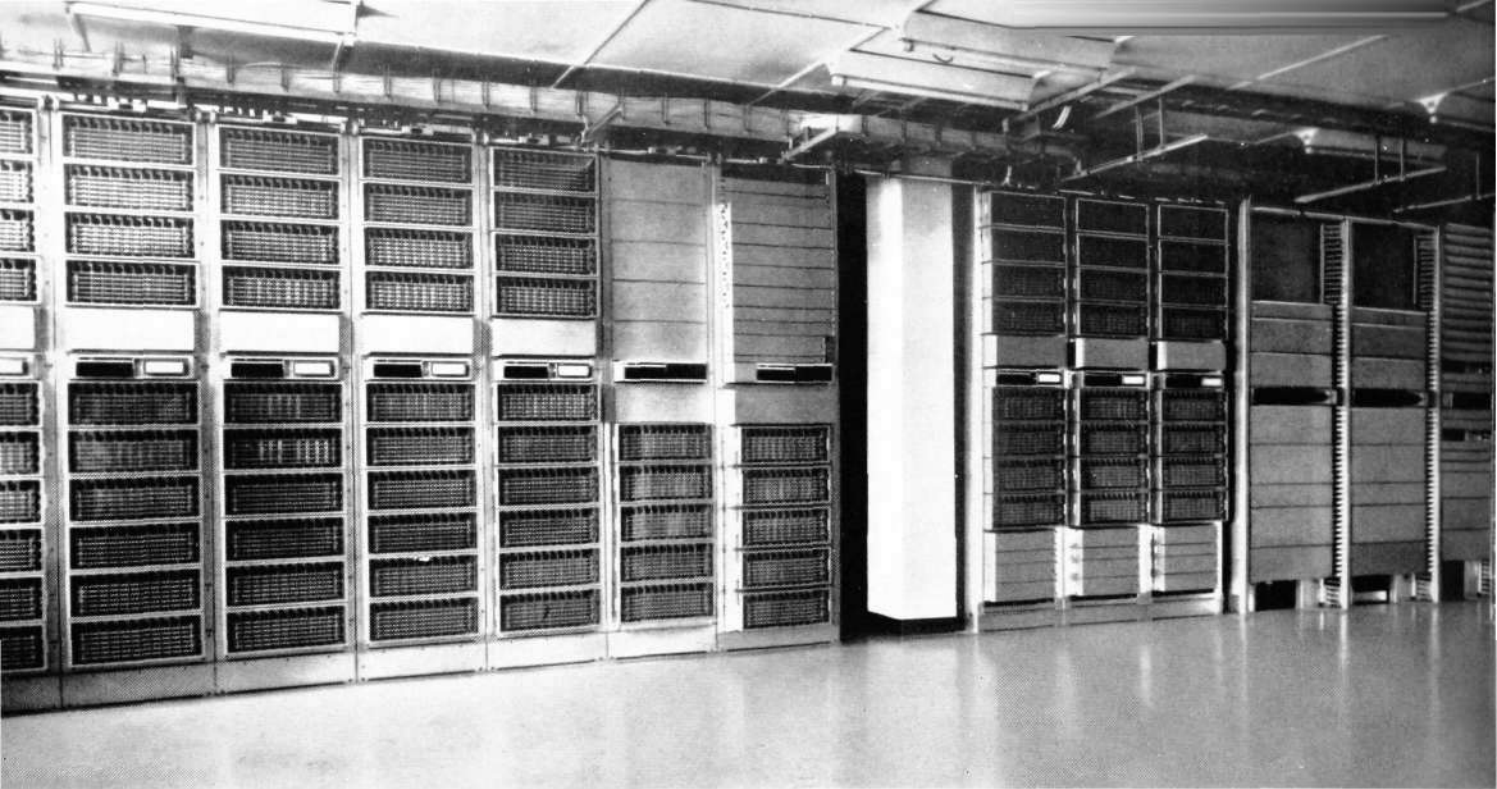
Town	Exchange	Number of lines
Stockholm, Suburban Area	Drottningholm(extension)	200
»	Handen (extension)	500
»	Hanviken (extension)	500
»	Huddinge (extension)	1000
»	Hässelby (extension)	1000
»	Lännersta (extension)	500
»	Mälarhöjden (extension)	2000
»	Roslags-Näsby(extension)	500
»	Råsunda (extension)	3000
»	Saltsjöbaden (extension)	500
»	Storängen (extension)	1000
»	Sundbyberg (extension)	2000
»	Tullinge (extension)	500
»	Ulriksdal (extension)	2000
»	Vendelsö (extension)	500
»	Årsta (extension)	4000
»	Ängby (extension)	2000
»	Örby (extension)	3000
Södertälje	(extension)	1000
Trollhättan	(extension)	1000

Town	Exchange	Number of lines
Uddevalla	(extension)	1000
Uppsala	(extension)	1500
Västerås	(extension)	4500
<i>Turkey</i>		
Kastamonu		500
Sivas		2000
<i>Venezuela</i>		
Acariqua		1000
Barinas		1000
Boconó		500
Carora		600
El Tigre		1000
Guanare		500
Maturin		1500
Punto Fijo		1500
San Antonio		300
	<b>Total</b>	<b>254980</b>

*Public exchanges with crossbar switches*

Town	Exchange	Number of lines
<i>Australia</i>		
Sydney	Sefton (extension)	400
<i>Brazil</i>		
Araraquara		2000
Santo André	Santo André (extension)	800
»	São Caetano (extension)	400
»	Ribeirão Pires (extension)	200
»	Mauá (extension)	200
»	Rudge Ramos	400
<i>Burma</i>		
Rangoon	Maung Taulay	6000
<i>Denmark</i>		
Aarhus	Risskov (extension)	1000
»	Vest (extension)	1000
Frederikshavn		2800
Helsingør/Elsinore	(extension)	1000
København/Copenhagen	Bella (extension)	1000
»	Damsø (extension)	6000
»	Glostrup (extension)	1000
»	Herlev (extension)	1000
»	Hundige	1400
»	Hvidovre (extension)	1000
»	Kastrup (extension)	1000
»	Lyngby (extension)	1000
»	Nærum (extension)	1000
»	Søborg (extension)	1000
»	Valby (extension)	1000
»	Vallensbæk	2000

Town	Exchange	Number of lines
København/Copenhagen	Virum (extension)	1000
Slagelse		5000
<i>Finland</i>		
Helsinki/Helsingfors	Haaga/Haga (extension)	1000
»	Herttoniemi/Hertonäs (extension)	1000
»	Kaarela/Kårböle (extension)	1000
»	Keskusta/Centrum (extension)	1000
»	Malmi/Malm (extension)	1000
»	Meilahti/Mejlans (extension)	2000
Kokemäki		700
Pietarsaari/Jakobstad		2000
Uusikaarlepyy/Nykarleby		400
<i>Iceland</i>		
Keflavik		1400
<i>Ireland</i>		
Dublin	Dundrum	3000
»	Palmerston	600
<i>Netherlands</i>		
Rotterdam	Hillegersberg	10000
»	Zuid II (extension)	2500
<i>Sweden</i>		
Alingsås	(extension)	1300
Karlskrona	(extension)	1000



X 7773

Interior from 2000-line exchange at Hanthawaddy, one of the Ericsson crossbar exchanges at Rangoon, Burma

Town	Exchange	Number of lines
<i>Sweden</i>		
Landskrona	(extension)	2500
Lysekil	(extension)	300
Motala	(extension)	1000
Nyköping	(extension)	2000
Skövde	(extension)	2100
Sunne	(extension)	200
Visby	(extension)	500
<i>USA*</i>		
Douglas, Georgia		1900
Export, Pennsylvania		2300

Town	Exchange	Number of lines
Hood River, Oregon		1000
Winter Park, Florida	(extension)	1000
<i>Yugo-Slavia</i>		
Banja Luka		1000
Beograd	Senjak	1000
Ljubljana		1000
Osijek		1000
Zenica	(extension)	600
<b>Total</b>		<b>89900</b>

\* These exchanges, system NX-1, were delivered by North Electric Co., Galion, Ohio.

	Number	Number of lines**
<i>Public rural exchanges with crossbar switches, system ARK, ART</i>		
Finland	30	2980
Italy	—	760
Netherlands	7	2300
Panama	2	350
Sweden	—	2400
Yugo-Slavia	8	2300
<b>Total</b>	<b>47</b>	<b>11090</b>
<i>Rural exchanges with 100-line selectors, system XY</i>		
Norway	13	3260

\*\* The number of lines includes both new exchanges and extensions of existing exchanges.

# NEWS from

## All Quarters of the World

### Electronic Exchanges for U.S. Air Force

North Electric Company, Galion, Ohio, affiliated to the Ericsson group, has received an order for a number of electronic exchanges for a communication system within the U.S. Air Force. This is probably the largest contract on record for all-electronic exchanges.

The switchboards will be designed to operate on the time division multiplex principle developed at the Ericsson Electronics Laboratory. The equipments will be made to U.S. military standards, some for fixed in-

stallation, others for mobile use with transport by helicopter.

Within the Ericsson group the work is being divided between North Electric and Ericsson, Stockholm. The latter are undertaking the circuit design, which generally implies some modification of existing techniques, while North Electric is responsible for adaptation to the U.S. military standards, as well as for the mechanical design and manufacture.

The order was obtained in the face of very stiff competition from the American telephone industry. The overriding factor in the U.S. Air Force decision to place the order with North Electric Co. was the superiority of the technical solutions offered by the Ericsson group. The choice of the very much higher priced electronic equipment instead of conventional switchboards based on electromagnetic elements was warranted by the special conditions under which the equipment will operate.

Representatives of the United States Air Force and of General Electric, which is in charge of the entire project of which the switchboards form a part, visited NEC at Galion on January 27 for discussion of the supply schedule. The photograph was taken during a pause in the proceedings. (From left to right) Capt. G. Wadsworth, USAF, Mr. W. Jenkins, GE, Dr. C. Jacobæus, LME, Mr. W. Tucker, NEC, Col. E. Jones, USAF, Mr. T. Pfeiffer, U.S. Army Signal Corps, Mr. A. Kinney, GE, Mr. T. Bartle, U.S. Army Signal Corps, Mr. T. Braselton, USAF, Mr. H. Crowley, USAF, Mr. G. Svala, NEC.

### Long Distance Circuits Brasilia-Rio

L M Ericsson has received an additional order for telecommunications equipment for Brasilia, the new capital of Brazil. The new contract comprises transmission equipment for the long distance circuits between Brasilia and Rio de Janeiro with connections to other cities on the route. This will bring up the value of material supplied and installed by Ericsson for Brasilia to some 16 million kronor.

The inaugural ceremonies at Brasilia took place on April 21, and the government offices then moved from Rio to the new capital 600 miles inland. Telecommunications will be of prime importance for the various ministries, which must remain in close contact with Rio de Janeiro and other centres along the coast.

The contracted long distance network is being built on the most modern principles, using carrier systems operating over microwave radio links. The network will comprise a couple of hundred circuits. The installation work is to be done by Ericsson's Brazilian affiliates, Ericsson do Brasil. Ericsson has earlier supplied equipment for temporary long distance connections with Brasilia, which are now to be replaced by the present system.

Apart from Rio, the cities of Juiz de Fora, Belo Horizonte, Araxá, Uberlandia and Uberaba will now have contact with Brasilia.





## Ericsson Equipment for Portuguese Luxury Hotel

On November 24 the Ritz Hotel was opened in Lisbon, the latest addition to the big international hotel group. With its 15 floors, some 300 rooms, restaurants, travel offices and exhibition rooms, the hotel is equipped with modern telephone and tele-signalling systems supplied and installed by Ericsson's Portuguese sales company.

Among the latter installations are an electric clock system with about 100 slave clocks, and time recorders for the 350 staff.

The telephone equipment consists of a switchboard with 90 staff extensions. No telephones are installed in the bedrooms, which are equipped, instead, with an efficient service signal system.

To make sure that signals are promptly answered, a lamp panel is placed in the reception office with one lamp for every room. The lamp lights as soon as a call is signalled and remains alight until attended to.

To provide telephone access to the staff from the reception office, every bedroom has a buzzer which is connected to the floor telephone. Members of the staff, when occupied in bedrooms, indicate their whereabouts by inserting a plug in the room service signal panel. Any telephone call

to that floor is then signalled on the buzzer in the bedroom.

In addition, there is a loudspeaking intercom system for passing orders to the kitchen staff, and a paging system.

**Brazilian operators at Rio de Janeiro connect calls to Brasilia over LM Ericsson's terminal equipments for radio telephony, which were installed in record time.**



## Nicola Tesla Celebrates 10th Anniversary

Nicola Tesla, the Yugoslavian telephone manufacturing corporation, celebrated its 10th anniversary on December 19, 1959. The licence agreement concluded between the corporation and L M Ericsson in 1953 has led to fruitful cooperation, and the corporation, which now employs about 1 000 persons, has been manufacturing crossbar exchange equipment of good quality for several years. Sixty such exchanges have already been cut-over or are under production.

A large number of persons, among whom the Prime Minister of Croatia, had been invited to the celebrations, which included a tour of the factory. Work then ended for the day and factory and office staff foregathered with the guests in a new wing of the factory. Speeches were delivered by the chairmen of the Works Council and its executive committee, a representative of the Croatian government, the Director General of the PTT, and by Mr. C. Berglund of L M Ericsson, the only foreign guest invited. Gold watches were presented to 44 men and women who had been with the corporation from the start. In the evening over 800 employees and guests attended a performance of "Rigoletto" at the Zagreb Opera, which concluded the anniversary festivities.

At the end of 1959 Ericsson's head factory was visited by a hundred or so inventors, all of whom are members of the Swedish Inventors' Society. The photograph below was taken during their tour of the work-shops.

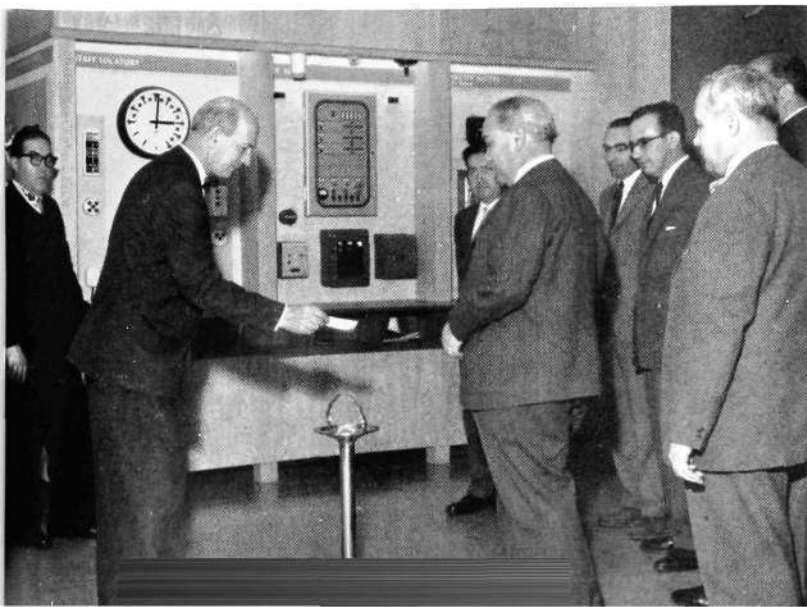


A group of journalists from one of the world's largest newspapers, Asaki of Tokyo, recently visited the head Ericsson factory. Asaki owns the ABC television station, and the group compiled a TV programme of a day in the life of an Ericsson relay adjuster, Nils Svensson, both at work (below left) and at home in his 40,000-kronor villa.

Mr. Sven T. Åberg, president of LM Ericsson, demonstrating the Ericofon to the Austrian Minister of Finance, Dr Reinhard Kamitz, during his visit to Stockholm in February (above).



Helsinki has opened its Ericsson-built trunk exchange. The Director-General of the P.T.T., Mr. S. J. Ahola, makes a trial call under the watchful eyes of Mr. Klaus Häkkinen of the Ministry of Communications and Mr. Sven Jalavisto, president of the Helsinki Telephone Corporation.



A Turkish delegation visited the head Ericsson factory in December. In the photo (left) Mr. E. Lundqvist, LME, starts a fire to show the Director-General of the Turkish P.T.T., Mr. N. Tan, how quickly the Ericsson fire alarm reacts to the situation. The gentleman on the far right is Mr. H. Yasaroglu. Between him and the Director-General is the Technical Director of the P.T.T., Mr. N. Osgür.

# 7 Million More Telephones in 1958

## World total now 124.8 million

Seven million telephones were installed during 1958. In the whole world there are 124.8 million telephones, and in Sweden more than 2.5 million, reports the latest edition of "The World's Telephones" issued annually by A.T.&T.

Twenty-three countries now have above 1/2-million telephones, and twelve countries or areas with more

than 25,000 telephones had at least 15 telephones per 100 population. (Earlier A.T.&T. statistics did not include countries with less than one million telephones, which should be noted when studying the diagram below.)

The outstanding accomplishment of the year, reports A.T.&T., was the inauguration in September 1959 of the

first telephone cable system to link North America directly to the mainland of Europe.

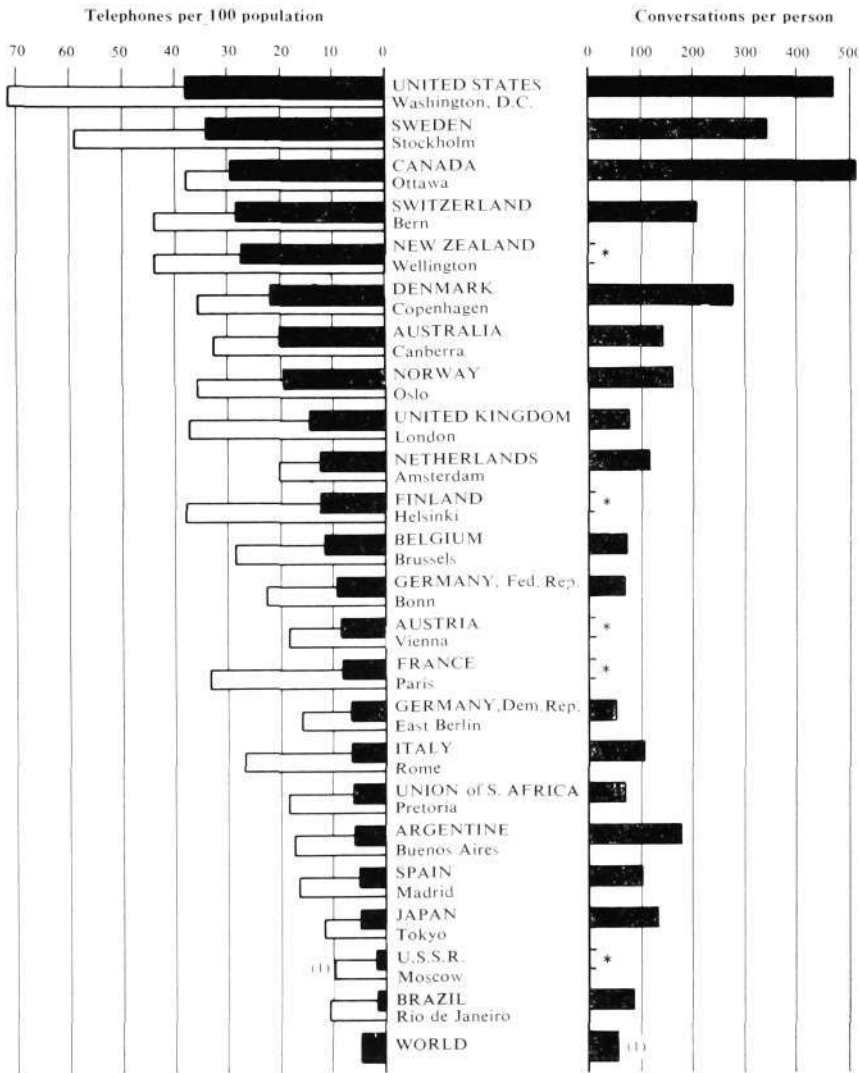
In the years before the second world war the world's telephones increased, on an average, by one million per annum. The largest increase hitherto was 7.8 million in 1957.

U.S.A., Sweden and Canada still hold the three top places on a per capita basis. The inclusion of countries with 500,000 or more telephones, 23 in all, has resulted in some changes in the order among other countries (cf. Ericsson Review No. 1, 1959).

A comparison per capita is more than usually difficult since five countries' statistics are missing. But it seems as though the old rule that people use the telephone more in cold countries still holds good. Canada, U.S.A., Sweden, Denmark and Switzerland lead the incomplete list.

Switzerland has the highest percentage of dial telephones (99.9 per cent), the Netherlands are second with 98.3, third W. Germany 98.2, fourth Italy 96.4, and fifth E. Germany 93.5 per cent.

Countries with more than 500,000 telephones



\* Not available  
 † Estimated



UDC 621.395.345  
LME 83023, 83024

JACOBÆUS, C: *Electronic Exchanges—What can we Expect from them?* Ericsson Rev. 37 (1960): 1, pp. 2—8.

Though the leading telephone manufacturers have been working on the development of electronic telephone exchanges for the past ten years or more, no such exchange is yet operating in a public telephone network. Nevertheless, sufficient is known of the electronic systems and of their possibilities to form a reasonable opinion about their prospects. This article is based on a paper read at "7° Convegno internazionale delle comunicazioni" in Genoa in October 1959.

UDC 656.257  
LME 86, 87

WESSEL-HANSEN W: *Relay Interlocking Plant at Copenhagen Main Station.* Ericsson Rev. 37 (1960): 1, pp. 9—18.

The Danish State Railways (DSB) have recently installed a relay interlocking plant for the suburban lines terminating at the main Copenhagen railway station. The plant is designed on the most modern principles with relay groups for control of shunting movements. The shunting route circuits were designed by DSB, and relay groups, relays, control machine and other equipment were supplied by L M Ericsson's Danish Company, Dansk Signal Industri A/S. The head of the Signalling and Telecommunications Department of the Danish State Railways, Mr. W Wessel Hansen, describes the new plant, starting with a few words about modern signalling techniques as employed by DSB.

UDC 645.924.5  
LME 861

BERGH, G: *LM Ericsson's Automatic Fire Alarm System HAA 100 with Control Board KBA 410.* Ericsson Rev. 37 (1960): 1, pp. 19—24.

L M Ericsson has brought out a new and improved fire alarm system in which the signal is produced by short-circuiting of the two line wires. The system, known as HAA 100, obviates any possibility of a false alarm being issued to the fire brigade headquarters as a result of a line fault. The article describes the new system and its principal advantages.

# The Ericsson Group

## Associated and co-operating enterprises

### • EUROPE •

**Denmark**  
L M Ericsson A/S København F, Finsens Vej 78, tel: Fa 6868, tgm: ericsson  
Telefon Fabrik Automatic A/S København K, Amaliegade 7, tel: C 5188, tgm: automatic

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

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

**France**  
Société des Téléphones Ericsson Colombes (Seine), Boulevard de la Finlande, tel: CHA 35-00, tgm: ericsson  
Paris 17e, 147 Rue de Courcelles, tel: Carnot 95-30, tgm: eric

**Germany**  
Ericsson Verkaufsgesellschaft m. b. H. Düsseldorf 1, Worringer Strasse 109, tel: 84461, tgm: ericstel

**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. — Società Impianti Elettrici e Telefonici Sistema Ericsson Roma, C. P. 4024 Appio, tel: 780221, tgm: sielte

F. A. T. M. E. Soc. per Az. — Fabbrica Apparecchi Telefonici e Materiale Elettrico »Brevetti Ericsson» Roma, C. P. 4025 Appio, tel: 780021, tgm: fatme

**Netherlands**  
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den Haag—Scheveningen, 10, Palaeestraat, tel: 55 55 00, tgm: ericstel-haag

**Norway**  
A/S Elektrisk Bureau Oslo NV, P.B. 5055, tel: Centralbord 46 18 20, tgm: elektriken  
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, P. B. Mj 2214, tel: Centralbord 56 53 54, tgm: signalindustri

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

**Spain**  
Cia Española Ericsson, S. A. Madrid-4, Conde de Xiquena 13, tel: 31 53 03, tgm: ericcion

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

AB Alpha Sundbyberg, tel: 282600, tgm: aktiealpha-stockholm  
AB Ermex Solna, tel: 82 01 00, tgm: elock-stockholm  
AB Ermi Bromma 11, tel: 262600, tgm: erimoblag-stockholm  
AB Rifa Bromma 11, tel: 26 26 10, tgm: elrifa-stockholm  
AB Svenska Elektronör 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: eliem

Mexikanska Telefonaktiebolaget Ericsson Stockholm 32, tel: 190000, tgm: mexikan  
Sievertskabelverk AB Sundbyberg, tel: 282860, tgm: sievertsfabrik-stockholm  
Svenska Radioaktiebolaget Stockholm 12, Alströmergatan 14, tel: 22 31 40, tgm: svenskradio

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

### • 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: 28512, tgm: inderic  
Bombay, Manu Mansion, 16, Old Custom House, tel: 254130 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: Gambir 50, tgm: javeric

**Singapore and Malaya**  
The Swedish Trading Co. Ltd. Singapore 1, 42 Chartered Bank Chambers, Battery Road, tel: 249 64, tgm: swedetrade  
**Syria**  
Georgiades, Moussa & Cie Damas, Rue Ghassan, Harika, tel: 1-02-89, tgm: georgiades  
**Vietnam**  
Vo Tuyen Dien-Thoai Viel-Nam, Matériel Radio & Téléphonique du Vietnam Saigon, 17, Cong Truong Lam-Son, tel: 20805, tgm: telerad

### • AFRICA •

**Belgian Congo**  
Société Anonyme Internationale de Télégraphie sans Fil (SAIT) Bruxelles (Belgique), 25, Boulevard du Regent, tel: 125070, tgm: wireless (For maritim radio and carrier)

**British East Africa**  
Transcandia Ltd. Nairobi, Kenya, P. O. B. 5933, tel: 3312, tgm: transcandia

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

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

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

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

**Lebanon**  
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**Turkey**  
Ericsson Türk Ltd. Şirketi Ankara, Adil Han, Zafer Meydanı, Yenisehir, tel: 23170, tgm: ellem  
Istanbul, İstanbul Bürosu, Liman Han, Kat 5, No. 75, Bahçekapi, tel: 228102, tgm: ellemist

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### • AMERICA •

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

Cia Argentina de Telefonos S. A. Buenos Aires, Perú 263, tel: 305011, tgm: cecea  
Cia Entrerriana de Telefonos S. A. Buenos Aires, Perú 263, tel: 305011, tgm: cecea

Cia Comercial de Administración S. A. Buenos Aires, Perú 263, tel: 305011, tgm: cecea  
Industrias Eléctricas de Quilmes S. A. Quilmes FCNGR, 12 de Octubre 1090, tel: 203-2775, tgm: indelqui-buenosaires

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

**Canada**  
Ericsson Telephone Sales of Canada Ltd. Montreal 8, Que., 130 Bales Road, tel: RE 1-6428, tgm: caneric  
Toronto 18, Ont., 34 Advance Road, tel: BE 1-1306

**Mozambique**  
J. Martins Marques Lourenço Marques, P. O. B. 456, tel: 5953, tgm: linsmarques  
**Nigeria**  
Scan African Trading Co. Yaba-Lagos 32, P. O. B. 1, tgm: swed-africa  
**Rhodesia and Nyasaland**  
Reunert & Lenz, (Rhodesia) Ltd. Salisbury (Southern Rhodesia) P.O. B. 2071, tel: 27001, tgm: rockdrill

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

### • AMERICA •

**Bolivia**  
Johansson & Cia, S. A. La Paz, Casilla 678, tel: 2700, tgm: johansson  
**Costa Rica**  
Tropical Commission Co. Ltd. San José, Apartado 661, tel: 3432, tgm: troco

**Cuba**  
Mc Avoy y Cia Habana, Apartado 2379, tel: U-2527, tgm: macavoy  
**Curaçao N. W. I.**  
S. E. L. Maduro & Sons, Inc. Curaçao, P. O. B. 172, tel: 1200, tgm: madurosons-willemstad

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

**Guatemala**  
Nils Pira Ciudad de Guatemala, Apartado 36, tel: 25114, tgm: nilspira-guatemala

**Haiti**  
Salon Culturel, Michel Schutt Ainé, Port-au-Prince, tel: 14, tgm: cultus

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

**Colombia**  
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**Ecuador**  
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**Mexico**  
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**Peru**  
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Soc. Telefónica del Perú, S. A. Arequipa, Casilla de Correo 112, tgm: telefonica

**El Salvador**  
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**Uruguay**  
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North Electric Co. Galion, Ohio, P. O. B. 417, tel: Howard 8-2420, tgm: northphone-galionohio

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

### • AUSTRALIA & OCEANIA •

**Australia**  
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## Agencies

### • EUROPE •

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

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

**Greece**  
»ETEP», S. A. Commerciale & Technique Athens, 11, Mackenzie King Street, tel: 617041, tgm: aeter-athinaí

**Ireland**  
Communication Systems Ltd. Dublin, 40, Upper Fitzwilliam Street, tel: 615767, tgm: crossbar

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

**Yugo-Slavia**  
Merkanitile Inozemna Zastupstva Zagreb, Pošt pretinac 23, tel: 25-222, tgm: merkanitile

**China**  
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**Hong Kong**  
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**Iran**  
Irano Swedish Company AB Teheran, Khiban Sevom Esfand 201-203, tel: 36761, tgm: irano-swede

**Iraq**  
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**Japan**  
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**Jordan**  
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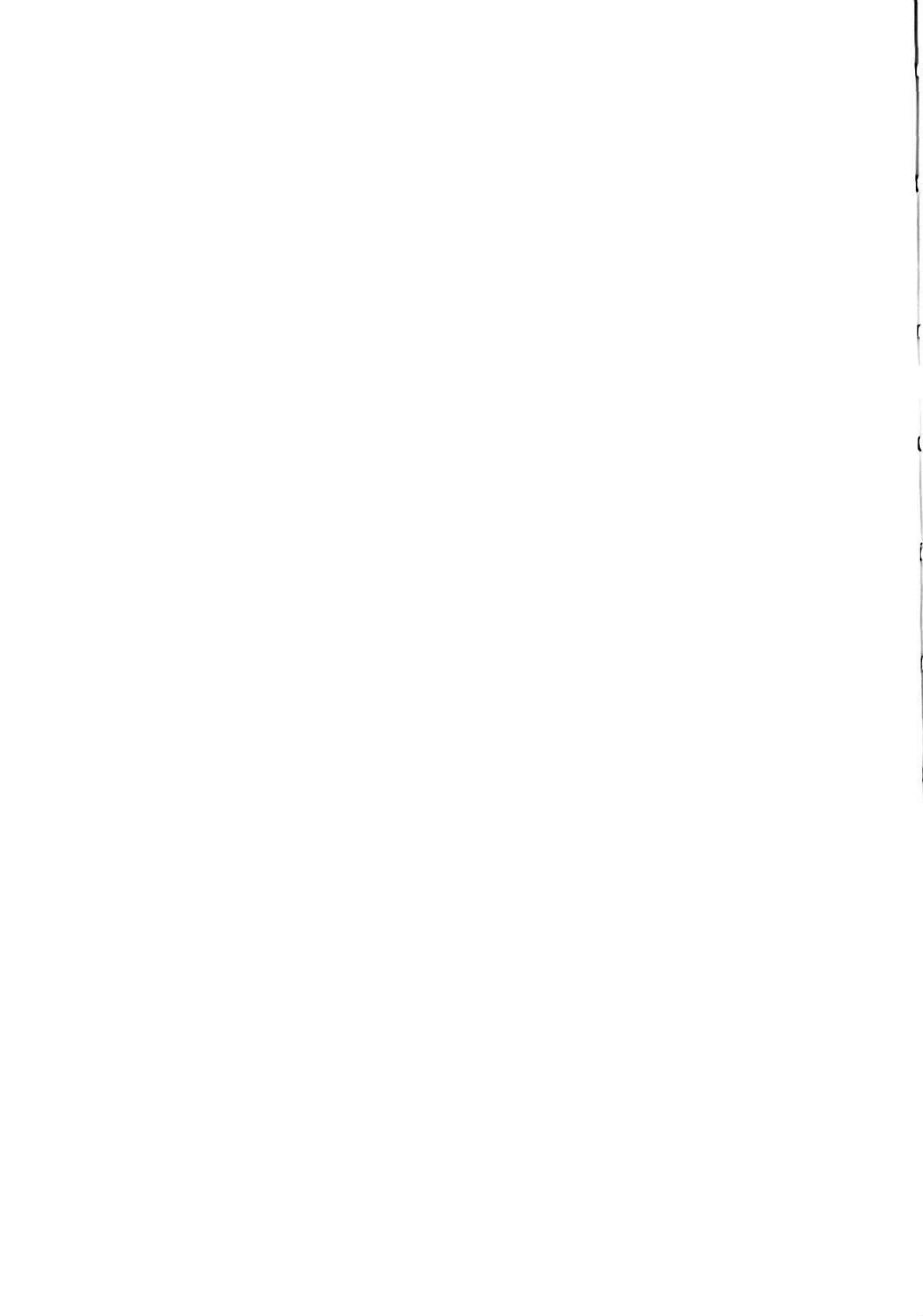
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# ERICSSON

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1960

# Review





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On cover: L M Ericsson's New Loud-  
speaking Intercom Telephone with  
Transistor Amplifier.

# Crossbar Systems ARM 201 and ARM 503 for Transit Exchanges

R B A G E R, T E L E F O N A K T I E B O L A G E T L M E R I C S S O N, S T O C K H O L M

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*L M Ericsson's standard production of crossbar exchange systems comprises equipments for the automatic switching of traffic between the exchanges within a zone or between different zones or regions. Equipments of this kind are called transit exchanges and L M Ericsson has designed two such systems for the export market, ARM 201 and ARM 503, which will be described in this article.*

Present demands for long distance circuits necessitate highly reliable and rapid switching equipment, good transmission properties and high utilization of lines. These factors, allied with flexibility and low maintenance cost, have been the fundamental requirements imposed on the designers of L M Ericsson's crossbar systems for transit exchanges.



Fig. 1 X 8203  
Transit exchange, system ARM 201, at  
Aalborg, Denmark

On grounds of circuit economy a large part of the long distance traffic must be passed through several exchanges in tandem. The time taken to set up a connection through a transit exchange must therefore be extremely short if the occupation efficiency of circuits is not to be seriously impaired. The ARM systems, based exclusively on rapid crossbar switches, are admirable in this respect.

But circuit utilization, and therefore operating economy, is not dependent solely on rapidity of switching. The ability of the selector stages to obtain access to as large as possible a number of lines on a route is also an important factor. The ARM systems are so designed that, with low internal congestion, they provide full availability even on large routes, so that the circuit utilization is the maximum practicable.

One method that is being increasingly employed for improving circuit efficiency is the use of alternative routing. Alternative routing provides high circuit efficiency at a low circuit cost, and the ARM systems are specially designed to allow for the wide use of this facility.

Since traffic routing is controlled by only a few units (the markers), the routing arrangements can be very simply changed as and when required. This has an important bearing also on the quality of service, since the traffic can be quickly rerouted in the event of faults on important circuits.

With rising wages maintenance becomes an increasingly significant factor in the economy of telephone operation. Experience from ARM exchanges shows that their maintenance expenditure is extremely low and that the staff need not be more highly trained or qualified than telephone maintenance personnel in general.

## General Principles

Systems *ARM 201* and *ARM 503* consist of group selector stages for two- or four-wire through-connection, with crossbar switches for setting up connections through a single or two group selector stages. The systems operate on the bypath principle, the switches being operated under the control of markers.

The line relay sets with associated registers can be supplied for different signalling systems. Interworking with existing local or transit exchanges can therefore be arranged by adaptation of the line relay sets and registers.

A line relay set can be fitted with a pad for level adjustment, which is switched in and out of circuit under control of register and marker. For metering purposes incoming relay sets from local and terminal exchanges usually incorporate tariff relays controlled from the marker equipment. During conversation metering impulses from the tariff relay contacts are transmitted via the line relay set to the local or terminal exchange. Other metering methods as well, however, can be employed in the ARM systems.

Of the two systems, *ARM 201* covers the range between 100 and 8,000 circuits, while *ARM 503* is intended for exchanges with a capacity not exceeding 2,000 circuits (1,000 incoming and 1,000 outgoing).

Fig. 2

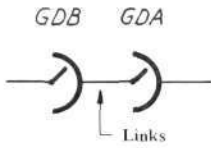


Fig. 3

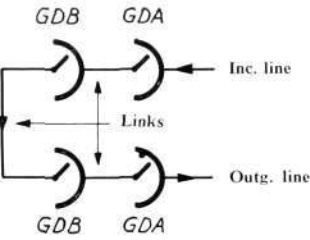


Fig. 4

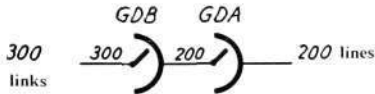
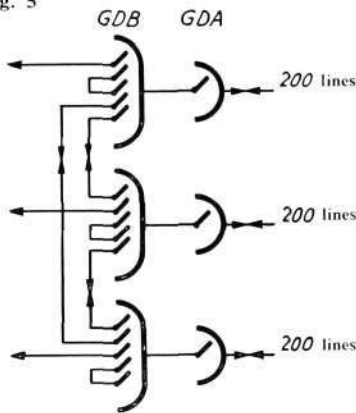


Fig. 5



X 2503

Fig. 2

Group selector stage ARM 201 consisting of two partial stages GDA and GDB

Fig. 3

Connection through four partial stages

Fig. 4

Group selector stage unit ARM 201 for 200 lines

Fig. 5

Three group selector stage units for two-way traffic

## System ARM 201

In system *ARM 201* each group selector stage consists of two partial stages, *GDA* and *GDB*, which are interconnected by means of links (fig. 2). The lines terminate on the *GDA* multiple, and the *GDB* verticals in the various group selector stages are interconnected by links. Thus a connection between two lines terminating on the *GDA* multiples passes through four partial stages *GDA-GDB-GDB-GDA*, as shown in fig. 3.

Some lines, e.g. to the local exchange, may also be terminated on *GDB*, and connections to such lines pass through two partial stages (fig. 5).

The group selector stage is made up of units which, when installed to full capacity, have 200 *GDA* verticals and 300 *GDB* verticals (fig. 4). A group selector unit of this kind accommodates 200 lines in the *GDA* multiple and 300 links to the *GDB* verticals. Additions to the two partial stages *GDA* and *GDB* can be arranged in steps of 100 verticals. According to the number of *GDA* verticals, the unit is called a 100-group or 200-group, and will have 100 or 200 lines connected to its *GDA* multiple.

If the lines are to be used for two-way traffic, the group selector stage must be designed for switching in both directions and is then called *GD*. A *GD* unit can therefore accommodate incoming, outgoing and two-way circuits. A selector stage for incoming traffic alone is called *GI* (with partial stages *GIA* and *GIB*), and for outgoing traffic alone *GU* (with partial stages *GUA* and *GUB*). For the sake of simplicity this article will be concerned solely with two-way selector stages *GD*.

System *ARM 201* is made in two types: *ARM 201/2* for max. 20 groups (one-way or two-way) and *ARM 201/3* for max. 20 incoming and 20 outgoing groups. Type *ARM 201/3* can comprise two-way units, and a twin exchange can be added to double the capacity.

Lines to and from other exchanges, incoming lines from the local exchange, and lines to and from operators' positions are terminated on the *GDA* multiple. *GDB* is normally used for outgoing lines to the local exchange and for links to *GDB* in all other groups. These links carry the traffic between the various units. In addition, a number of *GDB* are connected to other *GDB* in the same unit for switching traffic between lines terminating on the *GDA* multiple of that unit (fig. 5).

Every line terminating on *GDA* can be switched to any other line in *GDA* in the same or another unit by connection through four partial stages. The system is designed for full availability in *GDA* and with five alternative choices (e.g. one direct and four alternative routes). The lines of one route can and should be allocated to several units, with a view both to quality of service and to equalization of traffic between the groups. A route can normally contain 90 lines, but can be increased in a simple manner by different arrangements such as the use of alternative choices.

By terminating outgoing lines to the local area on *GDB* instead of on *GDA*, a larger number of lines can be accommodated in *GDA*. This also increases the traffic handling capacity, since outgoing local traffic passes through only two partial stages while other traffic requires four partial stages. In all, five outgoing routes can be accommodated in *GDB*.

Traffic to the routes in *GDB* from a line in *GDA* has access only to lines in the *GDB* stage of the same group selector unit. Consequently the total number

of lines on the route will be somewhat higher than under conditions of full availability. The utilization of such lines can be increased, however, by the use of overflow routes through four selector stages.

### Switching Procedure

The block schematic in fig. 6 shows in a simplified form the equipment employed on setting up a connection through the selector stage.

On an incoming call the line equipment *FIR* is connected to a free register *REG* via a register finder *RS*. An indication of the origin of the line is sent from *FIR* to *REG* and stored there.

The register receives the numerical information. Immediately upon receipt of the routing digits, it calls and seizes a free route marker *VM* via connecting relays *RM*. Reception relays, which identify the number of the group selector unit accommodating the incoming line, are connected to the register wires in *VM*.

A d.c. signal code consisting of positive on two of five wires is used for transmission of digits and special indications from register to route marker. Transmission takes place on 26 wires; in this way either five digits, or four digits and one of five special indications, can be transmitted simultaneously.

The route and tariff are determined by contacts on the digit reception relays in *VM*, and a circuit is closed for the route relay corresponding to the digit combination received.

The outgoing line equipments *FUR* are connected to one or more of three test blocks *TB*. For each test block there is a route-free indicating relay which operates if any line on the route is free in the test block.

The route relay in *VM* connects the marking wires from the route-free indicating relay unit *VL*, which indicates in which test blocks there exist free lines on the wanted route. *VM* now selects one of these test blocks, to which it becomes connected as soon as the block is released from any other connection that may be in progress. The routing information is passed to *TB*, which selects a free line. Thereafter *VM* is informed of the group selector unit to which the selected outgoing line is connected.

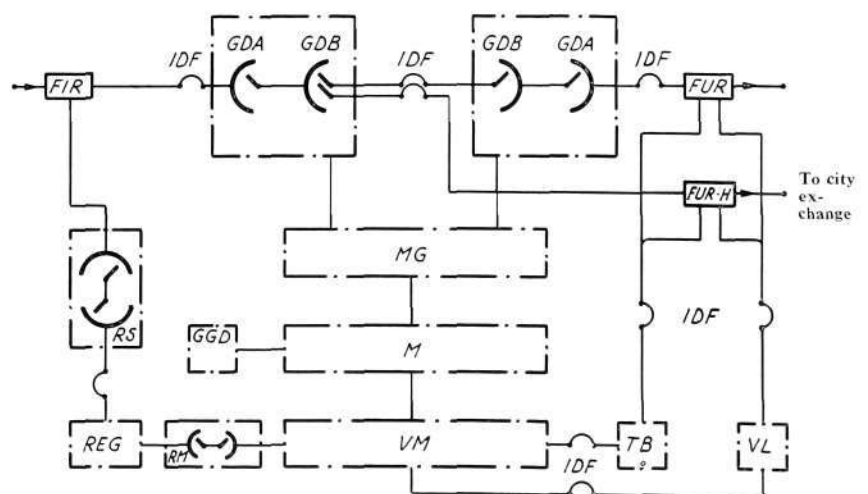


Fig. 6 X 8197  
Block schematic of transit exchange with group selector stage ARM 201

*VM* now selects a free marker *M* and passes to it information of the group selector units in which the incoming and outgoing lines are situated.

Before switching can start through the group selector stages, the marker must check whether any other marker is engaged in either of the two selector units. This check is made by an equipment *GGD*. After establishing that no switching is in progress in either unit, the marker obtains access to the units via *MG*, an equipment which connects test and control wires between the marker and selector units.

In the incoming selector unit the horizontal magnet for the incoming line is energized and operates. With the aid of test chains the marker selects a free path from the incoming to the outgoing line, and the corresponding horizontal and vertical magnets operate.

The connection has now passed through four partial stages, and from the outgoing line relay set *FUR* a circuit is closed through the selectors to the incoming *FIR*, so releasing the marker equipment in preparation for the next call.

Thus only *FIR* and *FUR* and verticals in the four partial stages *GDA-GDB-GDB-GDA* remain occupied during conversation. The register remains in circuit if it is to control the subsequent switching process.

### Build-up of Selector Stages

Selector stages *GDA* and *GDB* are designed on the link principle. The grouping for a selector stage with 5-pole through-connection is shown in fig. 7. The *GDA* stage has 100 or 200 verticals, the *GDB* stage 100, 200 or 300. Both *GDA* and *GDB* stages have 6-bar switches with ten verticals, and ten switches are accommodated on each bay.

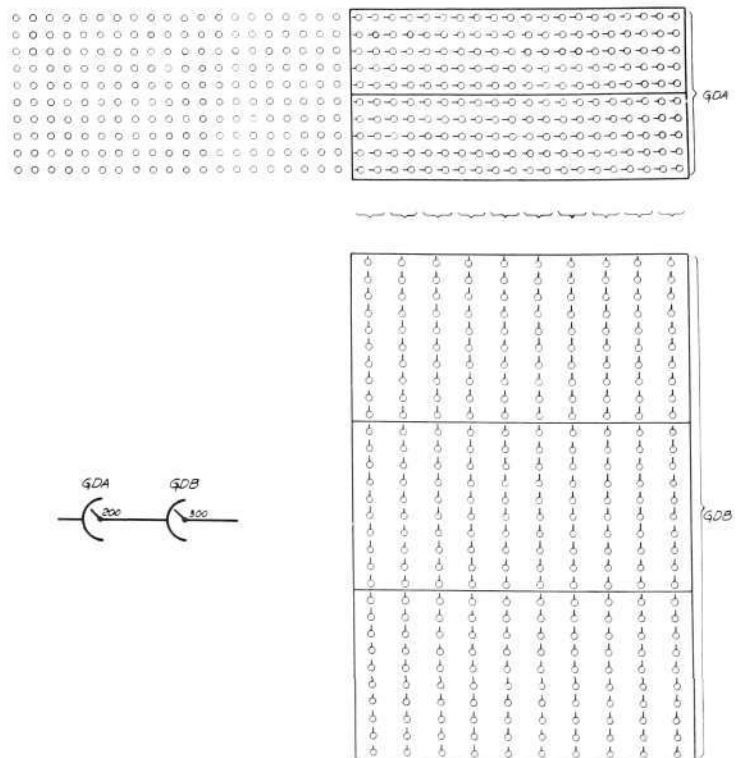


Fig. 7 X 8198  
Grouping plan for selector stage ARM 201  
with 5-pole through-connection

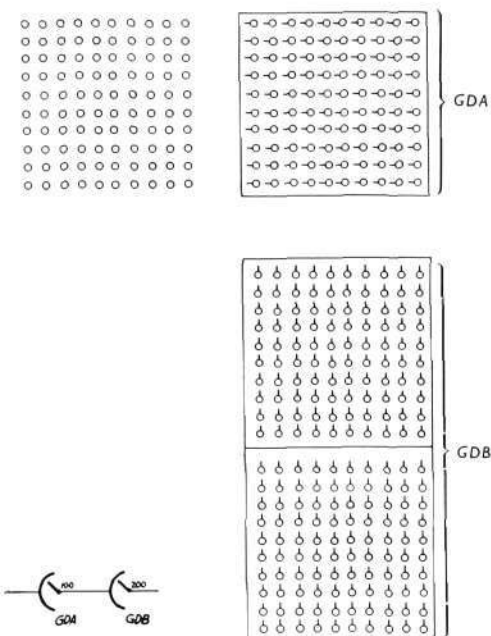


Fig. 8 X 2504  
 Grouping plan for selector stage ARM 201 with 10-pole through-connection

The lines are formed in groups of 20, which are multiplied over 20 verticals in a horizontal row in GDA. Similarly 20 verticals in two adjacent vertical rows in GDA are multiplied over the verticals of a vertical row in GDB. Via an I.D.F., to which the vertical side of every GDB vertical is connected, there run groups of links between the various GDB stages, between verticals within one GDB stage, and outgoing to the local exchange. Each group of links consists of a number of half horizontal rows of five GDB verticals and can contain a maximum of 80 links.

For use in international transit centres the selector stages have 10-pole through-connection (fig. 8) and are built in units for 100 lines with 100 verticals in the A stage and 100 or 200 in the B stage.

## Structure and Function of Switching Units

### Register finders RS

The incoming line equipment has access to registers via register finders. The number of wires in the register finder is determined by the signalling system, while its capacity will depend on the traffic conditions.

### Registers REG

After connection to an incoming line the register receives and stores the digits, which may come from another register, from an operator's keyset or from a subscriber's dial.

When the marker equipments are released after completion of switching through the exchange, the register can take over the connection and send to the outgoing line the digits and signals required for its completion. The register is released when the connection has been completed or has been taken over by a register in a subsequent exchange.

Various kinds of register may be employed, depending on the method of transmission and reception of digits and other register signals and on operating requirements.

### RM units

The RM unit provides a connection between register and route marker on 48 signal wires. The RM units are made up of multicoil relays in link arrangement and mounted on a rack with capacity for 50 registers and 5 route markers. A route marker can serve two such racks and thus 100 registers.

### Route markers VM and markers M

The marker functions of the system have been divided between two units, route marker VM and marker M.

The route marker, which serves ten incoming group selector units, identifies the calling register, establishes connection with the register via RM, receives the numerical information and analyses it. It also contains equipment for determination and choice of route, test block and marker.

Apart from these preparatory functions in setting up the connection the route marker is used for tariff determination, transmission of tariff to incoming line equipment, time supervision, statistics metering, signals to Centralograph for fault recording, etc.

One route marker equipment occupies one entire rack to which its relay sets are connected by plug and jack. The equipment of one rack suffices for determination of 160 routes. If additional routes are required, an extra rack is installed accommodating route relays only.

With the guidance of the preparatory work performed by the route marker, the marker *M* extends the connection through the selector stages. The marker occupies one rack containing relay sets for selecting and switching functions with connection to max. 20 route markers. All relay sets are of plug-in type.

#### *Test blocks TB for route connection and line selection*

The use of test blocks for line selection means that lines belonging to the same route can be placed in different selector units. This evens out the traffic through the different units and ensures better utilization of the equipment. The arrangement also leads to improved quality of service and to better facilities for maintenance since a unit can be taken out of operation without the traffic being entirely cut off on that route.

East test block has space for 150 lines which can be allocated to any of 30 routes with not more than 30 lines per route. The lines cannot be spread over more than 10 selector units. One route should be distributed over more than one test block. The route marker limits this distribution to three test blocks, so that one route can normally not contain more than 90 lines. If a route requires more than 90 lines, the maximum of 90 can be multiplied by the use of up to five alternative choices.

A test block, which can serve 10 or 20 route markers, has equipment for identification of calling-route markers and for connection of 48 signal wires to the route marker. The equipment also contains route connection relays and relays for testing and selection of a free line on a desired route.

If a test block is to serve 10 route markers, three test blocks are placed on a single rack; for 20 route markers two test blocks are placed on one rack. All relay sets are of plug-in type.

*ARM 201* can be equipped with test blocks for selection of a particular line within a route, an arrangement known as individual selection.

#### *Route-free indicating relays VL*

An outgoing route can be divided into three groups spread over three test blocks. Each such group is provided with a route-free indicating relay. These relays are connected to group-free marking wires from the outgoing line equipments. The relays operate as soon as a line on the route becomes free, and mark this condition by extending positive to all code receivers. A code receiver, in response to the digits received, switches to the desired route and ascertains from *VL* which test blocks have free lines on the route.

#### *Common groups*

The common groups consist of equipment which controls the calls from the registers so that the route markers are called in succession, and of lockout chains *GGD* for the markers' calls to the selector units. Each selector unit has its own lockout chain in which the individual relays represent markers. When a marker has recorded the condition of incoming and outgoing group selector units, it attempts to call the corresponding *GGD*. As soon as the two relay chains are free, the marker can seize the selector units and set up the connection.

*MG unit for connection of selector stage to marker*

A number of wires are connected between marker and selector unit for testing and control functions. The connection to the incoming selector unit is on 168 wires, and to the outgoing on 96 wires. The connection is established by multicoin relays. The *MGD* racks contain equipment for connection of five selector units to five markers.

### System ARM 503

System *ARM 503* is a group selector stage made up of two partial stages *GVA* and *GVB* which are interconnected by means of links (fig. 9). The stage is one-way (from *GVA* to *GVB*), the incoming lines terminating on *GVA* and the outgoing on *GVB*. Accordingly a two-way line must be terminated on both partial stages. The stage is 5-pole and is made in two types: *ARM 503/1* with plug-in type crossbar switches and *ARM 503/2* with crossbar switches permanently cabled to the rack.

The smallest selector unit in *ARM 503/1* consists of a 10-vertical switch for the *GVA* stage and of a 10-vertical switch for the *GVB* stage (fig. 9). This unit is called a 20-group and has 20 inlets in *GVA*, 20 outlets in *GVB*, and 10 links between *GVA* and *GVB*. The number of links can be increased to 20 by adding one *GVA* and one *GVB* crossbar switch (fig. 10). Two such selector units are accommodated on one rack, the capacity of which is thus 40 inlets and 40 outlets.

In type *ARM 503/2* the smallest unit consists of two 20-groups, each with 20 links, thus having a capacity of 40 inlets and 40 outlets accommodated on one rack.

In the event of internal congestion, i.e. if the outgoing line is inaccessible on account of all links from the incoming to the outgoing selector unit being engaged, the connection can be forwarded on a free overflow circuit *OFLR* in another selector unit and from this unit via a link to the selector unit on which the desired line terminates. An overflow relay set is connected to the *GVA* and *GVB* multiples of each selector unit (20-group), the remaining 19 inlets in *GVA* and 19 outlets in *GVB* being available for lines (fig. 11).

An *ARM 503* exchange with *GVA/GVB* stages alone has a maximum capacity of 12 group selector units, i.e. 240 inlets and 240 outlets.

For a larger number of lines a *GVC* stage is introduced as in fig. 12. In such case the *GVA/GVB* stages normally consist of units containing not more than 200 inlets and 200 outlets. Within a 200-group of this kind all selector units (20-groups) are interconnected by links, and overflow links *OFLR* are provided between the various 200-groups. Certain outlets from *GVB* terminate on verticals in the *GVC* stage and form links between *GVB* and *GVC*. Outgoing lines are connected to the remaining outlets on *GVB* and to the outlets in the *GVC* stage.

The addition of the *GVC* stage brings the maximum capacity of the *ARM 503* system up to 1,000 inlets and 1,000 outlets.

The outgoing lines of a route should be equally distributed over all group selector units. The system is designed for full availability and with three alternative choices (for example one direct and two alternative routes).

A route can normally contain 40 lines, but can be simply increased by use of the alternative choice facilities.

Fig. 9

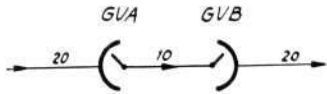


Fig. 10

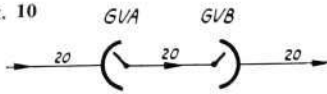


Fig. 11

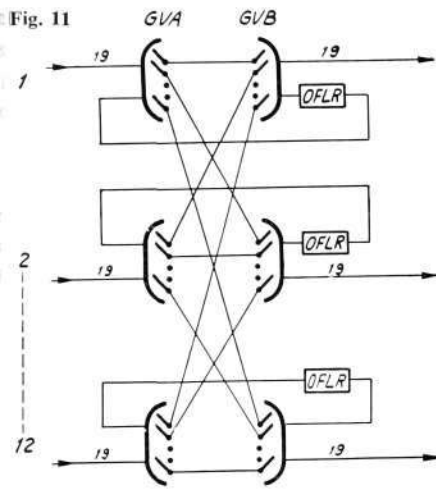


Fig. 12

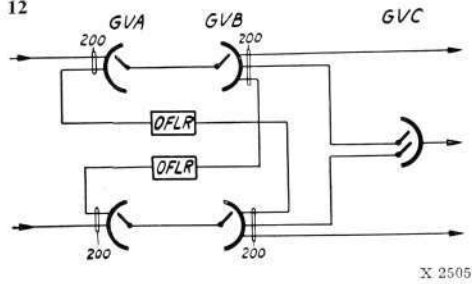


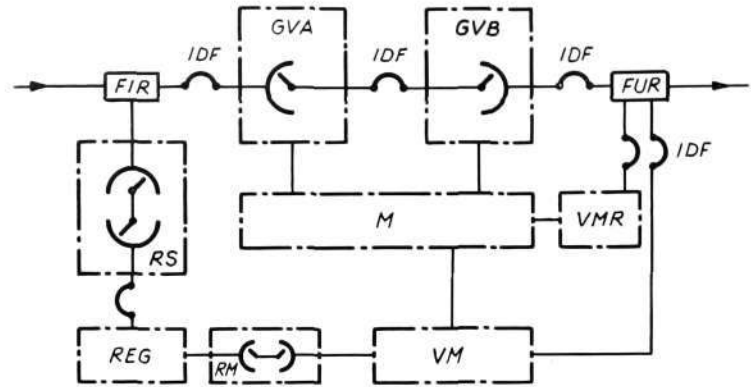
Fig. 9  
Group selector unit ARM 503 with 10 links

Fig. 10  
Group selector unit ARM 503 with 20 links

Fig. 11  
Selector stage consisting of 12 group selector units ARM 503

Fig. 12  
Group selector ARM 503 with GVA, GVB and GVC stages

Fig. 13  
 Block schematic of transit exchange with group selector stage ARM 503



### Switching Procedure

The equipment used in system *ARM 503* is shown in the block schematic in fig. 13.

On an incoming call the line equipment *FIR* is connected to a free register *REG* via a register finder *RS*. The digits come in to the register, and when sufficient information for identification of the route has been received a free route marker *VM* is called and connected to *REG* via connection relays *RM*. An indication of origin of the line goes from *FIR* to *REG* and is stored there.

Transmission to *VM* of digits and special indications follows the same principle as in *ARM 201*. Route and tariff determination take place thereafter in *VM*.

In selector stage *GVA* a circuit is prepared for the horizontal magnet for the incoming *FIR*. A free marker *M* is then selected and connected to the *GVA* unit. A signal to identify the marker is sent through *GVA*, *FIR*, *RS*, *REG* and *RM* to *VM*, whereupon *VM* is connected to *M*. The free links between *GVA* and *GVB* are then marked and the *GVA* horizontal magnet operates.

From *VM* circuits are formed for operation of relays in *VMR*, which connect test wires from *FUR*. A free *FUR*, to which there is access on a free link between *GVA* and *GVB*, is now selected. Testing and busying of the *GVB* unit on which the selected line terminates now take place from *M*, after which the *GVB* horizontal magnet is energized and operates. From the marker *M* a circuit is formed to operate the vertical magnets in *GVA* and *GVB*.

The connection is now established and a signal is sent to *REG* for release of *VM* and *M*, which can then attend to new calls. Only the line equipments *FIR* and *FUR* and verticals in *GVA* and *GVB* are occupied during the conversation. If the register is to control the subsequent switching it remains in circuit, otherwise it releases.

### Structure and Function of Switching Units

#### Register finder *RS* and register *REG*

The structure and function of the register finder and register are the same as in system *ARM 201*.

#### *RM* unit

Between the register and the route marker there are 48 signal wires as in system *ARM 201*. Every *RM* has a capacity of eight *REG*, which can be connected to two *VM* through two links. One route marker can serve five *RM*

units, the maximum capacity being thus 40 registers which can be connected to two route markers via ten links. The *RM* unit fits into the rack by plug and jack.

#### *Route marker VM*

A route marker *VM* consists of a number of relay sets of plug-in type, mounted on a rack with space for two *VM*.

The job of the route marker is to analyse the number transmitted from the register, prepare the marker *M* for operating the selectors, and select a group of lines on the wanted route. Otherwise the functions of the route marker are the same as in system *ARM 201*.

The route marker contains equipment for 20 routes with three alternative choices. Each route can be divided into three groups, each of 40 lines. This arrangement can be used, for example, for a direct route with 40 lines and two alternative routes, each of 40 lines. Thus if all three groups are used for the direct route, the latter can contain 120 lines. The route marker can normally be extended to comprise up to 55 routes, each of 20 lines.

#### *Marker M*

The relay sets in marker *M* are of plug-in type. Two markers are mounted on one rack.

The purpose of the marker is to set up the connection through the selector stages, including the selection of a free line on the wanted route, finding a free path through the selector stages and completing the connection by causing the horizontal and vertical magnets to operate.

#### *Route connection relays VMR*

*VMR* consists of multicoil relays which connect the marker *M* to the line relay sets *FUR*. Each *VMR* has a capacity for 10 routes of 20 lines each.

## Examples of Applications for ARM 201 and ARM 503

A few examples of the applications for selector stages *ARM 201* and *ARM 503* are outlined below.

### *Group Centre for Rural Exchange System*

L M Ericsson's rural exchange system *ARK 50* is supplied in two types, *ARK 511* (30–90 lines) and *ARK 521* (100–2,000 lines). Both types are terminal exchanges, while a group centre is usually built up of a terminal exchange and a transit stage *ARM 503* as shown in fig. 14.

Both the local part of the group centre and the terminal exchanges in the group area operate on the principle of induced occupation to the transit stage, in which, on receipt of a call, a register (*REG-N*) is connected to the line relay set (*FDR*). *REG-N* thereafter controls the connection through the *GVA* and *GVB* stages on to the called exchange.

The *ARK 50* system works on the principle of compelled v.f. code signalling from the registers. The lines to *ARM 503* from other group or zone centres have access to code receivers *KM*, the function of which is to receive the digits required for switching through *GVA*–*GVB*. The time of occupation of *KM* is very short and one *KM* can therefore serve a large number of lines.

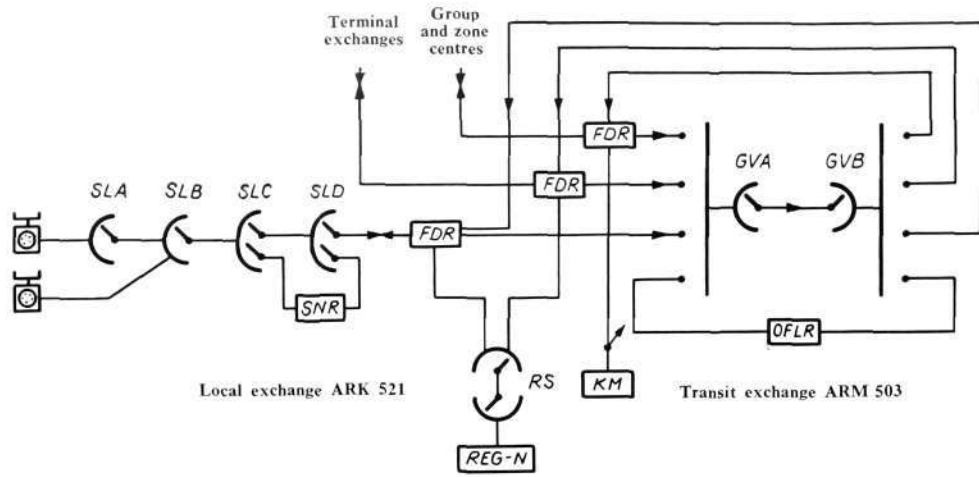


Fig. 14 X 7778  
Group centre for rural exchange system

### Zone Centre

A local city exchange can be extended by a transit stage *ARM 201* or *ARM 503* to incorporate lines to terminal exchanges, group centres, other zone centres, or possibly trunk exchanges. Fig. 15 shows a zone centre made up of a local exchange *ARF 10* and a transit stage *ARM 201* with four-wire through-connection.

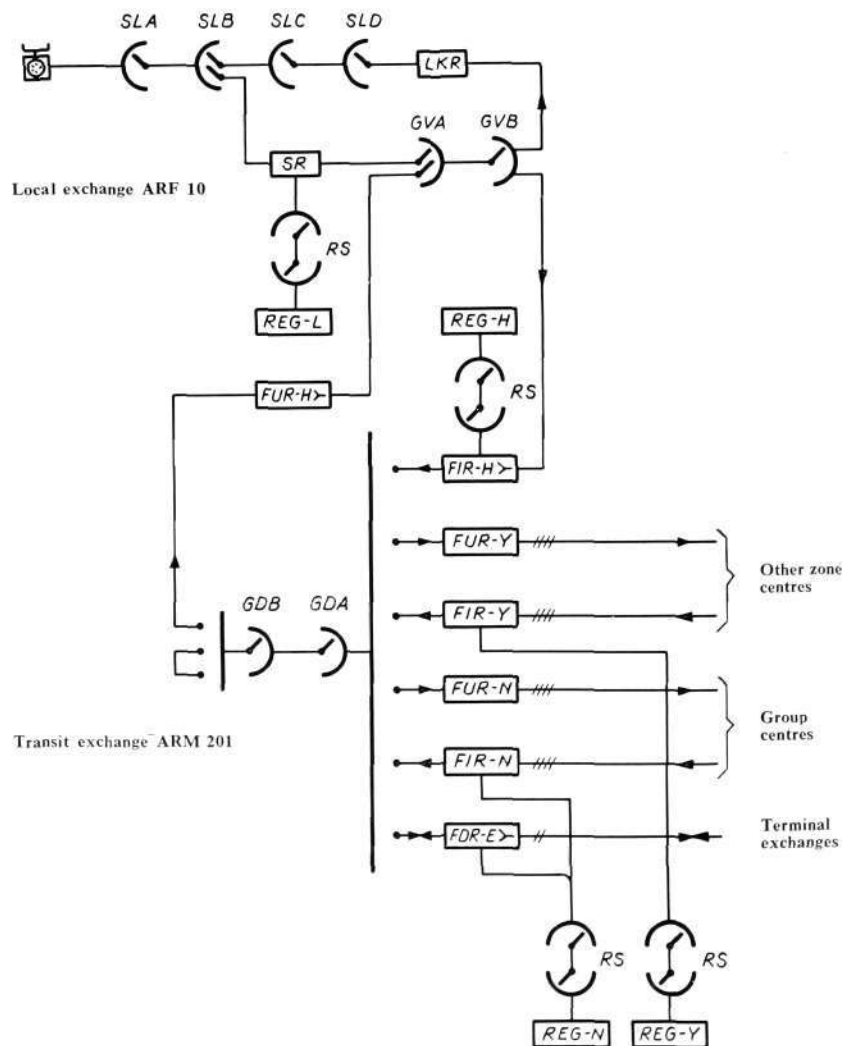


Fig. 15 X 8200  
Zone centre

To the outlets between the local group selector stage (*GVA/GVB*) and the transit stage are connected relay sets *FIR-H* with access to register *REG-H* via register finder *RS*. On a call via the transit stage the digits dialled by the subscriber are transmitted to *REG-H* from the local register *REG-L*. *REG-H* takes over the connection and must therefore be able to operate in response to the register signalling used on the lines terminating in the transit stage.

The incoming and two-way lines from other zones have access to *REG-Y* via register finders. On calls to another zone *REG-Y* sets up the connection to the transit stage after a sufficient number of digits has been received to identify the route, after which the register is disconnected.

On calls to local exchange, group centre or terminal exchange within the zone, *REG-Y* receives all the digits of the subscriber's number before switching through the transit stage is effected. *REG-Y* can usually control the selectors in the local exchange, group centres and terminal exchanges without the aid of other registers.

The incoming and two-way lines from group centres and terminal exchanges within the zone have connection through register finders to register *REG-N*. If *REG-N* is connected to terminal exchanges with induced occupation, it can receive decadic impulses. *REG-N* must be able to store the maximum number of digits that may be required on calls to another zone and must be equipped for the register signalling used on those lines. *REG-N* can usually control the switching also through the selector stages in the local exchange, group centres and terminal exchanges within the zone.

*REG-N* also serves the incoming lines from the zone's group centres. If the registers in the group centres are equipped for signalling both inside and outside the zone, the *REG-N* at the zone centre can receive the routing digits, after which the connection is switched through the transit stage and *REG-N* is disconnected. If the group centre registers are not so equipped, *REG-N* must receive all digits on calls to other zones and take over the control of the subsequent switching.

Depending on the principles of signalling in use, it may in certain cases be better to connect the lines from the local zone to *REG-Y* instead of to *REG-N*.

Since the transit stage operates on a four-wire basis, the relay sets for two-wire lines are fitted with hybrids.

## *Trunk Exchanges*

The transit stages *ARM* can be used for trunk exchanges working on an automatic or semi-automatic basis. An exchange of this kind with transit stage *ARM 201* and four-wire through-connection is shown in fig. 16.

The figure shows three main types of trunk circuits: automatic, semi-automatic, and manual. These three types represent the following traffic conditions:

subscriber-dialled trunk traffic; the calling subscriber dials the number of the wanted subscriber (or of the operator at a manual local exchange);

operator-dialled trunk traffic; the operator dials or keys the number of the called subscriber (or of a manual local exchange);

manual trunk traffic; the operator at the originating exchange must pass through one or more operators on the route to the wanted subscriber.

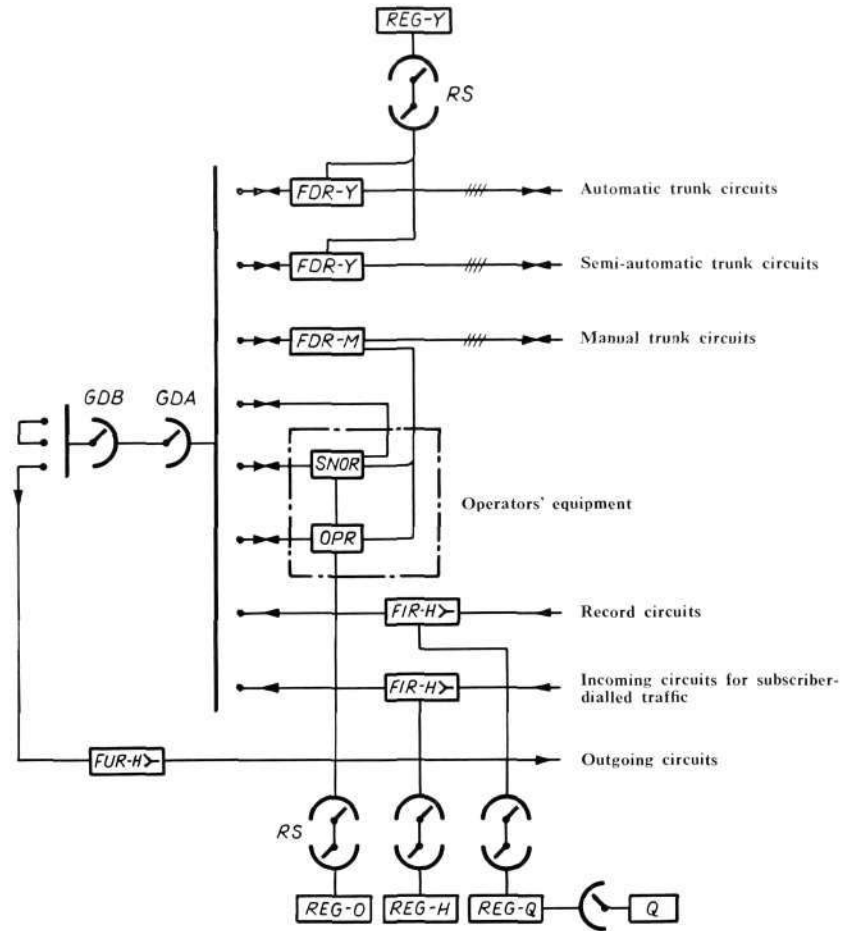


Fig. 16 X 8201  
Trunk exchange with transit stage ARM 201

Lines (*FIR-H*) for subscriber-dialled traffic and record circuits from the area served by the trunk exchange terminate on the *GDA* multiple of the transit stage. Outgoing lines (*FUR-H*) to the trunk exchange area terminate on *GDB*. This is on the assumption that the zone centre contains equipment for distributing the traffic to the various exchanges in the area.

Lines for subscriber-dialled trunk traffic from the home area have access to registers *REG-H*. Switching through the transit stage to an automatic trunk circuit in the desired direction and the subsequent switching through the trunk network are controlled by *REG-H*, which receives and stores both the trunk routing digits and the subscriber's number.

Calls handled by an operator can be set up with cords, plugs and jacks. With the introduction of automatic selector stages, however, the operators' cords, plugs and jacks can be replaced by automatic switching devices under the control of push-buttons and lever keys on the operators' positions. An arrangement incorporating cordless boards is shown in fig. 16, *SNOR* signifying the operator's switching equipment corresponding to a cord pair and *OPR* the position equipment. Each operator's position thus has one *OPR* and a number of *SNOR* which are controlled by buttons and keys on the switch-board.

Manual trunk calls can be set up on a record circuit *FIR-H* with access to a register *REG-Q*. The register receives the information required to direct the connection to the wanted group of operators. The register has access to a queuing device *Q*, the function of which is to put through calls in due order as and when an operator in the wanted group becomes free.

After an operator becomes free, *REG-Q* controls the connection through the selector stage to one side of an *SNOR*. On receipt of the booking, the operator connects the other side of *SNOR* through the selector stage to a line on the wanted route. This she can do either immediately (demand service) or later (delay service).

An incoming call on an automatic or semi-automatic trunk circuit *FDR-Y* seizes a register *REG-Y* which, on receipt of the required digits, decides whether the call is to be transited through the exchange or is destined for the home area. If the register is not required for the subsequent switching, it cuts out of circuit. Otherwise it awaits further digits for routing the call to the wanted subscriber or operator.

An incoming call on a manual trunk circuit is signalled on lamps at the operators' positions. When an operator answers the call by throwing a key on *SNOR*, connection is established from the manual line through the selector stage to *SNOR*.

A manual trunk circuit can be tied to a particular operator's equipment. Such circuits can thus be reached direct from the operators' positions without being switched through the selector stage. Connections of this kind can be established and cancelled from the operator's position, and a tied circuit may even be loaned to another operator.

For establishment of a connection from an operator's position through the selector stage a register *REG-O*, which receives the digits from the operator's keyset and controls the switching process, is connected to the position equipment *OPR*.

## *International Trunk Exchanges*

Selector stages *ARM 201* are used in automatic and semi-automatic international trunk exchanges, and the equipment is designed to comply with the C.C.I.F. recommendations for switching of international traffic.

The normal procedure is that a connection shall be automatically established between an operator at the international centre in the country of origin and the wanted subscriber in the country of destination. If this is not possible, the assistance of an operator at the incoming international exchange is required.

International calls are booked with an operator in the country of origin. The operators may be divided into several linguistic groups with which subscribers obtain connection by dialling an international code.

If an operator gets into language difficulties when setting up an automatic international call, she can send a signal for assistance by an operator at the incoming international centre.

Calls which cannot be established automatically by the originating operator require the assistance of an operator in the country of destination. Connection with the latter is obtained by sending *code 11* after the international code and language digit. If connection is required with a particular operator's position or group of positions, *code 12* is used, possibly followed by the number of the position or group. *Code 11* and *code 12* form part of the international signalling scheme.

In order to meet the special demands placed on international exchanges, the *GDF* stages are made with 10-pole through-connection and the selector unit is built for 100 lines in the A stage and a maximum of 200 B verticals.



Fig. 18  
CLR operation

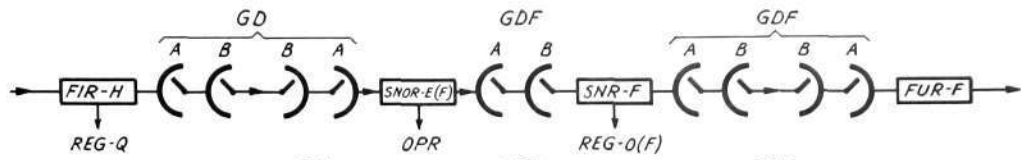


Fig. 19  
Delay working

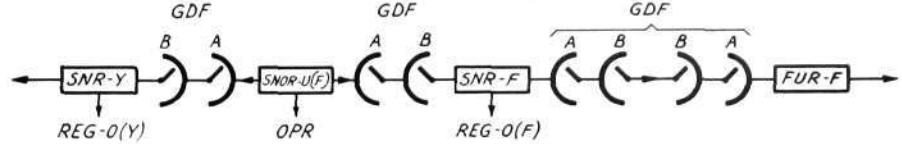


Fig. 20  
Code 11 call

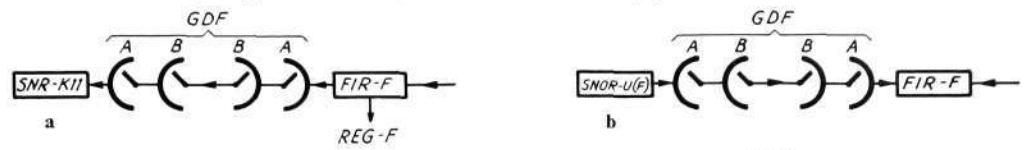
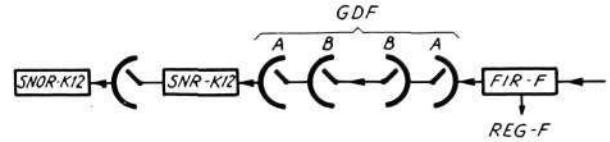


Fig. 21  
Code 12 call



X 8202

Incoming calls are not normally connected to an operator immediately but are indicated on lamps at the switchboard positions. A free operator then throws a key to connect a call to one of her cord circuits *SNOR*.

The switching process through the selector stages for different types of call is as follows:

A call from the home country seizes a *FIR-H* and a register *REG-Q* with queuing unit *Q*. When the operator answers, the call is switched through *GD* to one side of *SNOR-E(F)* or *SNOR-U(F)*. If the connection can be extended immediately, the operator switches to a register *REG-O(F)* over one side of *SNOR* via *GDF* and *SNR-F*. *REG-O(F)* receives the digits from the operator's keyset and the connection is then switched through four partial stages to an outgoing international line on the desired route (fig. 18).

If the connection cannot be established immediately, the *SNOR* is restored. The call is later set up by the operator connecting one side of a free *SNOR-U(F)* to her position equipment. The connection to the international line thereafter proceeds as described above. To re-establish connection with the calling subscriber, the operator connects the other side of her cord circuit to a national register *REG-O(Y)* via *GDF* and *SNR-Y*. The register receives the digits from the operator's keyset and controls the connection through the national network (fig. 19).

The procedure described above applies to connections both on semi-automatic and on manual international circuits. A connection to a manual circuit tied to a particular operator, however, is extended direct from the corresponding *SNOR-U(F)* on the dotted circuit shown in fig. 17 without passing through the selector stages.

An incoming international call on a semi-automatic line is connected to a register *REG-F* which receives the numerical information from a register in the country of origin.

If the call is to terminate in the country and can be put through automatically to the wanted subscriber, it is extended direct to the national trunk or transit exchange without passing through the *GDF* selector stages. *REG-F* thereafter controls the connection within the national network.

If the call cannot be established automatically, but an operator's assistance is required (*code 11* call), the incoming international line is connected via *GDF* to a free *SNR-K11* (fig. 20 a). The call is signalled on language lamps at all operators' positions which are equipped for *code 11* calls and which belong to the language group in question.

The answering operator connects to the calling line via *SNOR-U(F)* and *GDF*, after which *SNR-K11* is released (fig. 20 b). After receiving particulars of the number, the operator connects to the wanted subscriber in the same way as on a ring-back call.

An incoming call on a manual circuit does not busy the selector stages *GDF*, but is connected to a queuing device *Q* and signalled on lamps at the operators' positions serving that group of languages. A free operator answers the call and connects a *SNOR-U(F)* via *GDF* to the calling line in the same way as on a *code 11* call.

If the manual circuit is tied to a particular operator, the call goes direct to the relevant *SNOR-U(F)*.

An incoming *code 12* call is connected by *REG-F* via *GDF* and *SNR-K12* to the *SNOR-K12* served by the called operator (fig. 21).

Incoming calls to assistance operators are signalled on language lamps at all operators' positions belonging to the required language group and having cord circuits *SNOR-AO*. The answering operator connects via *GDF* to the calling line.

# LM Ericsson's Transistorized Voice Frequency Telegraph Systems — Amplitude Modulated, Type ZAT 24A Frequency Modulated, Type ZAT 24F

S RODHE, TELEFONAKTIEBOLAGET LM ERICSSON, STOCKHOLM & S VALZ, FATME, ROME

UDC 621.394.44  
LME 813

*Development of v.f.t. systems at LM Ericsson dates back to 1928 with a system for traffic between telegraph and radio stations. A long line of equipment has since followed to meet various traffic needs. The first f.m. system in Europe was designed by LM Ericsson in 1946. Latterly development has been primarily concentrated on systems for teleprinters. The latest design is a transistorized 24-channel system in which either a.m. or f.m. can be selected by replacement of certain channel units in the equipment.*

During recent decades telegraphy has increased in significance as a means of communication, due particularly to the increased use of telex. Long distance transmission between switching centres of the telex network is now almost exclusively carried out by v.f. telegraphy. In this the characters are transmitted in the form of modulation of the tone constituting the channel carrier frequency; this modulation is produced by the d.c. signals from the telex subscribers' apparatus. Multi-channel systems are built up from channel units whose carrier frequencies lie within the frequency range used for telephony; hence either physical or carrier telephone circuits, on open wire lines, cables or radio links, can be used as bearer circuits for v.f. telegraphy.

According to the method of modulation, we distinguish between amplitude modulated (*a.m.*) and frequency modulated (*f.m.*) v.f. telegraph systems. Historically first came the a.m. principle, and CCIT—nowadays CCITT—has over a period of years established generally accepted recommendations for standardizing a.m. systems. In recent years interest in f.m. systems has increased, and since 1956 work has been in progress on recommendations for these systems also.

In view of the fact that both these types will exist side by side in the telegraph network, LM Ericsson has cooperated with their Italian subsidiary FATME to develop and design a v.f. telegraph system with 24 channels alternatively for a.m. or f.m., with respective type designations *ZAT 24 A* and *ZAT 24 F*. The basic equipment including the channel filters is the same for either alternative, so that a change from one to the other modulation principle can be made simply by exchanging plug-in channel units for sending and receiving. Transistors are used rather than tubes, giving the advantages of increased reliability, reduced operating and maintenance costs, and occupying less space.

## Frequencies

In accordance with CCITT's recommendations, the carrier frequencies of the v.f. telegraph systems are 420, 540, 660, . . . . . c/s, i.e. odd multiples of 60 c/s. With a separation between adjacent channels of 120 c/s, the useful

bandwidth is limited to 80 c/s; this is adequate, both for a.m. and f.m. systems, for transmission at the standardized teleprinter speed of 50 bauds.

The maximum number of telegraph channels on a bearer circuit is determined by the transmission bandwidth and the level of interference. Considering bandwidth only, a telephone band of 300–3 400 c/s can accommodate 24 channels with carriers from 420 to 3 180 c/s.

The transmission levels chosen must subdivide the permissible loading of the telephone channel amongst all the telegraph channels, hence the number of telegraph channels may need to be restricted so that individual channel levels are sufficiently high in relation to the level of interference. This can result in the maximum permissible number of channels being less than bandwidth considerations would indicate.

The highest telegraph levels recommended by CCITT are –20.9 dbm per a.m. channel or –22.5 dbm per f.m. channel at a point of zero relative level in a telephone bearer channel carrying 24 telegraph channels. With a reduced number of channels, higher levels are permitted.

## Methods of Modulation

Amplitude modulation implies that the modulating d.c. signals controlling the v.f. telegraph sender cause the carrier frequency to be emitted or suppressed according as the signal changes between start and stop polarity. CCITT recommend that tone is emitted during the idle condition, i.e. corresponding to stop polarity. In frequency modulation the frequency of the emitted signal is shifted between two distinct values at  $\pm 30$  c/s from the nominal centre frequency. The higher frequency is sent for start polarity of the modulating d.c. and the lower for stop polarity.

These two methods of modulation, a.m. and f.m., have relative advantages and disadvantages resembling those of single and double current working in d.c. telegraphy. Thus the distortion of the reproduced signals with a.m. transmission is affected by variations of equivalent in the bearer circuit.

The receiver must therefore be provided with some form of automatic level regulation, though with a fairly limited operating range. With f.m. transmission on the other hand distortion is practically independent of level variations, these being readily eliminated by amplitude limiting in the receiver.

Frequency displacement in the bearer circuit is most important for an f.m. channel. Here the frequency determines the signal waveform, so that frequency drift causes distortion of the received signals. The effect of frequency drift on a.m. channels is appreciably less.

An f.m. system is less susceptible to interference than an a.m. system by some 6 to 9 db, depending on the type of interference.

Since as mentioned above the permissible signal level for f.m. is in general somewhat lower than for a.m., this improvement is reduced by a corresponding amount.

The choice between a.m. and f.m. is consequently primarily decided by the characteristics of the telephone bearer circuit. AM is suitable for transmission over circuits with relatively low interference level and without excessive variations of equivalent. FM should be chosen for circuits with high interference level or with large and rapid variations of equivalent, but should be avoided for circuits with large frequency drift, e.g. on certain older types of carrier system.

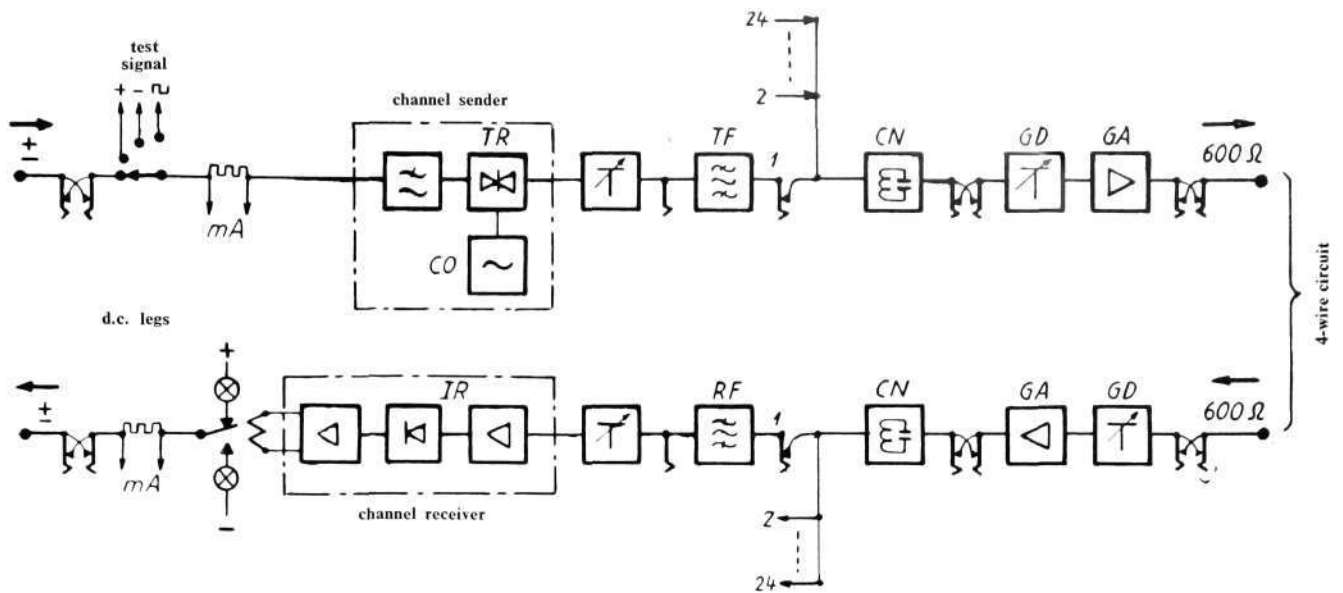


Fig. 1 X 7780

Block schematic of v.f. telegraph system  
ZAT 24

- CN impedance compensating network
- CO carrier frequency oscillator
- GA telegraph group amplifier
- GD attenuator
- IR channel receiver
- RF receive filter
- TF send filter
- TR static relay

## Functional Design of the Systems

A block schematic of a channel terminal in LM Ericsson's a.m.-f.m. system is shown in fig. 1. The equipment is normally connected on the audio-frequency side to a four-wire circuit: sending and receiving thus take place over separate line pairs or channels.

A fully built out system provides equipment for 24 duplex connexions.

The d.c. circuits are arranged for double-current working, normally  $\pm 20$  mA. The input impedance of the channel sender is 1 000 ohms and the output impedance of the channel receiver 2 000 ohms.

DC signals arriving at the channel sender traverse a low-pass filter for rounding off the waveform, and thereafter modulate the carrier frequency which is produced in the channel oscillator CO. Modulation is effected by the static relay (modulator) TR. The sending level is adjusted in the continuously variable attenuator which follows, and the frequency spectrum produced by the modulation is limited in the sending filter to the bandwidth of the channel.

The sending filters of all channels in one terminal are connected in parallel across the compensating network CN, whose function is to prevent mutual interference between the filter impedances. All channels are now sent to line together via the group amplifier GA: the attenuator GD provides for adjustment of the output level to a suitable value. The maximum total output of all channels which can normally be obtained is + 16 dbm; this peak level may theoretically be reached if each telegraph channel in a 24-channel system has a level of - 12 dbm.

The lowest channel level which can be accepted on the receiving side of the four-wire circuit is - 40 dbm. The working level for the system is set by the attenuator GD. The received signals are amplified in the group amplifier GA and directed to the various channel receivers IR via the receive band-pass filters RF, parallel-connected across the network CN.

The receiving level of each channel can be individually adjusted by the pad of each channel receiver. The receiver converts the v.f. signals to d.c. signals: these are repeated out into the local circuit by a polarized telegraph relay whose contacts are connected to a telegraph voltage.

As indicated in fig. 1, the equipment is provided with jacks for test measurements and patching. In addition there are instruments which can be switched to the channel senders and receivers for checks on operation. Transmission tests can be made between two separate terminals or between sender and

receiver connected back-to-back in the same terminal, using continuous start or stop polarity or with 50-baud reversals from a test sender in the equipment.

The power requirements—24 V d.c. for transistors and lamps, and 60–0–60 or 80–0–80 V telegraph voltage—can be supplied from batteries or from a.c. mains via a supply unit in the equipment. The power consumption of the transistorized equipment is low: a total of about 100 W for a 24-channel terminal including that drawn from the telegraph voltage.

## Units and Bays

The terminal equipment for 24 circuits is mounted on one side of a rack of height 2 590 mm (8' 6") and width 514 mm (20<sup>1</sup>/<sub>4</sub>")—see fig. 2. There are also alternative bays for smaller numbers of channels.

Following LM Ericsson's normal principles for mechanical design of transmission equipment, this equipment is subdivided into plug-in functional units placed on shelves in the bay, together with panels bolted on the rack.

These panels in general constitute the basic equipment of the terminal, such as the terminal strips at the top of the bay for connecting external cabling, the common jack panels, the mains supply units at the foot of the bay, etc.

The send and receive filter for the same circuit are mounted in a plug-in filter unit: see fig. 3. All the filter units are on six shelves immediately below the terminal strips. The send and receive filters are identical in construction and characteristics. In addition to five passive resonant circuits, each contains an active transistor element. The transistor inserts negative resistance in the circuit, in part compensating the dissipation in the filter. By suitably choosing the amount, a pass-band response is obtained which is optimally rounded for pulse transmission. In addition, the pass-band insertion loss of the filter is reduced and its stop-band insertion loss increased. The filter response curve is shown in fig. 4.

The equipment for the local d.c. circuits is arranged on six telegraph panels, each for a group of four circuits. Fig. 5 shows part of such a panel: on the left are seen the milliammeters which can be connected by switches to different d.c. circuits in the group. On the right are the controls for one of the circuits: in addition to the attenuators already mentioned for the control of send and receive levels, there is a switch for transmission testing and a potentiometer for compensation of bias distortion in the received signals.

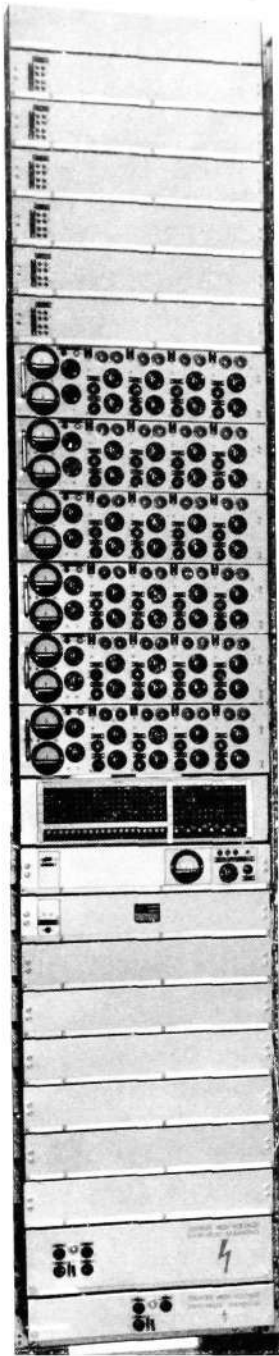


Fig. 2 X 2500  
Voice frequency telegraph bay with equipment for 24 circuits

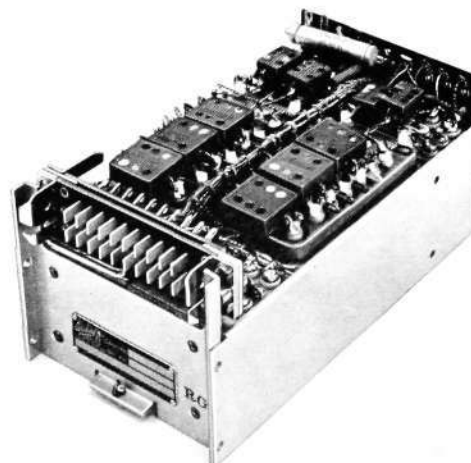


Fig. 3 X 2501  
Channel filter unit

Fig. 4  
Filter response curve

X 8204

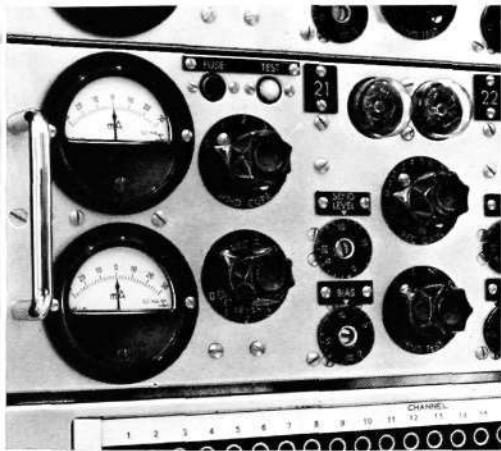
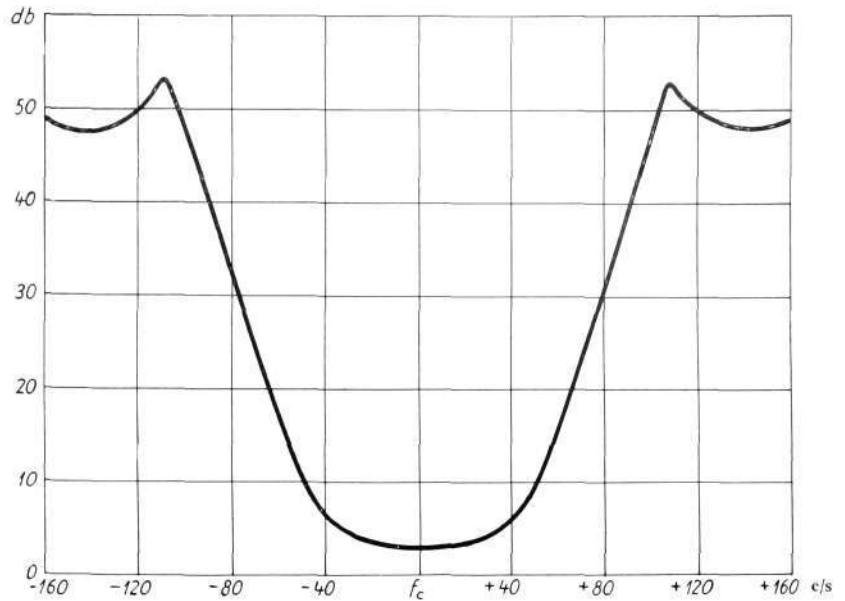


Fig. 5  
Part of a telegraph panel

X 2502

The telegraph panels can be swung out on hinges; the space behind them being occupied by the receive telegraph relays and the plug-in units for the channel senders in either a.m. or f.m. version.

Below the bay jack panel, where most of the jacks in the terminal are assembled, there are shelves for the test sender, alarm equipment for supply interruptions and blown fuses, and pads and group amplifiers on the line side.

The channel receivers for either a.m. or f.m. are mounted in the lower part of the bay. The two supply units at the foot can be connected for various mains voltages; the nominal mains frequency can be either 50 or 60 c/s.

## Channel Units for a.m.

The *a.m. channel sender* comprises an oscillator and modulator in a single plug-in functional unit.

The oscillator is composed of a tuned circuit for the channel carrier frequency and two transistor stages in a special circuit, whose frequency and output voltage are independent of supply voltage and transistor characteristics over a wide range.

The modulator is of bridge type, with diodes controlled by d.c. in the arms of the bridge. The polarity of the controlling d.c. signal selects either of the two bridge conditions: unbalance, allowing passage of the voice frequency, or balance, when it is stopped. Fig. 6 shows the relative attenuation of the modulator for varying control current. In accordance with CCITT's recommendation there is a high loss for zero control current, i.e. open-circuit in the d.c. loop. Because of the steep change-over between pass and stop conditions, the control current can depart appreciably from its nominal value of  $\pm 20$  mA without giving rise to distortion in the emitted signals.

The *a.m. channel receiver* comprises a v.f. amplifier, a demodulator with automatic compensation for level variations, and a d.c. amplifier to drive the telegraph relay. These are built together as a single plug-in unit.

Fig. 6  
AM static relay characteristic

X 2506

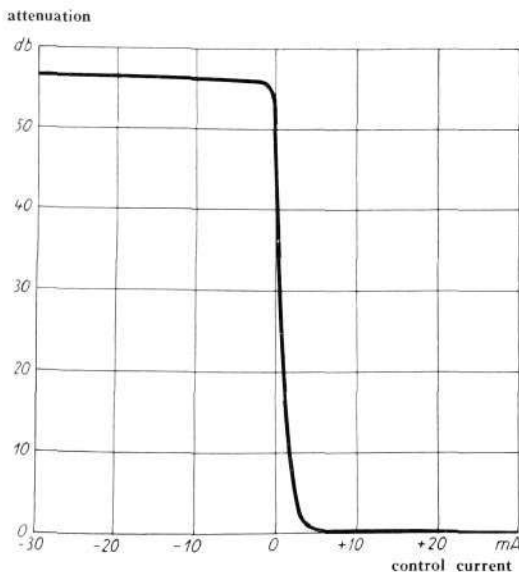
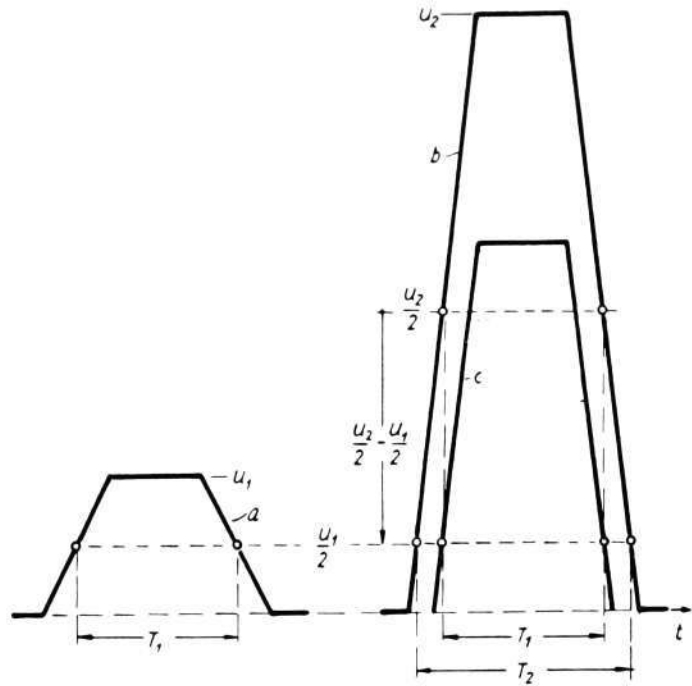


Fig. 7

X 8205

Level compensation in a.m. receiver

- a Signal voltage with peak value  $U_1$   
The telegraph relay operates at a voltage of  $\frac{1}{2} U_1$
- b Signal voltage with peak value  $U_2 > U_1$  without compensation
- c Resultant signal voltage after compensation by a backing-off voltage of  $\frac{1}{2}(U_2 - U_1)$



The v.f. amplifier has two transistor stages, the second being push-pull connected. Both current and voltage feedback are used. A v.f. voltage is taken from the output, and can after rectification be connected to one of the instruments on the telegraph panel for checking the operating level of the receiver.

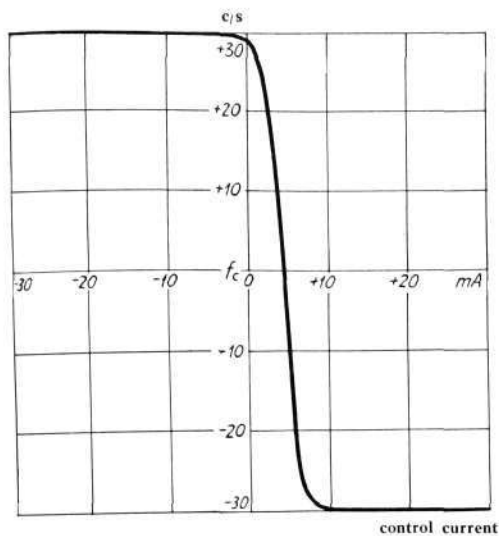
The v.f. signals are demodulated to d.c. in a full wave rectifier. The waveform of the received signals has sloping flanks due to the bandwidth limiting in the channel filters. Variations of the equivalent of the bearer circuit cause variations in the amplitude of the received signal: this state of affairs is shown schematically in fig. 7. The peak signal amplitudes under different circumstances are taken to be  $U_1$  and  $U_2$ . For distortionless reproduction of the signals the receive relay must operate at those instants which correspond to an amplitude of half the peak value. If  $\frac{1}{2} U_1$  is the voltage at which the relay changes over, the signal will be reproduced with correct duration  $T_1$  for amplitude  $U_1$ . The higher amplitude  $U_2$  would, without taking precautions, give a duration  $T_2 > T_1$ . Compensation is therefore made by a backing-off voltage  $\frac{1}{2}(U_2 - U_1)$ , which is added to the signal voltage at such times that the signal half-amplitude  $\frac{1}{2} U_2$  is reduced in the resultant voltage to  $\frac{1}{2} U_1$ . The relay then reproduces the signal without distortion. A potentiometer on the telegraph panel provides for adjustment of the compensating voltage to give minimum distortion.

With this automatic regulation the distortion is less than 5 % over a range of levels of  $\pm 9$  db relative to the nominal receive level. The receiver ceases to operate for levels lower than about 18 db below nominal, and on the d.c. side emits start polarity in accordance with CCITT's recommendation.

### Channel Units for f.m.

The *f.m. channel sender* combines oscillator and modulator in a single functional unit.

The tuned circuit of the oscillator is connected to the input of a two-stage transistor amplifier. By ensuring accurate phase of the positive feedback from the amplifier output to the tuned circuit, stable frequencies are obtained. The



**Fig. 8** X 2507  
**Frequency modulator characteristic**  
 Relation between modulating d.c. and frequency shift

amplifier has so much negative feedback that the oscillator output voltage is independent of variations of the supply voltage and changes in the transistors. The input impedance is high so that it produces practically no loading of the tuned circuit.

The modulator is a current-controlled diode bridge, connected to the tuned circuit in series with a capacitor. According to the polarity of the controlling d.c. signal, the capacitor is thus connected in or out of circuit, causing the frequency to shift  $\pm 30$  c/s relative to the channel centre frequency. The modulation characteristic is shown in fig. 8. The higher frequency corresponds to start polarity and is emitted if there is an interruption in the d.c. circuit, in accordance with CCITT's recommendation. For zero control current CCITT are considering recommending that the emitted frequency may differ from the nominal value for start polarity by up to  $\pm 5$  c/s: in this equipment the maximum deviation from the nominal value is 1 c/s.

The *f.m. channel receiver* comprises, like the a.m. version, a v.f. amplifier, demodulator and d.c. amplifier.

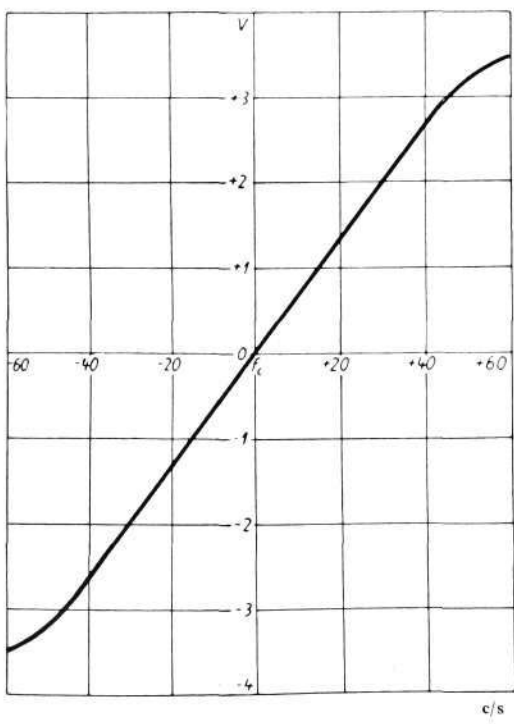
The received signal amplitude is limited before demodulation, thereby suppressing amplitude variations which can arise in the bearer circuit and eliminating amplitude modulation produced by the restricted bandwidth of the channel filters. This also gives some protection against interference because its amplitude is also limited.

The v.f. amplifier has two amplitude-limiting transistor stages with opposed Zener diodes connected across the input of each stage, so that both positive and negative-going half-waves are limited. A further buffer stage before the limiter prevents this from affecting the impedance seen by the receive filter. This arrangement gives instantaneous limiting and delivers a constant output over a wide range of input levels.

The amplitude limited v.f. signals are demodulated to d.c. signals in a discriminator. This has a characteristic which is linear up to about  $\pm 60$  c/s referred to the centre frequency—see fig. 9. A subsequent low-pass filter removes any v.f. residue and assists in reducing interference from adjacent channels.

The d.c. signals are finally fed to the telegraph relay via a Class B push-pull amplifier.

Bias distortion caused by frequency drift in the bearer circuit can be manually corrected by means of the potentiometer on the telegraph panel previously referred to. A relatively large frequency drift can be tolerated because of the wide frequency range covered by the discriminator and the ample margins in the design of the receiver d.c. amplifier.



**Fig. 9** X 2508  
**Frequency discriminator characteristic**  
 Discriminator output voltage as a function of frequency

## Transmission Characteristics of the Systems

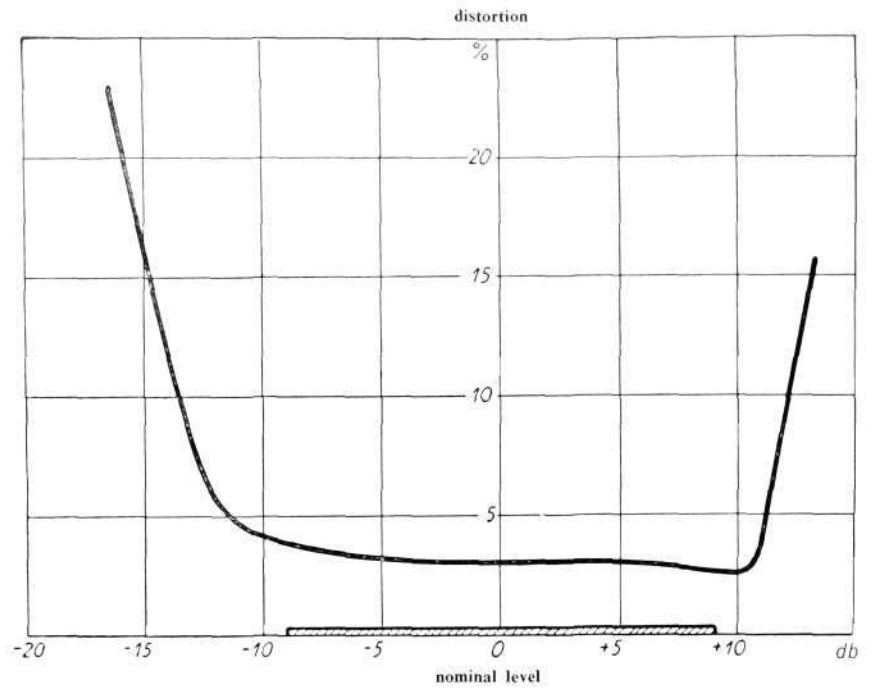
Extensive tests under various operating conditions have shown that the transmission characteristics of the systems easily meet the recommendations of the CCITT. Amongst the things investigated have been the stability of channel level and frequency for variations in temperature and supply voltage, and the telegraph distortion for changes in level and frequency and for various kinds of interference.

### AM-system

The distortion for a CCITT test message with slow variations of the received level has the behaviour shown in fig. 10. The distortion rises rapidly for decreasing levels as the receiver threshold is approached; this is 18 db below the nominal receive level.

Each separate signal pulse is individually regulated in accordance with the principle described earlier: consequently rapid level changes produce relatively low distortion. The distortion given by a sudden change in level of 6 db is on an

Fig. 10 X 8206  
 Dependence of telegraph distortion on receive level in a.m. channel  
 Working range of receiver: -9 db to +9 db referred to nominal level



average only about 10 % according to measurement results. This system of rapid regulation makes it even possible to use "inverted" transmission, i.e. with tone on for start polarity, instead of tone on for stop polarity as recommended by CCITT.

Frequency drift in the bearer circuit has only an insignificant effect on distortion. Displacements of up to  $\pm 10$  c/s in the received carrier frequency cause practically no additional distortion. The carrier frequencies from the channel senders vary at most  $\pm 1$  c/s over an ambient temperature range of  $+10^\circ$  to  $+40^\circ\text{C}$  and for mains voltage variations of  $\pm 15\%$ .

The interference in a channel from the other channels of the system is low: they produce at the most 1 % additional distortion. The susceptibility of the channel receiver to interference due to noise is shown in fig. 11. The curve

Fig. 11 X 8207  
 Telegraph distortion in the presence of interference by noise  
 The noise level is measured relative to the signal level after the receive filter

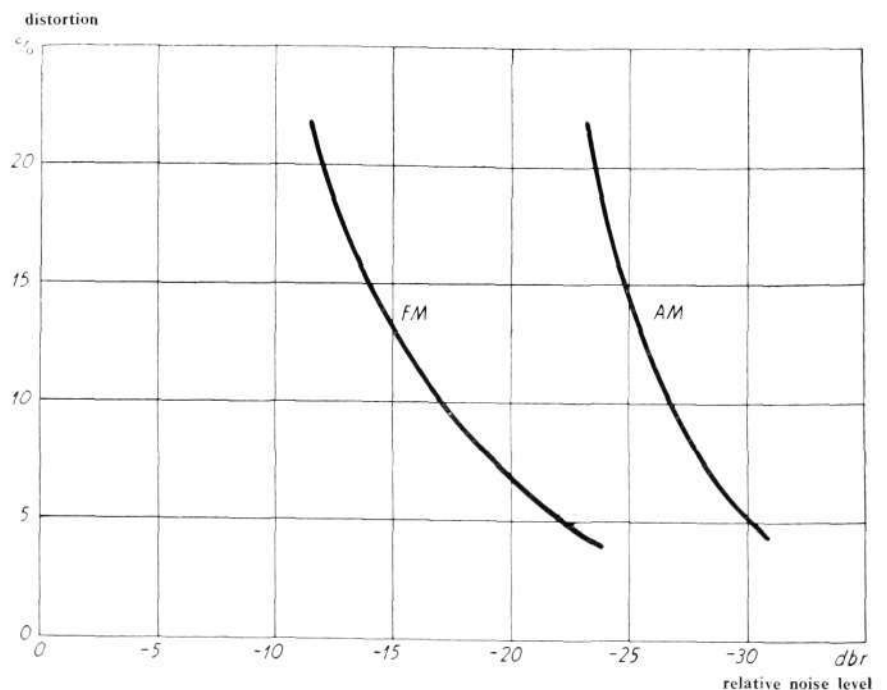
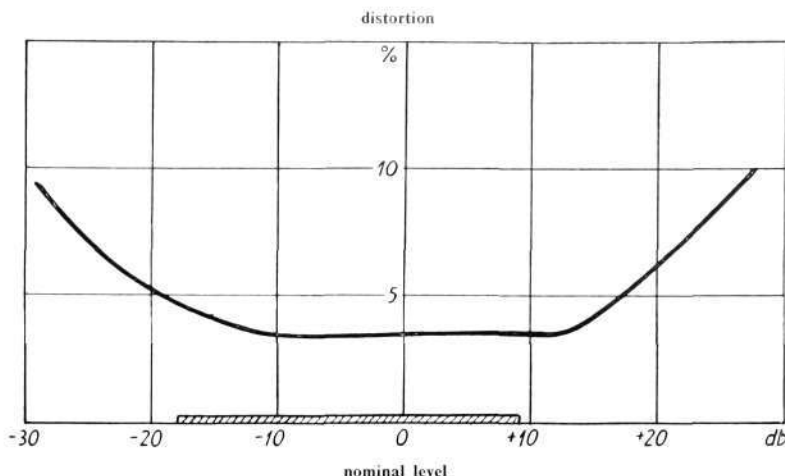


Fig. 12

X 6208

Dependence of telegraph distortion on receive level in f.m. channel

Working range of receiver: -18 db to +9 db referred to nominal level



gives the relationship between distortion and signal-to-noise ratio at the input of the receiver after the receive filter. 10 % distortion results from a noise level 27 db below the nominal signal level.

The interfering effect of discrete frequencies has also been investigated. This is greatest for frequencies at about  $\pm 30$  c/s on either side of the carrier frequency; these also produce about 10 % distortion for a 27 db signal to noise ratio.

#### FM-system

Level variations, whether slow or fast, have appreciably less effect on distortion in an f.m. channel. In fig. 12 are shown the average values for a large number of channels of the relation between received level and distortion for CCITT text. The working range includes levels between -18 db and +9 db relative to the nominal receive level. Sudden level variations of 15 db within this range cause less than 10 % distortion.

The increase in distortion due to frequency drift is about 2 % per c/s change in the centre frequency of the channel. For transmission over a bearer circuit meeting CCITT's recommendation of a maximum frequency displacement of 2 c/s, the increase in distortion can thus in the worst case amount to 4 %: however, being bias distortion, it can be manually corrected, as previously mentioned. It was not considered necessary to provide automatic compensation. The inherent frequency stability of the v.f. telegraph equipment itself is such that there is no significant increase of distortion for ambient temperature variations within the range +10° to +40° C, or for mains voltage variations of  $\pm 15$  %.

The f.m. system is about 9 db less susceptible to interference from noise than the a.m. system. As can be seen from fig. 11, the distortion is 10 % for a signal-to-noise ratio of 18 db at the input of the channel receiver. Interference consisting of discrete frequencies also affects the f.m. system less: here again the difference in susceptibility is about 9 db.

## Summary of Technical Data

### Data common to both systems (ZAT 24A and ZAT 24F)

<i>Telegraph speed</i>	50 bauds
<i>Telegraph distortion</i>	Less than 5 % for 1:1, 2:2, 1:6, or 6:1 signals or CCITT text
<i>Nominal carrier frequencies</i>	420 c/s to 3180 c/s at intervals of 120 c/s, as recommended by CCITT

<i>Frequency stability</i> for simultaneous mains voltage variations of $\pm 15\%$ and temperature variations between $+10^\circ$ and $+40^\circ$ C	Better than $\pm 1.5$ c/s
<i>V/F transmission</i>	4-wire
Impedances for send and receive directions	600 ohms balanced
Maximum send level	-12 dbm per channel
Minimum receive level	-40 dbm " "
Range of level adjustment for send and receive directions	40 db in steps of 1 db, in addition individual adjustment of levels for each channel
<i>Local d.c. loops</i>	4-wire. Double current operation with $\pm 20$ mA
Impedance, send direction	Normally 1000 ohms
" , receive "	" 2000 "
<i>Power supply</i>	From a.c. mains or batteries
AC mains	Voltage 110, 127, 150, 220 or 240 V Frequency 50 or 60 c/s
Batteries	For transistors & lamps 24 V Telegraph voltage 60-0-60 V or 80-0-80 V
Power consumption for terminal equipped with 24 circuits	About 100 W

### Data peculiar to system ZAT 24A

<i>Modulation principle</i>	Amplitude modulation
<i>Range of receive levels automatically compensated</i>	From -9 db to +9 db referred to the nominal receive level for distortion not exceeding 5% (for text)
<i>Receiver threshold level</i>	18 db below nominal level
<i>Stop condition</i>	Tone on or off
<i>Level of interference (noise) after receive filter causing 10% distortion (for text)</i>	About 27 db below signal level

### Data peculiar to system ZAT 24F

<i>Modulation principle</i>	Frequency shift $\pm 30$ c/s relative to the nominal channel frequency
<i>Range of receive levels</i>	From -18 db to +9 db referred to nominal for distortion not exceeding 5% (for text)
<i>Stop condition</i>	Transmission of lower frequency in accordance with CCITT recommendation
<i>Level of interference (noise) after receive filter causing 10% distortion (for text)</i>	18 db below signal level
<i>Sudden level changes causing 10% distortion (for text)</i>	$\pm 15$ db within the range of receive levels

# Loudspeaking Intercom Telephone with Transistor Amplifier

H EKSTRÖM & C G SÖDERBAUM, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

UDC 621.395.24  
LME 8376

*Telefonaktiebolaget L M Ericsson has manufactured loudspeaking intercom telephone systems for many years and has recently brought out a battery-driven system with transistor amplifiers. The use of transistors and printed circuits has made it possible to design an amplifier that can be fitted into the telephone instrument itself. This saves the cost of the previously separate amplifier. L M Ericsson's transistorized telephone presents an elegant solution of the problem of internal communications. It is universally usable for rapid contact between different persons or offices, in restaurants, hotels and large private houses.*

*When rapid connection is important, and loudspeaking conversation is both desirable and feasible, this system provides an admirable means of communication since calls are push-button dialed and no manipulation is normally required at the answering end.*

## General Description and Traffic Facilities

L M Ericsson's transistorized loudspeaking intercom telephone incorporates push-button calling and secrecy facilities. The system can be supplied either with master stations alone, the *all-to-all* principle, or with master and sub-stations, the *star* system.

The two types of system are shown in the block diagrams in figs. 1 and 2, with the intercommunication facilities shown by lines between the instruments and the calling direction by arrows.

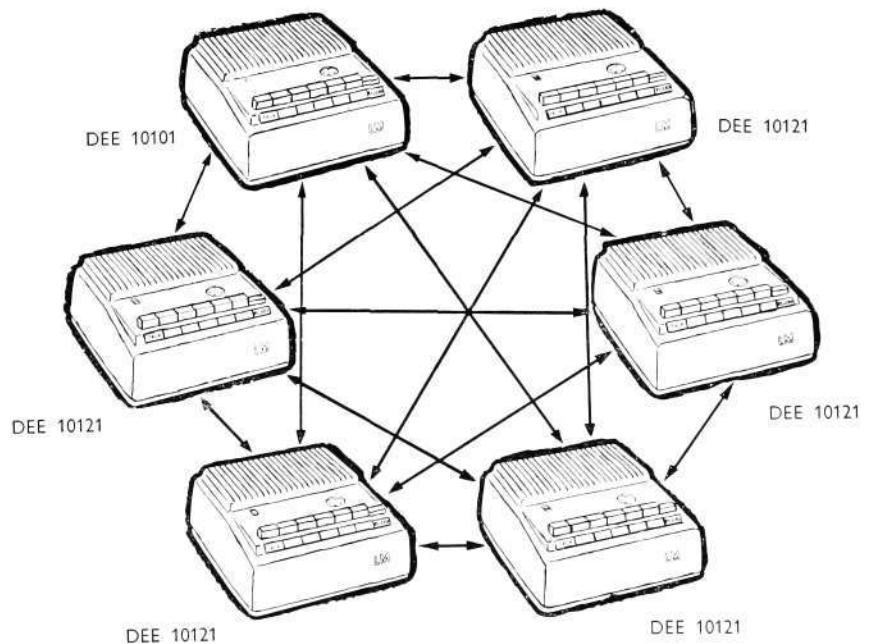


Fig. 1 X 8209  
"All-to-all" system with master stations alone

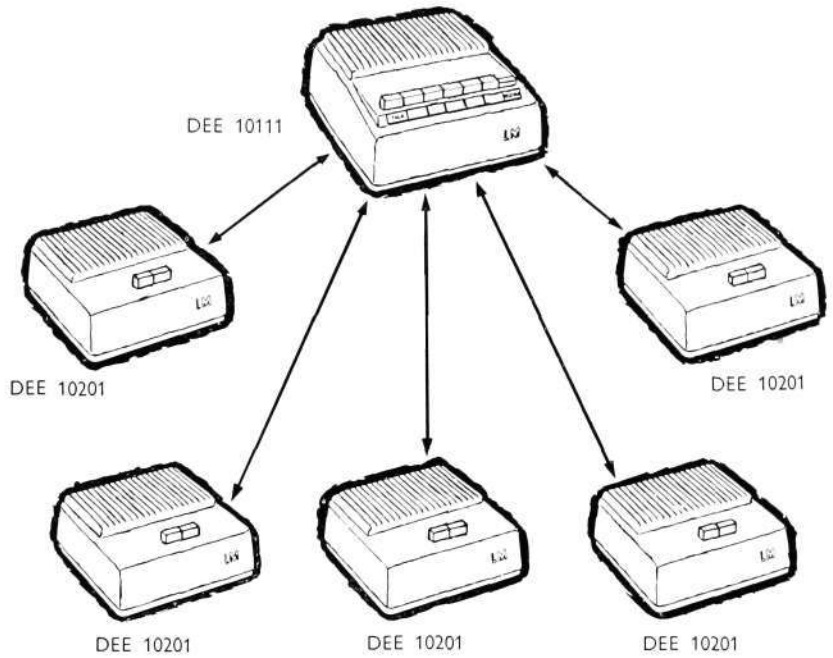


Fig. 2 X 8210  
 "Star" system with master set and 5 sub-sets

### "All-to-All" System

In this system (fig. 1) one set, *DEE 10101*, has a built-in transistor amplifier common to the entire system and supplied from built-in pocket torch batteries of standard international type or from a mains-connected power unit. The remaining sets, *DEE 10121*, have no amplifier or battery.

Calls are initiated by pressing one of the five line-buttons (fig. 3). When communication has been established, the direction of speech is controlled with the TALK button on the left. A star indicator operates on all sets to show that a call is in progress. The red button on the right is used to clear the call, whereupon the system returns to normal and the star indicators release.

On the left of the set is a secrecy switch. With the switch in off-position, calls can be established direct without any manipulation at the answering end. Thus the called party is not tied to his instrument but has the free use of his



Fig. 3 X 8211  
 Master set DEE 10101 and DEE 10121 for "all-to-all" system

hands and can move about the room at will while conversing. If it is desired that a conversation with another person in the room shall not be overheard on the intercom, the secrecy switch can be operated. A call will still be heard, but the speech will be faint and slightly distorted. In order to be able to converse, therefore, the switch must be restored.

### “Star” System

In this system (fig. 2), which consists of a master set *DEE 10111* with up to five sub-sets *DEE 10201*, the transistor amplifier and batteries are placed in the master set (fig. 4). If required, a separate mains-connected power unit can be used in place of batteries in this system as well. Since the star system has only one master set and no conversation can take place between sub-sets, the engaged condition need not be signalled. There are therefore no indicators in this system. The sub-set has one line button and a secrecy button.

Calls from master set to sub-set are set up in the same way as in the “all-to-all” system. Direction of speech is controlled by the TALK button on the master set. If the secrecy button on the sub-set is in the normal position, conversation can be established direct without any manipulation by the called party.

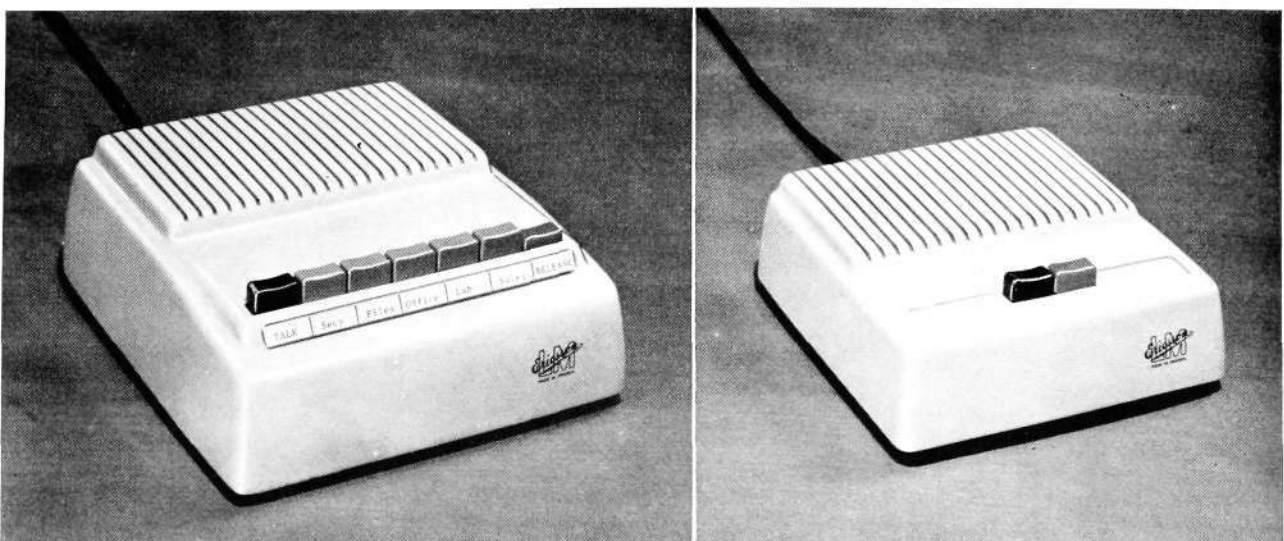
A call from a sub-set is made by pressing the line button and giving one’s name. The caller’s voice is then heard by the master set user. The latter presses the caller’s line button, followed by the TALK button, and then answers. Direction of speech is thus always controlled from the master set. By pressing the secrecy switch the sub-set user can prevent a conversation in his room being overheard via the master set. Before a conversation on the intercom telephone can be established, the secrecy switch must first be restored to normal.

The master set can call several sub-sets simultaneously. The called sub-sets can hear only the master set.

### Design Features

The instruments in L M Ericsson’s transistorized loudspeaking intercom telephone system have neutral-grey plastic cases with a simple dignity which fits well into any environment and they occupy little space. They are based on the latest discoveries in transistor engineering, and great attention has been paid

Fig. 4 X 7781  
Master set DEE 10111 (left) and sub-set DEE 10201 for “star” system



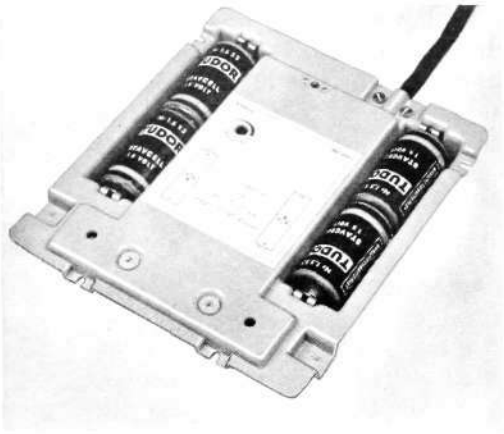


Fig. 5  
Base plate with four batteries

X 2509

to sound fidelity and reliability of operation. The high sensitivity of the built-in microphone-loudspeaker ensures satisfactory reproduction up to 30 ft. and more from the instrument.

The master set has a removable designation strip for change of names.

Master sets incorporating an amplifier are fitted with four pocket torch batteries calculated to last 6–8 months under normal conditions of usage. Access to the batteries is obtained by removal of the base plate (fig. 5).

The amplifier in master sets *DEE 10101* and *DEE 10111* is entirely transistorized and is built on a printed circuit board (fig. 6). It consists of two amplifier stages, class A, in transformer coupling, followed by an output stage, class B, in push-pull arrangement. The output and input impedance is 50 ohms. The amplifier operates on 6 V D.C. The current consumption during conversation is about 25 mA and in intervals between conversation about 14 mA.

The output power at 1,000 c/s is 200 mW with 5 % distortion. The input sensitivity is very high, 1 mV.

The amplifier coupling is temperature-stabilized within the range 0 – +50° C.

## Cabling and Installation

Each instrument is connected to the system cabling via 6'6" flexible cord with attached wall terminal box. The box also serves as junction box and has convenient screw terminals which facilitate connection.

The lines require merely an ordinary multiwire telephone cable with plastic insulation. Installation of this loudspeaking intercom telephone system is, therefore, very simple.

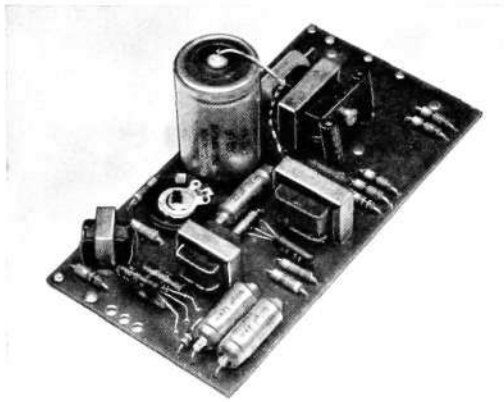


Fig. 6  
The amplifier is built on a printed circuit board

X 2510

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



Two Monarchs visit L M Ericsson:

The Shah of Persia and King Gustaf Adolf

On the second day of his official visit to Stockholm the Shah of Persia, Mohamed Reza Pahlavi, was accompanied by King Gustaf Adolf on a visit to the Midsommarkransen plant

of L M Ericsson. After a view of the Exhibition Room, in which both monarchs took a great interest, there followed a tour of some of the workshops.

Mr. Sven T Åberg acted as guide to the royal visitors. Above he is demonstrating to the Shah some of the finesses of the long-life tubes. (Below) On tour through the factory. The two monarchs, followed by their suites, on their way through one of the workshops.



(Right) The signing of the contract in Medellín. From left to right: Dr. Mesa, Technical Director, and Dr. Luis Echavarría, President of Medellín Municipal Works, Dr. Cipriano Restrepo Jaramillo, Mr. Olaf Gustafson, head of *Compañía Ericsson Ltda.*, Bogotá.



(Below) Signing of the contract in Bogotá by Dr. Luis Eduardo Páez del Río, President of *Empresa de Teléfonos de Bogotá*, Dr. Baudilio Bernal Guzmán, Legal Adviser to the Bogotá Municipality, and Mr. Olaf Gustafson.



## Thailand – New Ericsson Market

An order has come in from Thailand for the delivery and installation of an automatic telephone exchange for 10,000 subscribers in the Krung Kasem district of the capital, Bangkok. The exchange will operate on L M Ericsson's crossbar system and is expected to be cut over early in 1963. The contract is worth 5 million kronor.

Obtained in competition with the majority of the world's leading telephone manufacturers, this contract means that L M Ericsson has gained an entry into a market that has previously been reserved to other firms. There is reason to expect that it may lead to important future deliveries.

After this extension to its telephone plant, Bangkok will have some 50,000 dial lines.

## LM Ericsson Extends Telephone Networks of Colombia's Two Largest Cities

L M Ericsson has signed contracts for delivery to Colombia of telephone equipment for 46,000 lines. The telephone exchange capacity of the capital, Bogotá, and of Medellín, the two largest cities of Colombia, is to be increased by 23,000 lines each.

The value of the contract is some 30 million kronor.

The rapidly growing city of Bogotá, which has more than trebled its population in the past 20 years up to the million level, is in urgent need of additional telephone equipment. L M Ericsson's first contract for automation of the Bogotá telephone system was signed in 1946, covering 40,000 lines. Since then the exchange capacity has been successively increased under new contracts to 123,000 lines.

The new deliveries to Medellín will bring up the telephone capacity of the

latter city, Colombia's most important industrial centre with a population of 1/2 million, to 81,000 lines. The 23,000 lines contracted for include 15,000 lines of L M Ericsson's crossbar system, the first delivery of crossbar to the Medellín area. The contract also includes 25,000 telephones, of which 5,000 Ericofons, L M Ericsson's new "all-in-one" telephone.

The first automatic exchange in Medellín was delivered by L M Ericsson and opened for service in 1940. All later extensions and new exchanges have likewise been delivered by L M Ericsson.

The equipment for Bogotá and Medellín is to be supplied from L M Ericsson's Swedish plants and installed by its Colombian associates, *Compañía Ericsson Limitada*.

(Below) Bundespostminister in the Federal Republic of Germany, Herr R Stücklen, on a visit to L M Ericsson in Stockholm. (Right) Mr. Hugo Lindberg, LME.



## 4:th Maintenance Conference

An internordic conference for maintenance of telephone equipment at local and trunk exchanges was arranged by L M Ericsson in Stockholm at the end of May. As in previous years, the aim of the conference was to discuss the most rational methods of maintenance in order to be able to provide subscribers with the best possible service at the lowest possible price.

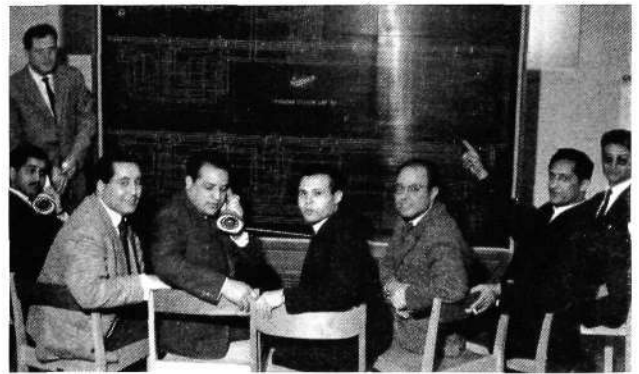
The conference lasted for five days. Denmark sent 10 representatives, Finland 7, Iceland 2, Norway 3 and Sweden 3. Including members of the Ericsson staff the conference was attended by 39 persons. The programme included 27 papers, and a survey was presented of L M Ericsson's production.



Five valuable addresses were read by members of the Swedish Telecommunications Administration, and one entire day was devoted to

extremely well organized demonstrations of the Stockholm Trunk Exchange and of radio and radar equipment at Arlanda Airport.

(Below) A dance troupe from Wankie, South Rhodesia, on a visit in May to the Central African Trade Fair at Bulawayo, where the Ericofon aroused keen interest.



Seven Tunisian technicians, the first of a contingent of 27, have been studying crossbar switching techniques at L M Ericsson in Stockholm. Sitting, from left to right: Rachid Ben Bader, Hedi Hamsa, Mohamed Chamekh, Abd el Kader Ben Hadj Slama, Mohamed Kamel Louahchi, Abdallah Ben Said, Tajib Chatti. The object of these visits is to create an organization for maintaining the automatic telephone systems which are being built by L M Ericsson in Tunisia.

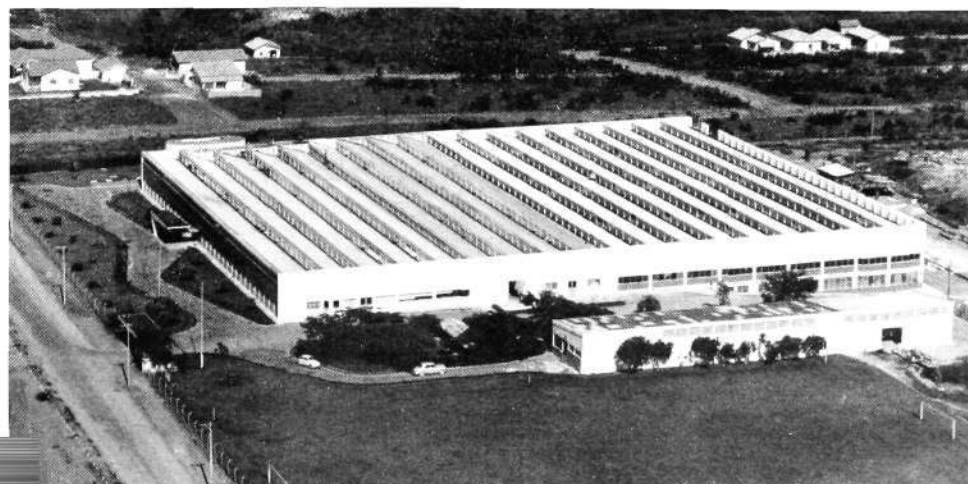
## ERICSSON TELEPHONE SALES OF CANADA LIM



Two former fellow students from the Stockholm Institute of Technology recently met at the Suppliers' Exhibition of the Pulp & Paper Convention in Montreal: Eric Carnell, head of Ericsson Telephone Sales of Canada Ltd. (left), and Hans W. Giertz, Professor of Timber

Research at the Norwegian Institute of Technology. The professor is the grandson of Lars Magnus Ericsson.

(Below) An aerial photo of L M Ericsson's factory at São José dos Campos, Brazil, which has recently been extended.



# Opening of Lisbon Underground Railway

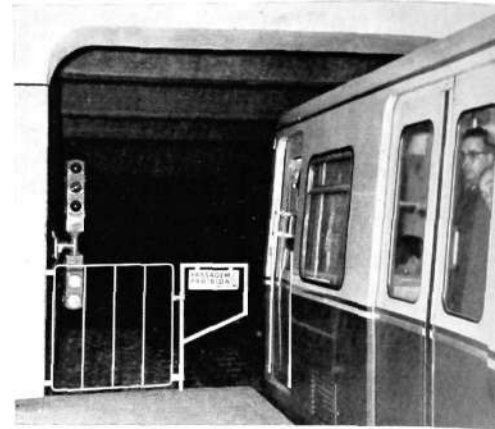
The Lisbon Metro was inaugurated at the end of last year in the presence of the President of Portugal, Admiral Américo Tomaz, and the Minister of Communications, Carlos Ribeiro.

The Metro is Lisbon's first underground railway, running through the centre of the town between Sete Rios—Rotunda—Restauradores and Entre Campos—Rotunda—Restauradores. It thus has two branch lines, which unite on the section between Rotunda and Restauradores. The line is double-track with a total length of 4 miles. The signalling system, consisting of electric interlocking plants at four stations and blocks between the sta-

tions, was supplied by L M Ericsson. Each main signal is provided with a mechanical train stop, the arm normally being up (Stop) and being lowered when the associated signal is switched to Go. If a train passes a Stop signal, a mechanism on the train is actuated by the raised train stop arm and the emergency brakes are applied.

The signalling plant incorporates equipment for automatic establishment of train routes to different schedules at Rotunda.

It is planned that the Lisbon Metro shall in due course be extended to a total length of line of about 25 miles.



(Left) A photograph from the inauguration of the Lisbon Underground. From left to right in foreground: França Borges, Chairman of City Council, Carlos Ribeiro, Minister of Communications, Admiral Américo Tomaz, President of the Republic, Cardinal Manuel Cerejeira, Coelho da Cunha, member of the board of Lisbon Metro, and Francisco de Mello e Castro, Director General of the Metro.

(Above) Underground train at exit signal



## North Electric Expands

North Electric Company (NEC), one of Ericsson's American subsidiaries with an annual turnover of more than 100 million kronor, has acquired 90 per cent of the shares in Power Equipment Company (PECO) with turnover of above 50 million kronor and a production range complementary to that of NEC. PECO is to be organized as a division of NEC. In conjunction with this transaction NEC's share capital is to be increased by about 35 million kronor. PECO is situated in the same town as NEC (Galion, Ohio), which will simplify the reorganization of joint operations. Research and development can also be concentrated to NEC's newly built central laboratories at Galion. NEC at present employs some 1,700 persons and PECO 800.

With his sympathetic nature and considerable technical ability M. Cauderay won a large number of friends both in Stockholm and elsewhere.

M. André Duprez, who joined the company as *Directeur général* in 1952, has been appointed M. Cauderay's successor. M. Duprez was earlier at the French P.T.T.

## Retirement of Henry Cauderay

M. Henry Cauderay has retired at the age of 65 years from the position of chairman of the board and head of Ericsson's French subsidiary company, Société des Téléphones Ericsson, Colombes. He joined the company as technical director in 1923. In 1944 he was elected to the board, first as vice-chairman and since Jan. 9, 1957, as chairman. On his retirement he was appointed honorary chairman of the board.



M. Cauderay has made important personal contributions within all branches of the company's activities, both on the design side—he himself designed and patented various telephone apparatus—and on the sales side, especially through his contacts with the P.T.T. He had an active part in the introduction of L M Ericsson crossbar systems in France.

In May 1942 large parts of the Colombes factory were destroyed by ten 500-kg bombs. Through great personal sacrifice and energy M. Cauderay was successful in getting the factory rebuilt within a short time.

UDC 621.395.347  
621.395.344  
LME 8344

**BAGER, R:** *Crossbar Systems ARM 201 and ARM 503 for Transit Exchanges.* Ericsson Rev. 37(1960): 2, pp. 34—50.

L M Ericsson's standard production of crossbar exchange systems comprises equipments for the automatic switching of traffic between the exchanges within a zone or between different zones or regions. Equipments of this kind are called transit exchanges and L M Ericsson has designed two such systems for the export market, *ARM 201* and *ARM 503*, which are described in this article.

UDC 621.394.44  
LME 813

**RODHE, S & VALZ, S:** *L M Ericsson's Transistorized Voice Frequency Telegraph Systems — Amplitude Modulated, Type ZAT 24 A; Frequency Modulated, Type ZAT 24 F.* Ericsson Rev. 37(1960): 2, pp. 51—60.

Development of v.f.t. systems at L M Ericsson dates back to 1928 with a system for traffic between telegraph and radio stations. A long line of equipment has since followed to meet various traffic needs. The first f.m. system in Europe was designed by L M Ericsson in 1946. Latterly development has been primarily concentrated on systems for teleprinters. The latest design is a transistorized 24-channel system in which either a.m. or f.m. can be selected by replacement of certain channel units in the equipment.

UDC 621.395.24  
LME 8376

**EKSTRÖM, H & SÖDERBAUM, C G:** *Loudspeaking Intercom Telephone with Transistor Amplifier.* Ericsson Rev. 37(1960): 2, pp. 61—64.

Telefonaktiebolaget L M Ericsson has manufactured loudspeaking intercom telephone systems for many years and has recently brought out a battery-driven system with transistor amplifiers. The use of transistors and printed circuits has made it possible to design an amplifier that can be fitted into the telephone instrument itself. This saves the cost of the previously separate amplifier. A brief description of the design of the new system and its facilities.

# The Ericsson Group

Associated and co-operating enterprises

## • EUROPE •

### Denmark

L M Ericsson A/S København F, Finsens Vej 78, tel: Fa 6869, tgm: ericsson

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

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

### Finland

O/Y L M Ericsson A/B Helsinki, Fabianinkatu 6, tel: A8282, tgm: ericssons

### France

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

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

### Germany

Ericsson Verkaufsgesellschaft m. b. H. Düsseldorf 1, Worringer Strasse 109, tel: 84 461, tgm: ericrel

### 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 hoib

### Italy

Setemer, Soc. per Az. Roma, Via G. Paisiello 43, Tel: 868.854, 868.855, tgm: setemer

SIELTE, Soc. per Az. — Società Impianti Elettrici e Telefonici Sistema Ericsson Roma, C. P. 4024 Appio, tel: 780221, tgm: sielte

F. A. T. M. E. Soc. per Az. — Fabbrica Apparecchi Telefonici e Materiale Elettrico »Brevetti Ericsson» Roma, C. P. 4025 Appio, tel: 780021, tgm: fatme

### Netherlands

Ericsson Telefon-Maatschappij, N.V. Rijen (N. Br.), tel: 01692-555, tgm: ericrel

den Haag—Scheveningen, 10, Pa-lacestraat, tel: 55 55 00, tgm: ericrel-haag

### Norway

A/S Elektrisk Bureau Oslo NV, P.B. 5055, tel: 1285, tgm: 1285, tgm: elektriken

A/S Industrikontroll Oslo, Teater-gaten 12, tel: Centralbord 335085, tgm: indroll

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

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

### Portugal

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

### Spain

Cia Española Ericsson, S. A. Madrid-4, Conde de Xiquena 13, tel: 31 53 03, tgm: ericsson

### Sweden

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

AB Alpha Sundbyberg, tel: 28 26 00, tgm: aktiealpha-stockholm  
AB Ernex Solna, tel: 82 01 00, tgm: clock-stockholm  
AB Erni Bromma 11, tel: 26 26 00, tgm: ermibolag-stockholm  
AB Rifa Bromma 11, tel: 26 26 10, tgm: elrifa-stockholm  
AB Svenska Elektronör Stock-holm 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: 19 00 00, tgm: mexikan

Sievert's Kabelverk AB Sundbyberg, tel: 28 26 60, tgm: sievertslabrik-stockholm

Svenska Radioaktiebolaget Stock-holm 12, Alströmergatan 14, tel: 22 31 40, tgm: svenskradio

### Switzerland

Ericsson Telephone Sales Corp. AB, Stockholm, Zweigniederlassung Zürich Zürich, Postfach Zürich 32, tel: 32 51 84, tgm: telericsson

Sievert's Kabelverk AB Sundbyberg, tel: 28 26 60, tgm: sievertslabrik-stockholm

Svenska Radioaktiebolaget Stock-holm 12, Alströmergatan 14, tel: 22 31 40, tgm: svenskradio

### • ASIA •

### India

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Bombay, Manu Mansion, 16, Old Custom House, tel: 25 41 30, tgm: indicic

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

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

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Istanbul, Istanbul Bürosu, Liman Han, Kat 5, No. 75, Bahçekapi, tel: 228102, tgm: ellemist

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Corp. Sudamericana de Teléfonos y Telégrafos S. A. Buenos Aires, Belgrano 694, tel: 332071, tgm: cartefe

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

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

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

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

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

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Soc. Telefónica del Perú, S. A. Arequipa, Casilla de Correo 112, tgm: telefonica

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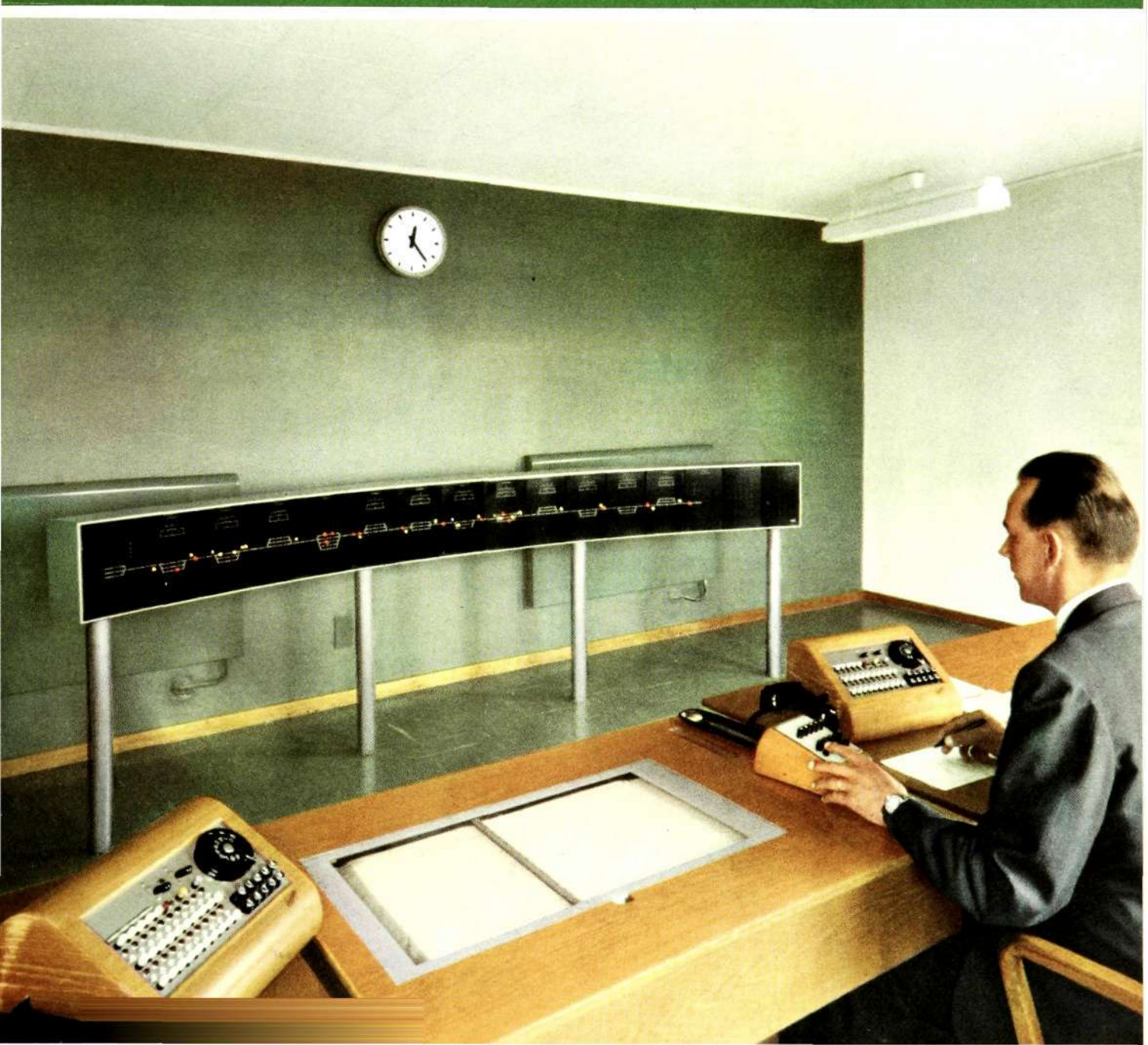
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# Review





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On cover: C. T. C. office at Kiruna, Sweden, with track diagram in background and (from left) train dispatcher's telephone for selective calling system, traingraph and C. T. C. keyset.

# The Development of Automatic Long Distance Traffic in Finland

V HAVERINEN, DIRECTOR OF POSTS AND TELEGRAPHS, HELSINKI

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*The Finnish telephone system is being rapidly converted to automatic operation, based chiefly on LM Ericsson's automatic trunk exchange systems ARM 201 and ARM 503. The present article starts by describing the special conditions applying to the Finnish telephone service and the requirements imposed on full-automatic long distance traffic. There follows a survey of the development of automatic working and of the systems employed, and the article concludes with a few words on the experience of operation hitherto.*

## Introduction

Telephone conditions in Finland are of a special nature and differ to some extent from those in other European countries. There are in Finland some 200 private telephone corporations, together operating some 1,600 exchanges. Under government ownership, that is under the P.T.T., there are about 1,300 local exchanges. The P.T.T. also has charge of practically all long distance traffic in the country. The private companies hold concessions from the government for operation during a specific period and under specific conditions.

When we started to plan for the automatization of the national telephone service on a wider scale, including the long distance network, we soon realized that general engineering standards must first be drawn up which would be applicable equally to the private and to the government operated areas. This was necessary because there was no single planning and executive body responsible for the entire telephone service of the country. A committee, comprising representatives from private and public administrations, was appointed in 1938 to draw up the necessary standards. Owing to the war and the problems arising out of it, the committee's work was not completed until 1952. The standards came into force in 1954.



Fig. 1  
The Post Office in Helsinki

X 8217

Apart from providing the guiding lines to be followed by the telephone operating companies, the standards had a decisive influence on the development of the automatic trunk network. For not only did they set forth the main principles for the distribution of losses in the network, but they provided for the division of the country into zones and districts (fig. 2), each zone having its own prefix. Compulsory criteria for inter-zone traffic are stipulated in broad outline. These criteria are absolutely necessary since the network as a whole is made up of the most varying telephone systems developed and supplied by different firms.

## The Automatic Trunk Network

The construction of the automatic trunk network may be said to have started in 1953, since it was in that year that the coaxial cable began to be laid between Helsinki and Tampere (117 miles, 6 tubes plus 13 carrier quads). The cable was completed in 1954. In the same year the Hämeenlinna–Lahti cable was constructed (42 miles, 4 tubes plus 5 carrier quads). The present coaxial cable network is shown in fig. 2, though only the Helsinki–Hyvinkää–Hämeenlinna–Tampere–Lahti sections are at present in service. The plans for the immediate future are to extend the line to Seinäjoki–Waasa, from Kouvola via Mikkeli and Varkaus to Kuopio, and to Kouvola–Lappeenranta. These latter projects have been started this year. The frequency range in use is 60–4028 kc/s. Within this range 960 circuits can be incorporated per tube pair with channel spacing of 4 kc/s. The intermediate repeater spacing is about 6 miles.

Finland has the extraordinary advantage of being able to build its trunk network from the foundation, based on uniform plans and without a lot of old ballast to carry.

Before 1953 there were a large number of 1–12 channel carrier systems for open wire lines, which will in future be used in the manual trunk network. Of the old circuits only the carrier circuits on the Helsinki–Turku–Mariehamn cable will in future be linked to the automatic international circuits via Stockholm, for which the two-frequency code within the v.f. band as recommended by C.C.I.T.T. will be used.

Apart from the coaxial cable circuits and the new 12-channel open wire circuits matched to the long distance system with outband signalling in both directions, radio links have already been acquired for the automatic trunk network. One between Mäntsälä and Hyvinkää is already in operation and one is on order for the Tampere–Pori section. The former is designed for max. 24 and the latter for max. 600 circuits.













## Main Requirements for Full Automatization of Trunk Traffic

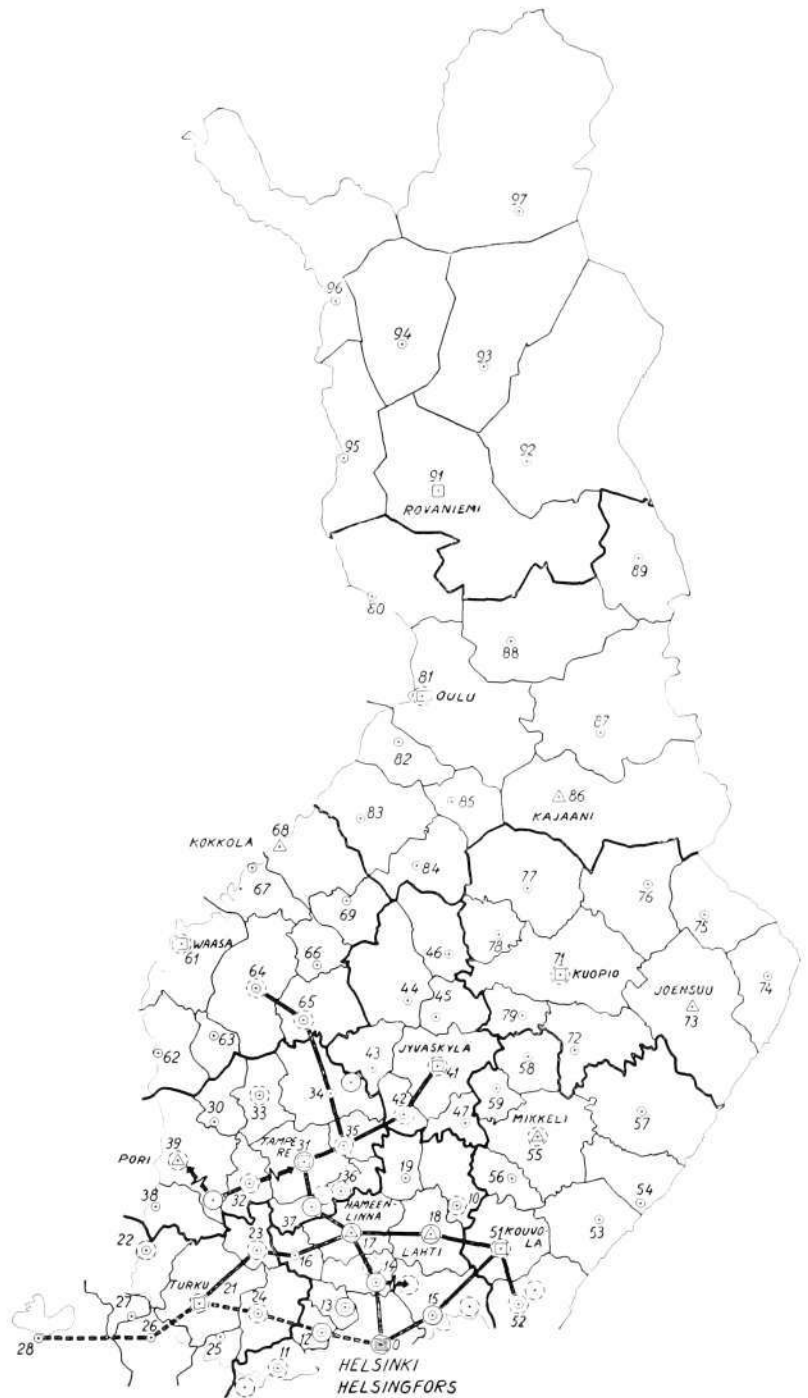
- A. A transit call shall always be connected between two trunk circuits on a four-wire basis. The lines shall therefore always be brought in to the switching stage on four wires. For this purpose metallic two-wire circuits, where existent, will be equipped with terminal repeaters.
- B. Trunk calls in the network situated between the regional centres (or between primary and secondary district centres) shall always be switched by means of trunk registers, signalling between these registers being with a 2-out-of-6 frequency code. The general arrangement of the registers is that the first register for code sending is connected to the circuit until the complete number has been sent through the entire trunk circuit. For setting up the connection the first trunk register sends the routing number by v.f. code one or more times. The intermediate registers at the transit points send no digits to a subsequent transit point. The originating

Fig. 2

Map of Finland

X 8218  
X 9150

-  Radio link
-  Carrier cable
-  Coaxial cable
-  Automatic trunk exchange, installed
-  » » » on order
-  Regional centre
-  Primary district centre
-  Secondary district centre
-  Zone centre
-  81 Zone prefix
-  Zone boundary
-  District boundary



register sends the subscriber's number only when connection has been made with the last v.f. code register and the latter has sent back the "terminal proceed-to-send signal". The originating register does not start to send numerical information until the subscriber has dialled the zone prefix plus two subsequent digits. If in the setting up of a trunk connection a point is reached at which there is no free path forwards, the trunk circuit is automatically cleared and the subscriber (operator) receives busy tone.

Since decadic impulsing is sometimes employed between the regional centre and the terminal trunk exchange, it must be noted that the trunk register must be able to repeat subscribers' numbers decadically as on terminating calls to decadic local areas. The main reasons for selecting

a system in which the traffic is controlled by the originating register were as follows. Quicker connection, since repetition at transit points is eliminated: in view of the form of the Finnish network simple facilities existed for preventing the establishment of a circuit forwards and backwards via the same points, since the controlling register can limit the number of tandem links from one case to another. Nor had Finland introduced the principle of limited trunk choice on single sections (without transiting), often with different methods of switching in different centres, as has been done in many other countries. For this reason it was not considered necessary to repeat the information at the transit points in order to simplify the interconnection of different sections.

- C. The switching equipment, registers and junction relay circuits shall be built for four-wire operation with bothway signal channels outside the v.f. band in accordance with the general specifications. In the design of the equipment the eventuality has also been taken into account that in exceptional cases the signal channels may lie within the v.f. band. In addition, a.c. circuits with one signal channel may be used. In such case the necessary matching relay sets are placed between the trunk relay set and the trunk exchange.
- D. The exchanges have been so planned as to offer three alternative choices in addition to the first choice route. If the traffic so requires, the first choice route can terminate directly in the zone centre (the local exchange in the zone centre).
- E. Since trunk connections are established over as many as four code routes, the equipment should incorporate arrangements for preventing the connection from being passed forwards and backwards on the same group of circuits. For this purpose the controlling registers have been designed so that the permissible number of trunk circuits in series is determined both by the routing code and by the direction.
- F. The trunk level is reached by dialling 9. This digit is always dialled before the routing code. Digit 9 is not transmitted on the trunk circuit, nor is new dial tone returned after this initial digit.
- G. During the period of transition from manual to fully automatic trunk traffic, most automatic trunk exchanges will have manual positions for junction routes on which there are so few circuits that direct termination on the automatic equipment would be unsatisfactory. Matching relay sets are placed between these manual positions and the automatic equipment. Connections from the manual board to the automatic trunk circuits are always set up through a register. In accordance with the specifications the trunk operator should be able to enter a connection, whether trunk or local, in parallel in order to offer manual assistance. For this purpose a special register signal (operator's signal) is sent on the circuit. The operators' positions should be usable as special positions, e.g. for reception of demand calls (09), and as trunk assistance positions, e.g. 020 for trunk directory enquiries. In such case this service can be centralized to a few exchanges, e.g. the district centres. The exchange equipments are designed to allow the transmission of these numbers, without dialling the trunk prefix, at the ordinary local rate. In the duty trunk centre such calls are sent direct to the proper positions over normal trunk circuits without passing through the selector stages in the local exchange.
- H. The connection of a trunk call to a zone circuit is effected in the zone centre, either on four or two wires. Whether it is forwarded on four or

two wires from the trunk to the zone level is determined by the two digits following the zone code.

- I. Fee determination always takes place at the originating trunk exchange on the basis of the zone number plus, at most, the two following digits. The metering impulses are sent to the subscriber's meter as long as the conversation lasts from a charging unit common to the exchange, the first impulse occurring at random after the call is answered. Accordingly the transmission of the first impulse does not generally coincide in time with the answering signal. The called subscriber's clearing signal does not directly affect the metering, but starts the time supervision for forced release. Metering impulses are not transmitted on the trunk circuits (this applies to national calls).
- K. The specifications relating to transmission level and signalling will be seen from figs. 8 and 9.
- L. Signalling is by discontinuous signals. The use of continuous signal currents was investigated. But it was found that the signal schedule specified by the Finnish standards allowed no possibility of simplifying the junction relay sets, rather the contrary.

## Present Extent of Trunk Automatization

Up to date 35 automatic trunk exchanges have been ordered, of which 10 are regional and district centres and the remainder terminal trunk exchanges. L M Ericsson is supplying the 10 regional and district centres and 21 of the remaining equipments and is therefore main contractor for the automatic trunk equipment at the present stage. The first automatic trunk exchanges, Tampere and Toijala, were cut over in February 1958, followed by Lahti and Hämeenlinna in July 1959. Since that time the traffic between these four places has been automatic. As from November 22, 1959, the capital, Helsinki, with surroundings was linked to this network, and likewise the Hyvinkää, Lojo, Vihti and Karis areas. Other exchanges are at present being installed, and probably the majority of the exchanges on order will be in service within the next two years. Additional contracts are to be placed in the near future, so that the conversion to automatic operation will proceed at a fairly rapid rate. Exchanges installed and on order are shown in fig. 2.

Ten of the exchanges are, with slight modifications, L M Ericsson's type *ARM 201*, which was described in Ericsson Review No. 2, 1960. The selector grouping etc. of the Helsinki trunk exchange is shown in fig. 3. The initial capacities of the regional centres will be: Helsinki 1,370 trunk circuits, Tampere 550, and the remaining eight centres 200–250 trunk circuits each.

At exchanges such as Tampere, where the local exchange is based on L M Ericsson's 500-line selector system (AGF), the registers in the trunk exchange are designed to control the connection through to the local subscriber without calling upon the local exchange registers.

The regional centre registers are of three types.

*REG-Y* receives code signals from the trunk circuits and sends numerical information to the local exchange and zone stage. It can also convert into decadic impulses the code signals it receives from the trunk circuit for transiting from a v.f. code to a decadic trunk circuit.

*REG-O* receives decadic impulses both from trunk circuits and from the operators at the automatic trunk exchange. On terminating traffic the numerical information is transmitted both to the local exchange and to the zone stage. On transit calls *REG-O* sends the received impulses either in code form or decadically to another trunk circuit.

*REG-H* receives numerical information from local and zone exchanges and forwards it either in code form or decadically to trunk circuits.

Most of the terminal trunk exchanges are of L M Ericsson type *ARM 503*. The trunking diagram for one such exchange is shown in fig. 11, this being a terminal trunk exchange in a zone which is fully mechanized on the step-by-step system. This exchange, like all other trunk exchanges of the *ARM 503* system, is linked to the adjacent district centre by code trunk circuits.

All terminal trunk exchanges of system *ARM 503* will have an initial capacity of some 50–70 trunk circuits, but can of course be extended.

The first two digits after the routing code determine whether the connection is to be forwarded to the zone level on two or four wires. The junction relay sets up to zone level are always matched to the existing system in the zone area. The trunk relay sets, on the other hand, are standardized for L M Ericsson type code signalling for the entire country and are therefore interchangeable.

The registers at the terminal trunk exchanges are universal in their function. They are built both for incoming and outgoing traffic and incorporate the following facilities:

- a) Code (trunk circuit) → decadic (zone and decadic trunk circuit).
- b) Decadic (zone and decadic trunk circuit) → code (trunk circuit).
- c) Decadic (trunk circuit) → decadic (trunk circuit).

The function of the register is determined in each case by the original signal it receives from the junction relay set.

Although the terminal trunk centres, as the name indicates, are actually intended for traffic between the home zone and the trunk level, they can also be used for the extension of traffic from one trunk circuit to another. Such cases will presumably be limited to calls between two adjacent zones. If required, certain local service numbers, such as record and enquiry services, can be centralized at night-time or permanently to the district centre, the service point being informed by a telephone answering machine of the origin of the call.

## Semi-Automatic International Traffic

Equipment for automatic international traffic will be connected to the automatic trunk exchange at Helsinki. This international trunk equipment will be installed in 1962. Initially the exchange will operate on a semi-automatic basis, but its design is such that it can be converted to fully automatic operation through some slight addition of equipment. Traffic from this exchange will initially be to countries in the west, being directed automatically via corresponding exchanges in Stockholm or Copenhagen to the country of destination. The junction relay sets and signalling equipment are designed to C.C.I.T.T.'s recommendations (Vol. V, Livre vert). These recommendations state that the exchange equipment should be designed so that the outgoing operator under conditions of semi-automatic operation can control the connection up to the wanted subscriber. The equipment should naturally enable the operator, when necessary, to summon the assistance of a specific language operator in the country of destination, both during the setting up of the call and during

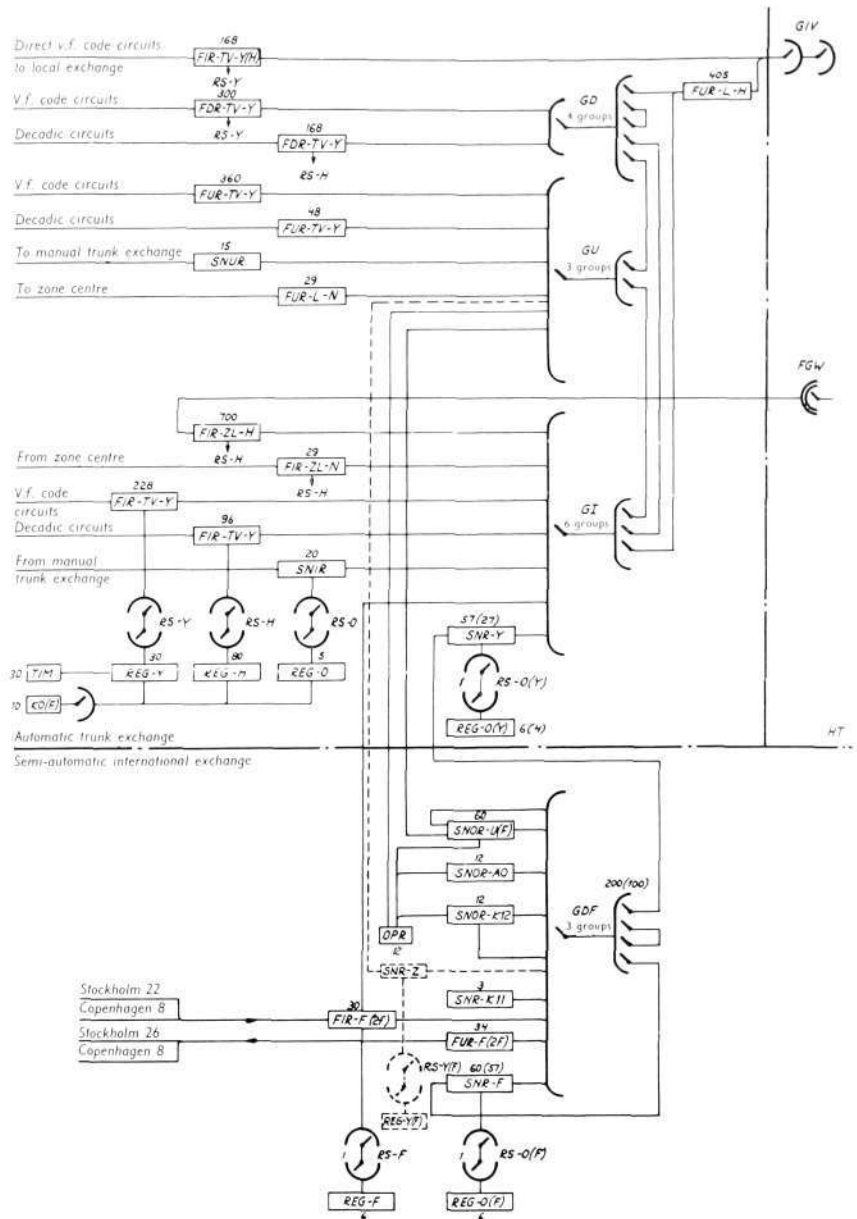


Fig. 3 X 8244  
Trunking scheme for Helsinki trunk and international exchange

conversation. This is necessary particularly when a call cannot be put through automatically to the called subscriber. An assistance operator is called, either during the setting up of the call or during conversation, by a special code. The trunking scheme in fig. 3 shows the Helsinki trunk exchange (for automatic national traffic) and the semi-automatic international exchange equipment. The national equipment, which is essentially L M Ericsson's system *ARM 201*, terminates on the selector stages (*GIV* and *FGW*) of the Centrum exchange operated by the Helsinki Telephone Company. The international exchange, also of system *ARM 201*, will have three two-way selector stages *GDF*. It will operate on the same principles as the national exchange, but with 10-pole through connection. The operators' position equipments *OPR* and switching equipments *SNOR* are placed in separate racks. Each operator's position has five *SNOR-U(F)* which are used both for incoming and outgoing calls. Outgoing calls can either be put through direct or the operator can ring back when the call is established. The waiting point, *SNR-K 11*, arranges that incoming calls are connected to a free operator in order of arrival.

Signalling on the international circuit is on the two-frequency principle recommended by C.C.I.T.T. The *FUR-F(2F)* relay sets for outgoing traffic

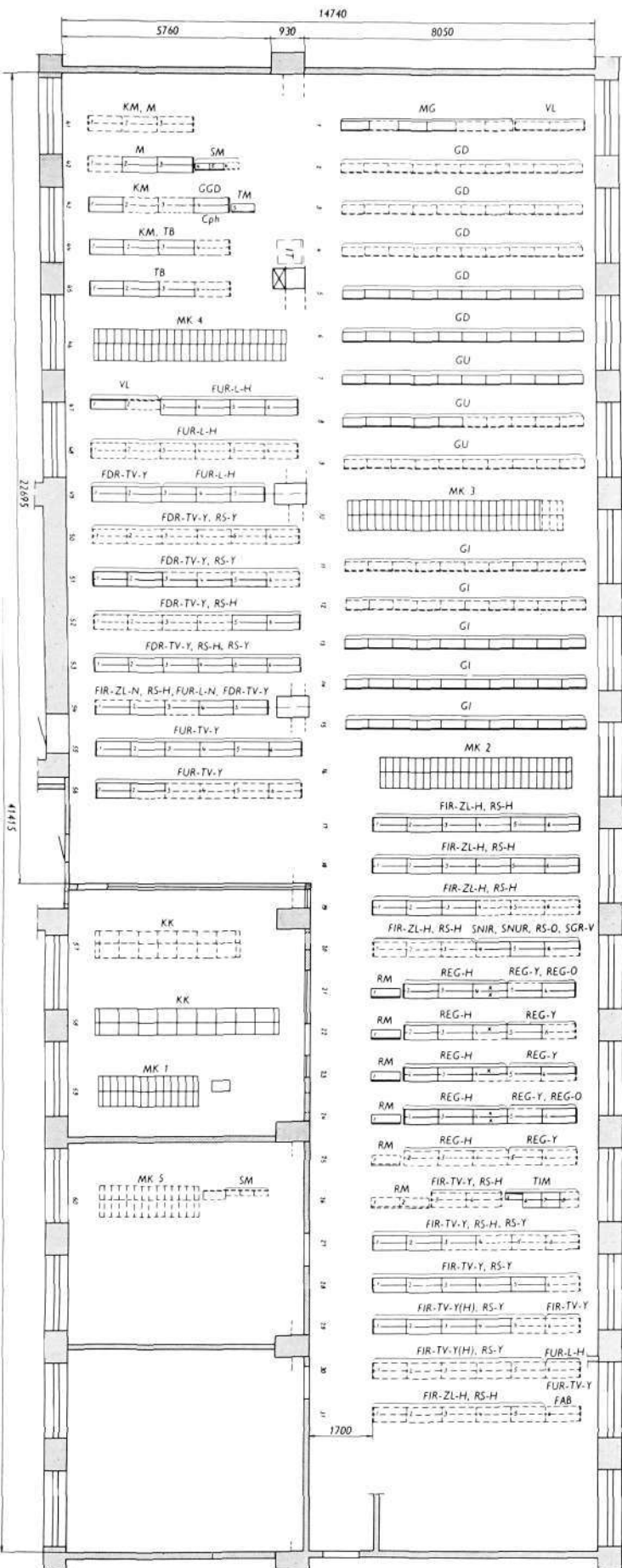


Fig. 4  
Floor plan for Helsinki trunk exchange

X 7791

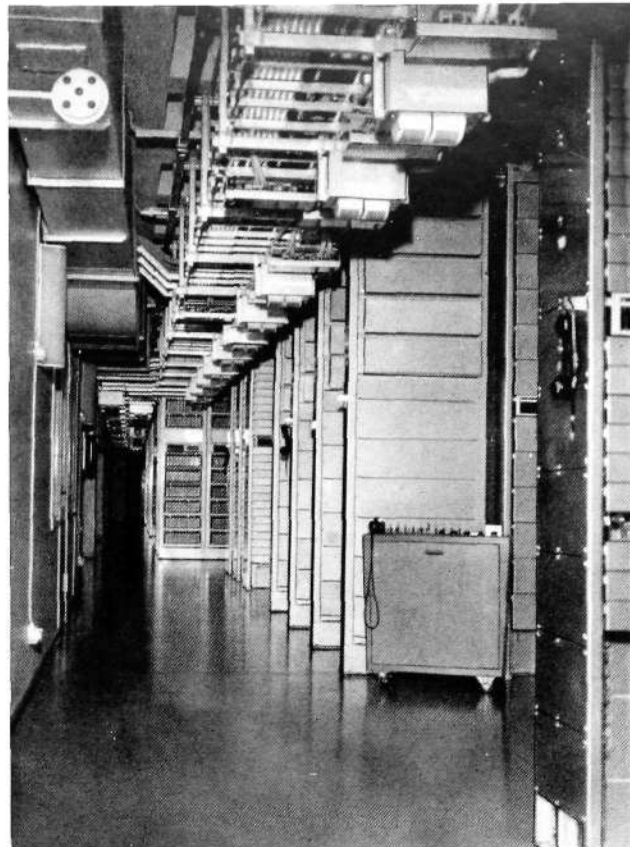


Fig. 5  
Interior from Helsinki trunk exchange

X 8223



Fig. 6  
Interior from Tampere trunk exchange

X 8224

terminate on the selector stage *GDF*, *FIR-F(2F)* for incoming traffic are connected both to *GDF* and *GI* stages in the automatic trunk exchange. Thus an incoming international call which can be extended automatically to the national network does not pass through a selector stage in the international exchange unless assistance in setting up the connection is required from the originating operator.

The *REG-F* register group serves the incoming traffic. An incoming international call which is handled by a Helsinki international operator is connected to the national network via relay set *SNR-Y* to which *REG-O(Y)* is connected. This register can receive numerical information from the international operators.

Number 99025 will be used in Finland for semi-automatic international traffic. The first three digits, 990, may be regarded as prefix for the international level; 25 is Finland's international code as stipulated by C. C. I. F. and may well be used also as suffix for outgoing semi-automatic international traffic.

### Full Automatic International Traffic

The possibility of subscriber dialling of international calls from automatic areas connected to the automatic trunk network has been carefully investigated. The following problems must first be solved. Two primary considerations are the possibility of adapting the existing zone centres to this form of traffic and the degree to which the registers allow a sufficiently comprehensive handling of numerical information. Outgoing international calls from Finland require 15 digits, 3 as prefix for the international level, 2 for the country of destination code, and 10 for the national number in the country of destination.

Most of the older zone centres are built on the decadic switching principle, so that there is no difficulty in these exchanges. Older types of register system are all of L. M. Ericsson design, and an adequate numbering capacity can be arranged at these exchanges at a very reasonable cost. At all new exchanges, on the other hand, these problems are catered for in the design of the equipment. Their registers are usually made for cyclic storage. As far as the zones are concerned, no metering problem is encountered since it has been decided in Finland that metering shall be arranged from the trunk exchanges.

In considering the numbering capacity required for the trunk registers, it must be remembered that the trunk register does not start to send to the trunk circuit until it has received the first four digits. Likewise a connection can be passed through four coded sections in tandem before it arrives at the international exchange in Helsinki. Nor can the speed at which subscribers dial be limited. Investigations based on time charts have shown that full numbering capacity should somehow be arranged in the outgoing trunk registers (figs. 3, 7 and 10).

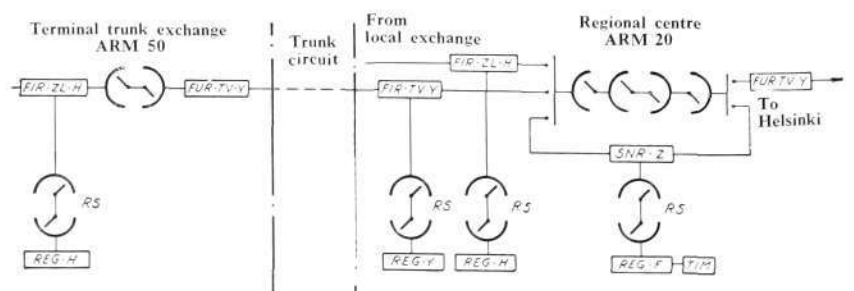
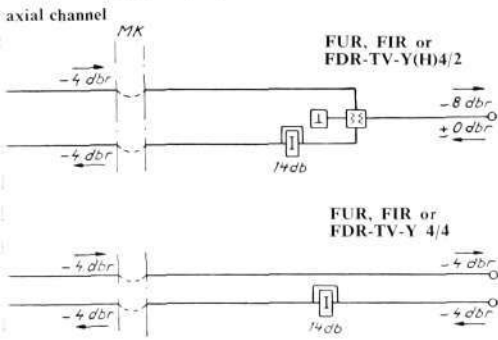


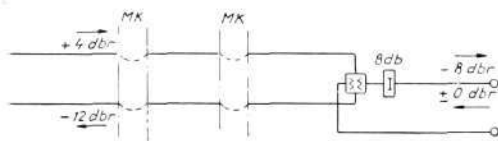
Fig. 7  
X 8220  
Auxiliary equipment in regional centre for fully automatic international traffic

Transmission levels for connection of coaxial channels. Connection to:

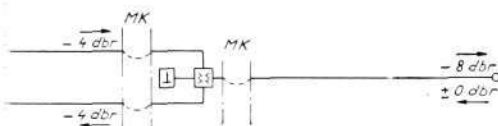
a) automatic trunk exchange FUR, FIR or FDR (Helsinki, Hyvinkää, Hämeenlinna, Tampere, Lahti, Toijola)



b) 4-wire repeater with hybrid transformer for manual exchange (Helsinki)



c) 2-wire repeater with hybrid transformer for manual exchange (Helsinki, Lahti, Jyväskylä, Valkeakoski, Tampere, Hämeenlinna, Hyvinkää)



X 2519  
X 2520  
X 2521

Fig. 8  
Hypsogram

In accordance with these trunking diagrams an international call is completed as follows.

From Helsinki zone the trunk register *REG-H* (fig. 3) sets up the connection to relay set *SNR-Z* in the international centre. The international register *REG-Y(F)* is seized and sends a terminal proceed-to-send signal to *REG-H*, which can thus release its verticals 1 and 2 since the stored digits are not required after the terminal proceed-to-send signal. *REG-H* now sends the remaining digits by v. f. code to *REG-Y(F)*, after which verticals 3-10 are released and can receive new digits. Calls from zones connected to Helsinki by decadic circuits are set up in the same way. *REG-Y* switches the connection on code circuits to *REG-Y(F)*, which thereafter receives direct digital information from the code register at the outgoing trunk exchange or at the first transit centre.

It is planned that fully automatic international calls shall, at present at least, be charged in the same way as national trunk calls, i.e. by means of metering impulses sent to the subscriber's meter during the duration of conversation. The *SNR-Z* relay set has therefore been equipped with rate relays which operate to specific traffic and connect metering impulses to the subscriber's meter. For reasons of economy it is not desired that relay sets for international metering shall be placed in the terminal trunk exchanges. It is therefore planned that metering impulses shall be sent from Helsinki to subscribers who are accessible via terminal trunk exchanges having direct connections with Helsinki. The impulses will be sent as repeated answer signals. Since they will be transmitted within the trunk exchange by mid-point signalling on balanced choke coils and on carrier circuits in special signal channels, there will be no disturbance of speech. If the call is from an operator, or if a transit connection arrives on a coded trunk circuit, no metering impulses are sent from the international centre. The sending of metering impulses is blocked by means of the "operator signal". This signal is also used to prevent the transmission of metering impulses when the rate has already been determined at a preceding point. The signal is here sent by *REG-Y*.

On grounds of cost it is the intention that the supplementary equipment for full automatic international traffic shall be placed in the regional centres and

Signal	Structure, direction and duration of signal in ms	Sent to	Sent from
Call signal	→ 150	FUR	FIR
Proceed-to-send signals:			
1) Transit	← 150 100 150	Tr. Reg.	Outg. Reg.
2) Terminal	← 150 100 150	Term. Reg.	Outg. Reg.
Digit transmission:	2 out of 6 frequencies in 10 digits/sec. Decadic impulsing 10 I.P.S.	Outg. Reg.	Tr. Reg.
End-of-selection signals:			
1) Free	← 600 150	Term. Reg.	Outg. Reg.
2) Busy	← 600 150	Term. Reg.	Outg. Reg.
Answer signal	← 150	FIR	FUR
Clear-back signal	← 600	FIR	FUR
Clear-forward signals:			
1) Clearing	→ 600 600	FUR	FIR
2) Release-guard	← 600 600	FIR	FUR
Operator signals:			
1) Offering	→ 150	FUR	FIR
2) Cancelling	→ 150	FUR	FIR
3) Re-ringing	→ 150	FUR	FIR

\*) Second impulse sent when ring key restored

c/s	No.	Value	1	2	3	4	5	6	7	8	9	0	12
540	1	0											
780	2	1	X										
1020	3	2		X									
1260	4	4			X								
1500	5	7				X							
1740	6	10					X						

12 - operator signal

Fig. 9  
Signalling schedule

X 8245

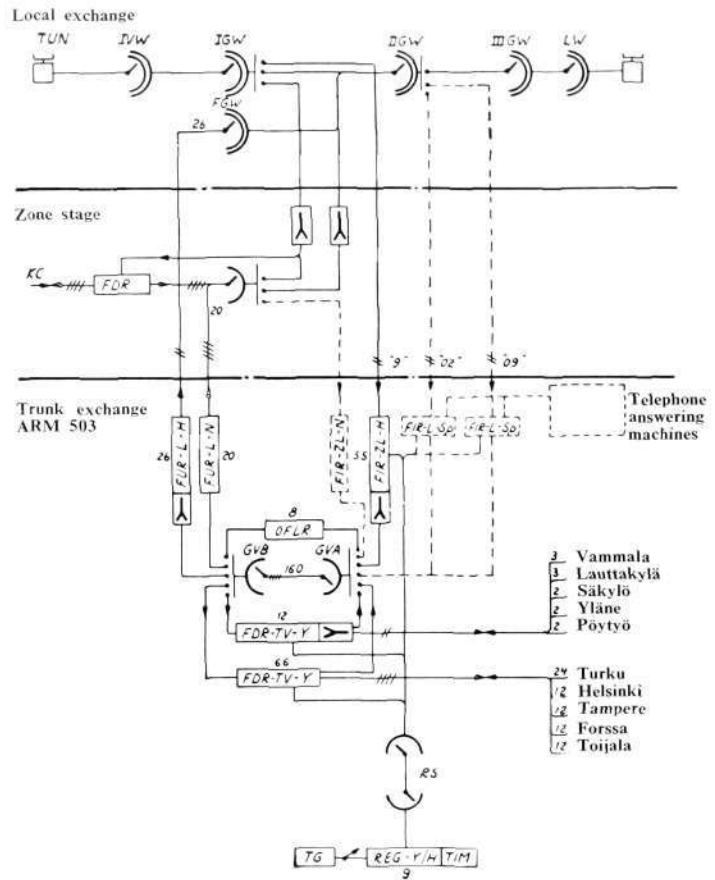


Fig. 10 X 8222  
Trunking scheme for the Loimaa terminal trunk exchange

not in the terminal trunk centres. This means that the metering of international calls from terminal trunk centres must be centralized at regional centres. Thus, if required, the national portion of the international charge can be calculated to at least zone accuracy. The supplementary equipment required for international traffic at regional centres is shown in fig. 7. As already mentioned, the total switching time to the international centre at Helsinki will generally be so long that outgoing registers must have full numbering capacity. For this purpose special registers *REG-F* are to be acquired for the regional centres, equipped with rate units and connected to the trunk stage by relay sets *SNR-Z*. The setting up of the connection is effected in the same way as for a call originated in Helsinki. In order that *REG-Y* may know whether the call comes from a terminal trunk or regional centre, it will receive an indication of origin from *FIR-TV-Y*. If the call is from a regional centre, *REG-Y* can forward the connection direct to an outgoing *FUR-TV-Y*, since the rate will already have been determined at a preceding regional centre.

The method of setting up full automatic international calls has been briefly described above. A small amount of additional equipment is required at the trunk exchanges, and minor modifications must be made to some registers at the local level. The intention is that modifications of a local exchange will be effected only when full international automatization has been decided for that exchange. The plans for this purpose are already prepared. In the event of general conversion to full automatic international traffic, the metering impulse rate, at present 5 marks, will be raised so that the interval between impulses is not so short as to cause interference with speech when the impulses pass the zone equipments. Investigations on this point have not yet been completed. At all events, even under present conditions it should be technically possible to arrange for full automatic traffic between Finland and its nearest neighbours.

## Recording of Charges

The question of metering of subscriber-dialled long distance calls is a difficult one. The method under the manual system was that subscribers received a bill on which each long distance call was specified. It has been difficult to depart from this principle since the administrations feared a counter-reaction on the part of subscribers. In various parts of the world mechanical methods have been developed in which the attempt has been made to retain the main principles of charging employed in manual telephony. The probably most complete of these methods is based on a stamping machine which marks on a tape the calling and called subscribers' numbers, the date and duration of the call, etc. If a machine of this kind is to be used, however, the local telephone system must be able automatically to identify the calling subscriber. Unfortunately most of the existing systems in Europe do not possess this capacity. The introduction of this facility in the systems now in operation would be so expensive that the Finnish telephone standards have not even counted on such an eventuality in the future.

A collective method of charging for telephone calls has therefore been decided on. The method is based on statistical summation of the charges. The subscriber's meter records the number of rate units which correspond to the sum of the charges with a given statistical accuracy. As the conversation proceeds, a rate impulsing unit common to the entire trunk exchange sends impulses to the subscriber's meter at a frequency corresponding to the rate. In networks owned by the P. T. T. the start of impulse transmission takes place at random, so that the first metering impulse need not coincide with the answer signal from the called subscriber.

It is obvious that statistical variations will cause errors in charging. In other words, the charge will differ to some extent from the telephone time actually used. With statistical time charging the error may either be positive or negative (overcharge or undercharge). This error quickly diminishes and approaches zero as the number of metering impulses increases, which can be proved mathematically. And as the price per metering impulse is set as low as technical and rate aspects allow, the accuracy of charging may be said to be completely satisfactory even for a short charging period. Actually, the earlier method employed on manual trunk calls, of charging per 3-minute period, was not altogether satisfactory for the subscriber since he had often to pay for unused time. As already mentioned, trunk calls are charged by the application to the calling subscriber's meter of impulses from the trunk exchange. The charge corresponds to the cost of the whole of the utilized circuit, including originating and terminating zone and trunk circuit. Since many of the zone exchanges and circuits in Finland are owned by private companies, the division of costs among them involves some problem.

The following arrangement was decided on. The P. T. T., which owns the entire long distance cable network and its exchanges, is credited on the basis of the metering impulses sent to the subscriber's meter in accordance with the long distance tariff from the rate impulsing units in the trunk exchanges. These impulses are totalled in summation meters and charged to the owner of the zone main exchange, who collects the P. T. T's and his own combined claims from the subscribers. The owner of the main exchange settles with any other telephone companies there may be within the zone. As regards the zone equipment, the costs are collected only on the originating side. This is effected by sending rate impulses to the subscriber's meter from the trunk exchange, corresponding to a mean rate for the zone. These impulses by-pass the summation meters in the trunk exchange, so that the zone owner gets his share in the form of these "compensation impulses". The zone share can also be charged by the originating zone centre itself sending rate impulses corresponding to the rates employed within the zone.

For subscriber-dialled international calls the intention is that the rate determining and impulsing equipment shall be placed in the first district centre through which the connection is set up.

Trunk rates are based on the following distances: 50 km, 100 km, 175 km, 300 km, 450 km and 650 km. The first distance, 50 km, applies both to the tie line trunk rate and to the first trunk rate proper. Thus there are altogether 8 national trunk rates. The geographical limits of the rate zones are generally drawn to within zone accuracy. In this connection it may be mentioned that since December 1, 1959, the P. T. T. has started to employ the method of random metering in its automatic zone areas. Within a zone there are only two rates, the group area rate and the zone area rate. Thus the group area rate is now used for local calls as well within the automatic areas of the P. T. T.

## Automatic Control and Supervision Equipment

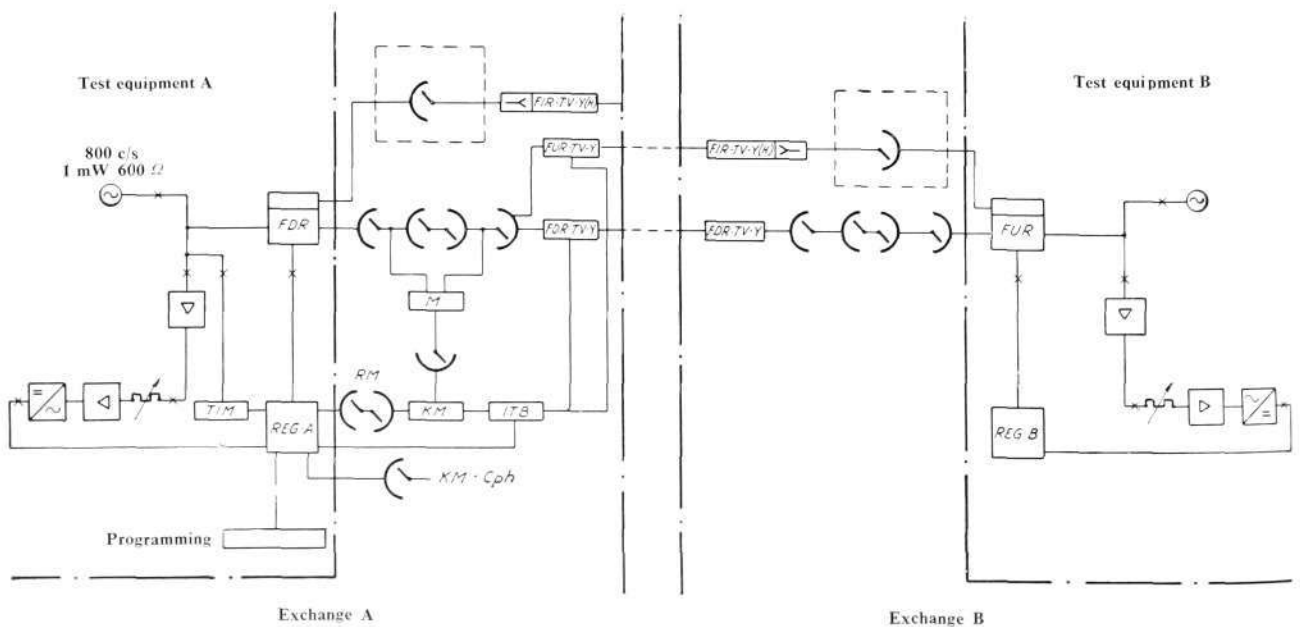
Apart from the usual test equipment considered indispensable for exchange operation, certain additional equipment has been thought to be necessary for supervision of the system. L M Ericsson, the present main contractor for the automatic trunk exchanges, has also contributed to the planning and development of this equipment.

The purpose of the equipments is to measure the composite attenuation at 800 c/s for all one-way and two-way trunk circuits connected to the exchange. If the attenuation is outside the permissible limits, the fact is recorded on a Centralograph. At the same time the length of all register and line signals is checked and any error is recorded on a Centralograph. The equipments can later be extended to include other functions such as coefficient of harmonic distortion and noise level after the presentation of C. C. I. T.'s recommendations in these respects. The equipments can also be used to investigate the traffic switching capacity of exchanges by the continuous setting up of connections on different routes and recording the number of cases of congestion in the various selector stages.

Fig. 11  
Block schematic of automatic line test equipment

X 7784

The principle of the equipment is shown in fig. 11, equipment *A* in the originating exchange (usually a district centre) and equipment *B* in the destination exchange (usually a terminal trunk centre). Equipment *A* is made up of the



following main components: *FDR* unit, register unit, programme unit and transmission tester. Exchange *A* is also equipped with an individual choice test block *ITB*. Every line connected to *ITB* has a number, so that *ITB* provides access to every line. Equipment *B* is connected to the selector stage as an ordinary outgoing junction relay set and has its own call number.

The various components have the following functions. The programmer is controlled by a programme in the form of a perforated paper tape. The register *REG-A* receives and stores the programme from the programmer and thereafter sets up the connection through the exchange to the trunk network. It also receives the information sent by v. f. code from *REG-B* on the receiver side and forwards it to the exchange Centralograph for storage. Relay sets *FDR* and *FUR* control the connections between the registers and selector stages. Provided that there are direct trunks from the trunk exchange past the trunk exchange at the other end to the local exchange, the necessary relay sets are incorporated in *FDR* and *FUR*. The tone generator sends 800-cycle test voltage at zero level for attenuation measurements.

For traffic observation the programmer sends the trunk prefix, the test number of the receiving end (automatic answering equipment) and particulars of the switching phase when the test is to be stopped. When this has been done, the test is repeated a predetermined number of times. The number of times congestion occurs can then be read off on the Centralograph.

It is thought that this method will facilitate maintenance work. The bulk of the routine tests can be done at night-time. These test equipments have been ordered for all trunk exchanges and are expected to be in operation by 1961.

## Power Equipment

In the trunk centres already in operation flywheel generators are used both for d. c. and a. c. These exchanges have no batteries. The standby units consist of diesels which start automatically on a failure in mains supply.

## Operating Experience

Subscriber-dialled trunk traffic between Lahti, Hämeenlinna, Toijala and Tampere has been in operation since July 1958.

The experience during this period has been positive. The operation of the exchange equipments is supervised by Centralographs and statistics meters. The records from these sources show that the fault rate for setting up connections has been about 2 per mille of the total calls handled. More accurate data will follow after extension of the network and growth in the number of transit connections. The statistics should also incorporate figures for Helsinki. A more detailed overall review of trunk circuits and exchanges will not be possible until the aforementioned automatic control devices have been installed.

# L M Ericsson's C.T.C. Makes Headway

I B O B E R G, L M E R I C S S O N S S I G N A L A K T I E B O L A G, S T O C K H O L M

UDC 656.259.12  
LME 86

*L M Ericsson's C.T.C. systems have been described in Ericsson Review Nos. 4, 1954 and 2, 1958. The traingraph used with the C.T.C. system was described in Ericsson Review No. 2, 1956. This article will present a summary account of the characteristic properties of L M Ericsson's C.T.C. systems, followed by brief descriptions of the major plants sold in recent years.*

L M Ericsson's C.T.C. is an electromechanical system made up of telecommunication relays of standard type. It is so rapid in operation that no cause has yet been found to change to an electronic system, which would at present be more expensive. The C.T.C. equipment can be connected to any type of relay interlocking plant. The control and indication devices can be designed to any railway requirements, and the C.T.C. plants delivered by L M Ericsson up to now show that these differ very considerably. L M Ericsson especially recommends its keyset system, however, which has achieved considerable successes.

## 1. Characteristic Features of L M Ericsson's C.T.C. System

### *Relay equipment*

The relays in the C.T.C. office and C.T.C. field stations are made up in relay sets of plug-in type, which have been standardized to the greatest possible extent. They have plexiglass covers (fig. 1) for assistance in fault tracing and maintenance.

Information between C.T.C. office and field stations is transmitted on a two-wire physical circuit in the form of groups of d.c. impulses. Four impulse groups of six impulses each are used for the control system. In each group one impulse is of reversed polarity and the last impulse is longer than the remainder. The impulses for the indication system are differentiated on similar principles. So effective is this method of impulsing that the probability of distortion causing a wrong control or indication is remarkably small. In fact, no such occurrence is known from practical operation. The system is therefore very reliable.

C.T.C. systems may be described in terms of different kinds of capacity. L M Ericsson's standard system comprises 36 controls and 49 indications per field station and can be wired for connection of 36 field stations. The total capacity is therefore  $36 \times 36 = 1,296$  controls and  $36 \times 49 = 1,764$  indications. This control and indication capacity, however, may be limited by the capacity of the transmission line. Only under conditions of light headway would it be possible to have 36 stations on one C.T.C. section. As a rule the number of indication transmissions per station is up to 10-20 per train passage. If, for example, 20 stations are connected to a C.T.C. section with 4 trains per peak traffic hour and 15 indication transmissions per train passage, the number of indication transmissions would be  $20 \times 4 \times 15 = 1,200$  per hour. On top of this come the control transmissions. If each transmission were to take 3 seconds, the line would obviously be fully loaded. In L M Ericsson's system, however, the impulse frequency is as high as 25 c/s and the transmission time per control or indication less than 2 seconds. In addition, the indication system is so wired that if a transmission is delayed on account of the circuit being engaged, and one or more changes of function occur during the delay

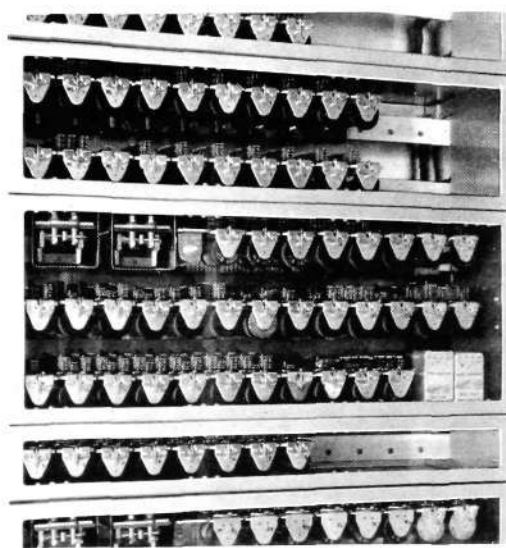


Fig. 1  
Plastic covers over relay sets facilitate maintenance.

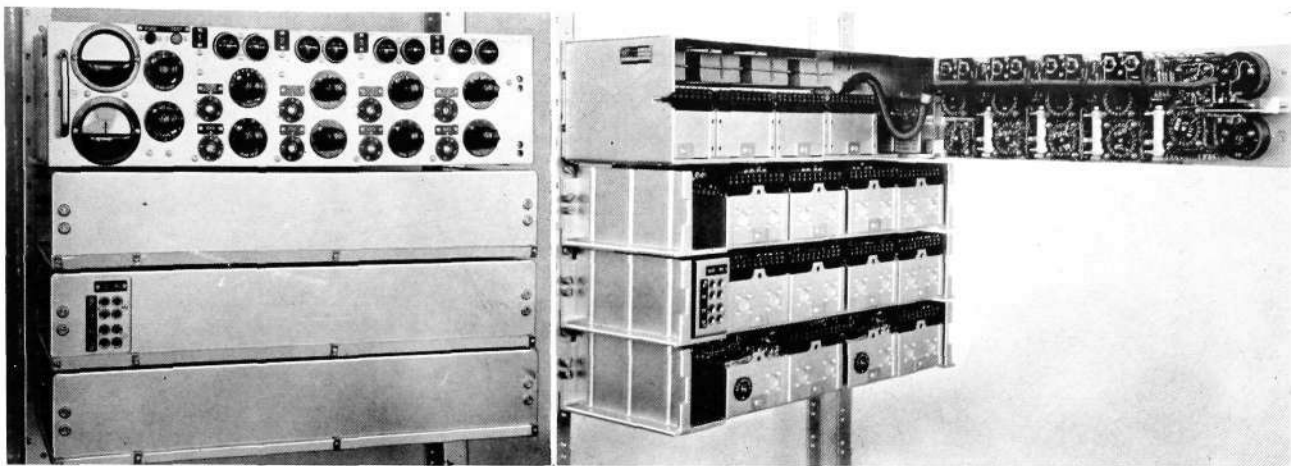


Fig. 2 X 7785  
V.f. terminal equipment for four telegraph channels

Two channels are required between the C.T.C. office and each C.T.C. section with the exception of the section nearest to the C.T.C. office.

period, all these indications are thereafter sent in a single transmission so that the time per indication is greatly reduced (49 indications are sent in 4 seconds). The problem of delay is nevertheless a factor to be taken into account, and the maximum delay time must be calculated for each individual plant. As a rule it should not exceed 15–20 seconds, but shorter delay times are to be preferred.

In order to increase the capacity of the C.T.C. system still further, L M Ericsson has introduced the principle of "partial indication". The personnel in the C.T.C. office do not generally require to know everything which takes place in the station signalling plants. Normally, therefore, it suffices to send only certain indications, "partial indication". Only in response to a special control from the C.T.C. operator is a "total indication" returned. This reduces the number of indication transmissions and permits a larger number of stations to be connected to the same circuit.

When a C.T.C. line is divided into sections, transmissions between field station and section boundary are by d.c. impulsing, but between section boundary and C.T.C. office on two telegraph channels. These channels can be placed in the v.f. band or in a carrier circuit or radio link (fig. 2).

A telephone exchange can accept a fault rate of 1 per 5,000–10,000 connections. A fault rate of this order would be impermissible in a C.T.C. system. In the example mentioned earlier, with 1,200 indication transmissions per hour, this would involve several disturbances every day, which cannot be tolerated in train operation. The reliability must be of a very much greater order, involving a fault rate of about one hundredth or one thousandth of the above figure. This has been successfully achieved.

#### *Different types of control and indication system*

In the oldest system the control and indication panels were combined into a single unit and equipped with lever keys or buttons for the transmission of individual controls to signals, points etc. The system has been in use since 1927 and is still being supplied by many firms, including L M Ericsson.

The control and indication system can be designed on similar principles to modern relay interlocking plants, i.e. with Line-To-Line (LTL) equipment. This means that controls governing the establishment of an entire train route are sent by means of keys or buttons located along the lines on the C.T.C. track diagram. This system is simple and L M Ericsson has delivered several LTL type C.T.C. plants.

Recently some firms have supplied systems with the control panel separate from and placed below the centre of the indication panel. The control panel has only *one* set of buttons or keys per station, which may be used for individual operation or for LTL. When a control is to be sent to a field station,

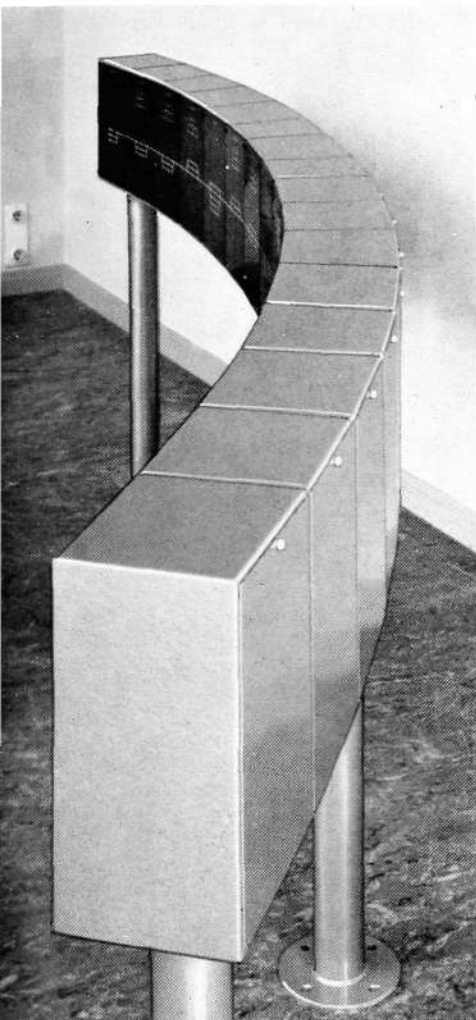


Fig. 3 X 2523  
The track diagram in the keyset-operated system is made up in sections.

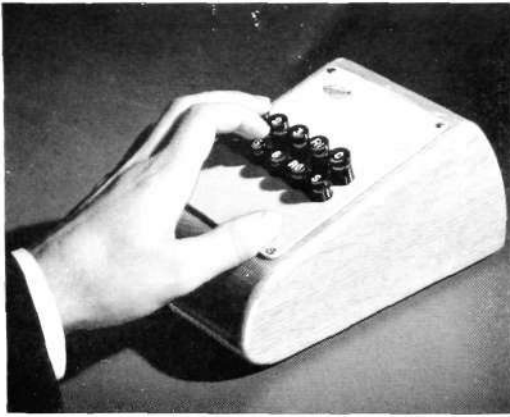


Fig. 4 X 2524  
 The simple control machine in the keyset system has push-buttons for keying four-digit control numbers, as well as auxiliary buttons.

the station's control register is first connected to the control machine, after which the control can be transmitted in the manners described above. This more modern system was introduced *subsequent to* the keyset-system described below and has certain of the advantages of the latter. The keyset system was developed by L M Ericsson in 1954 and several such systems have since been delivered.

*Keyset system*

The track diagram is separate from the control machine and is made up in sections (fig. 3). Additions or alterations to the track diagram can thus be easily effected.

The control panel consists of a keyset (fig. 4) for sending controls to all stations by keying a four-digit number and pressing a start button. With a logical numbering scheme it is extremely easy for the operator to remember the different control codes.

The chief advantages of the keyset system are:

The operator can remain in one position from which he can perform all operations with one hand.

The operator always has a complete survey of the *entire* track diagram from his desk.

One or more keysets can be installed in one office so that the number of operators can be varied during the twenty-four hours of the day.

Train category or train number systems etc. can be controlled with the keyset without adding to the complication of operation.

Alterations and additions to control and indication equipment can be easily effected.

*Automation*

All the control and indication systems referred to above can incorporate arrangements for more or less automatic operation. L M Ericsson supplies a destination indication system with which the C.T.C. operator can "mark" every train with a destination which thereafter "follows" the train across the track diagram. The destination indication automatically controls all signals and points up to the final destination.

*Traingraph*

L M Ericsson's traingraph can be connected to any control and indication system whatsoever (fig. 5).

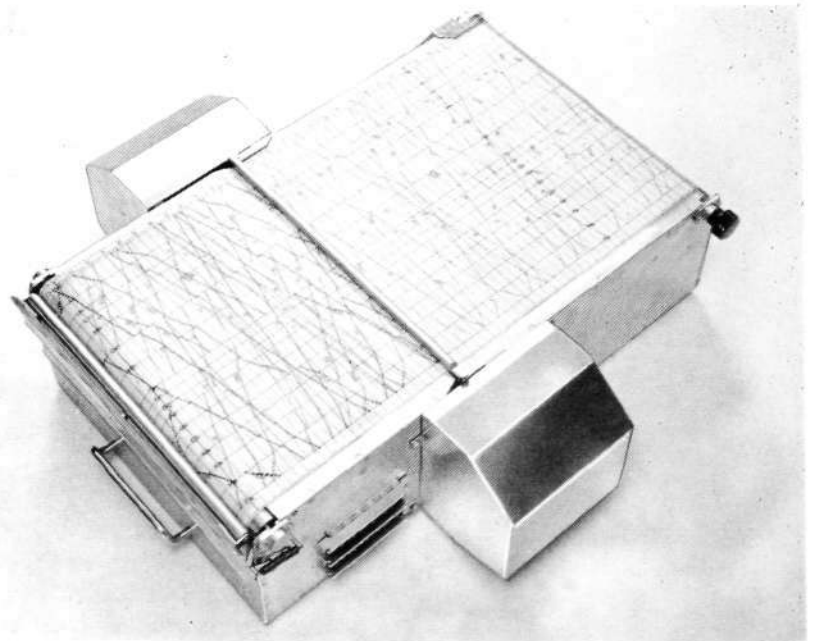
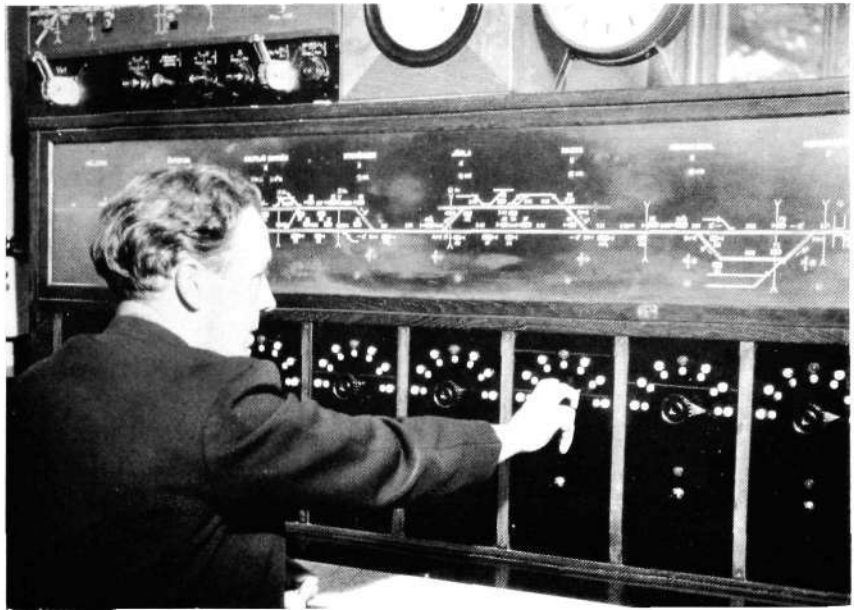


Fig. 5 X 8225  
 The traingraph records train movements (on left) so as to provide a direct comparison between the actual and scheduled train times (preprinted on the diagram).

Fig. 6 X 8226  
 L M Ericsson's first C.T.C. system was installed in 1938 on the Stockholm—Saltsjöbaden line.



## 2. L M Ericsson's First C.T.C. Installations

L M Ericsson's first C.T.C. installation was built as early as 1938 on the Saltsjöbaden line between Stockholm and Neglinge, a distance of about 7 miles with 5 field stations (fig. 6). The installation is still in operation and has hitherto functioned satisfactorily. The system is based on rotary selectors.

In 1951 the Gilserud installation was built in Sweden, and in 1952 the Lieråsen plant in Norway. Both systems are based on relays alone without rotary selectors. Their design is essentially similar to that of L M Ericsson's most modern C.T.C. systems, although the impulse frequency is lower, about 10 c/s. There is only one field station in each installation.

In 1955 the first rapid operating C.T.C. installation was opened in Sweden on the 20-mile single-track Ånge—Bräcke line with 4 field stations. In the following year the first installation was completed in Denmark on the Vordingborg—Masnedø line. The latter had only one field station. In 1956–1957 a longer C.T.C. line was brought into operation, from Nyborg to Holmstrup, with 27 miles of double track and 5 field stations. These installations have provided L M Ericsson with valuable experience which has led to a number of improvements, often at the suggestion of the two railways.

## 3. New Installations

### Sweden

The C.T.C. installation on the single-track line between Kiruna and the Norwegian frontier, the entire length of which runs north of the Arctic Circle, must be the northernmost C.T.C. installation in the world. The line carries very heavy iron ore traffic from the mines in Kiruna to the Atlantic port of Narvik with, at present, a maximum of 65 trains per day. The ore trains are up to 470 m in length and weigh up to 3,100 tons. The line also carries passenger traffic. The C.T.C. office (see front cover) is equipped with a train-graph, which is also used as train journal.

The C.T.C. system is likewise used to control and indicate the positions of circuit breakers and disconnecting switches in the catenary line and auxiliary power line systems.



Fig. 7 X 2533  
 X 9151  
 C.T.C. plants of the Swedish Railways installed and scheduled. All plants have been or will be delivered by L M Ericsson.

- C.T.C. office
- ▬▬▬ C.T.C. line

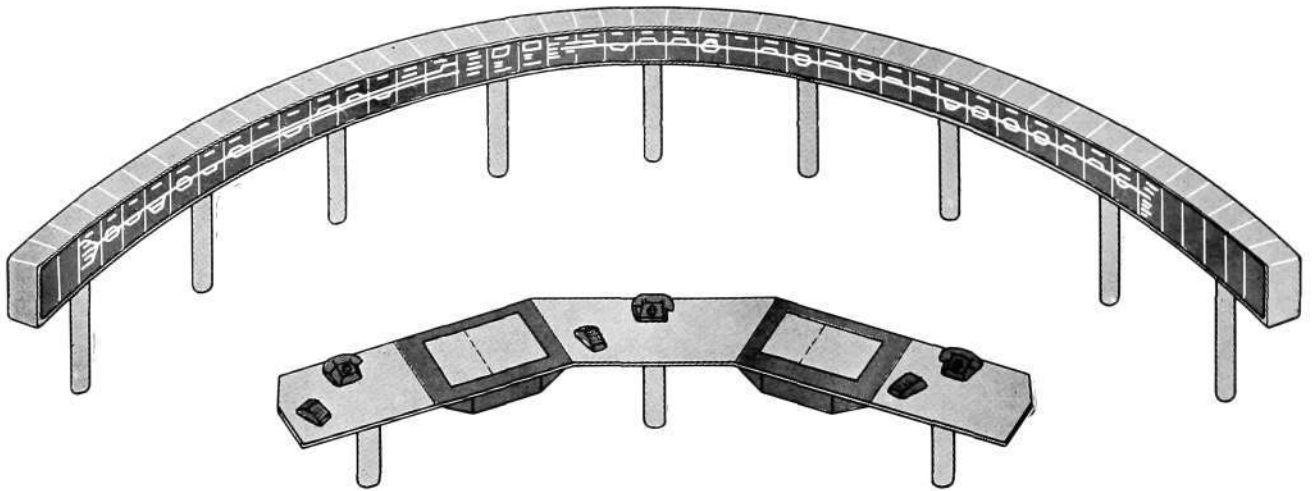


Fig. 8

X 7792

The new C.T.C. office at Ånge, which will be commissioned in the winter of 1960.

It will control 33 stations and will have two traingraphs and three operating positions, with operation from the outer positions during peak traffic and from the centre position during low traffic periods.

The C.T.C. installation is now being extended southwards to Gällivare and will then comprise 22 field stations extended over 144 miles of line. The southern line as well will carry principally iron ore traffic destined for Narvik.

The Kiruna plant was needed in order to bring up the railroad capacity to cater for the successively increasing ore transports. Since the introduction of C.T.C. it has been possible to reduce station staffs, a considerable advantage to the railway both from the economic aspect and also because it is difficult to get people to work at such remote stations as exist in northern Sweden.

The Swedish Railways are at present building the largest European C.T.C. installation between Ljusdal and Mellansel in northern Sweden, a distance of 224 miles with 44 field stations. The line is mainly single-track and carries mixed traffic with altogether 60 trains a day. It is at present so heavily loaded that delays can generally not be avoided. It is calculated that the C.T.C. plant will increase the capacity and make operation more economical. There will be one C.T.C. office at Ånge (fig. 8) for control of 33 stations and one at Vännäs for, initially, 11 stations. The plant will later be extended northwards about 125 miles with some 22 additional stations.

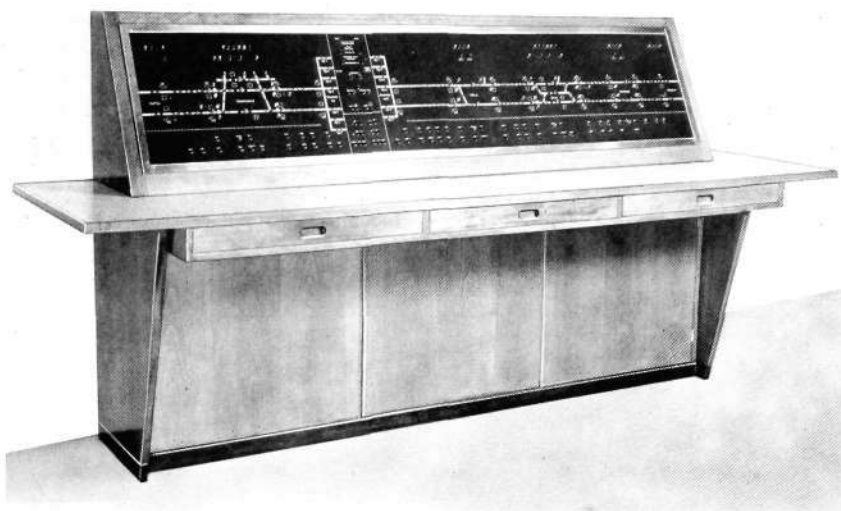
There will be two traingraphs in each C.T.C. office, from which the circuit breakers and disconnecting switches of the catenary line and auxiliary power line systems will also be controlled.

All Swedish Railways C.T.C. plants have keyset operation.

#### Denmark

As already stated, C.T.C. has been in operation on the Nyborg-Holmstrup double-track line, with C.T.C. office at Odense, since 1956-57. The plant is now being extended to Fredericia and the entire C.T.C. line will then be 58 miles long with 12 field stations. More than 120 trains run per day, most of which carry passenger traffic. In view of the directional bias caused by the ferry connections between Nyborg and Zealand, the plant has been constructed to allow left-track operation in certain cases on the line which is normally used for right-hand traffic. The plant is operated on the Line-To-Line principle, and a destination indication system, to be controlled from a small separate control panel under the track diagram, is now being installed. Once the destination of a train has been marked, the signal system is controlled automatically and successively until the train reaches its destination.

Fig. 9 X 8228  
 Control panel and track diagram for provisional C.T.C. office at Roskilde, Denmark. Operation by LTL method.



This year the Danish State Railways have brought a C.T.C. installation into commission between Nykøbing and Gedser, a part of the important single-track line across Falster carrying traffic between Denmark and Germany. Another C.T.C. plant has been opened between Tåstrup and Ringsted (fig. 9), which forms part of the double-track line between Copenhagen and Korsør. Both these plants have provisional C.T.C. offices which will be replaced by permanent offices when the plants are later extended. The Danish State Railways are also installing C.T.C. on the single-track Padborg-Tinglev line. This installation is expected to be successively completed during the years 1960-1963.

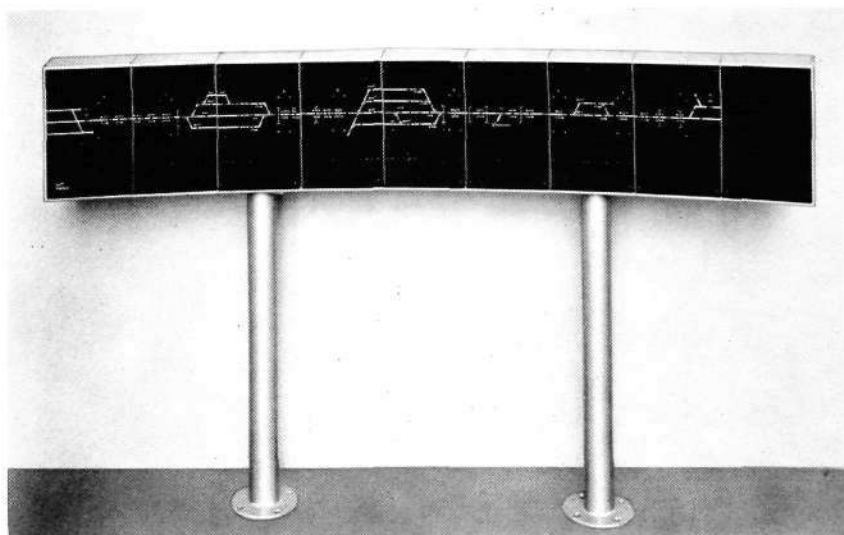
*Poland*

The first two C.T.C. plants in Poland are nearing completion, on the Sw. Wojciech-Port of Danzig and Otwock-Pilawa lines. Both lines are single-track. One plant operates on the Line-To-Line principle and the other has keyset operation (fig. 10). The Polish railways will thereby gain experience of two different control systems.

*Jugoslavia*

C.T.C. is being installed on the single-track Doboj-Zenica line which forms a link between Belgrade and Sarajevo and between Zagreb and Sarajevo. The line carries mixed traffic with up to 90 trains a day. Every station has three

Fig. 10 X 8229  
 L M Ericsson has delivered two C.T.C. installations to the Polish Railways. The photograph shows the track diagram in one of them.



tracks. Delays are at present usual. It is anticipated that C.T.C. will not only eliminate delays but will also allow more trains on the line. The first third of the plant is already in operation and the remainder is expected to be completed successively during 1960–1961. The system is based on keyset operation and incorporates a train category indication system. From his keyset the C.T.C. operator can give every train a category indication which follows the train across the track diagram. A traingraph is also provided.

#### *Portugal*

L M Ericsson has been granted the opportunity of building for the Portuguese Railways a C.T.C. system of a type which differs from the normal. The double-track stations are not equipped with electrical point machines but the points can be operated, if necessary, by hand. Signals and point locking are controlled from the C.T.C. office and the points are normally positioned for movement through the stations on the left-hand track. This simplified form of C.T.C., which is of course cheaper than the normal design, is adequate for the existing traffic requirements. It will, in fact, greatly increase the capacity of the line and at the same time reduce the operating costs. This line, between Setil and Vendas Novas, is single-track, its main object being the carriage of goods between Lisbon and the south-eastern areas of Portugal. The expected headway will be 25 trains per day. The C.T.C. system will be keyset operated.

#### *Formosa, China*

The longest and most important railway line in Formosa is between Kaoshiung in the south and Keelung in the north. It runs quite close to the west coast, passing, among other places, Tainan, Changhua and Taipei. Part of the line is single-track and part double-track. It carries considerable traffic, about 70 trains per day, but the capacity must be increased to above 100 trains per day. Railways are still the predominant means of conveyance in Formosa, where road traffic has not yet obtained much importance.

L M Ericsson is now conducting the final tests on a large C.T.C. installation along part of this line, between Changhua and Tainan, a distance of 94 miles with 26 field stations. The large number of stations and the dense headway, with many indication transmissions, has necessitated division of the line into two sections, and information between the C.T.C. office and the most remote section is transmitted on telegraph channels in a carrier system. The C.T.C. office is shown in fig. 11, from which it will be seen that the

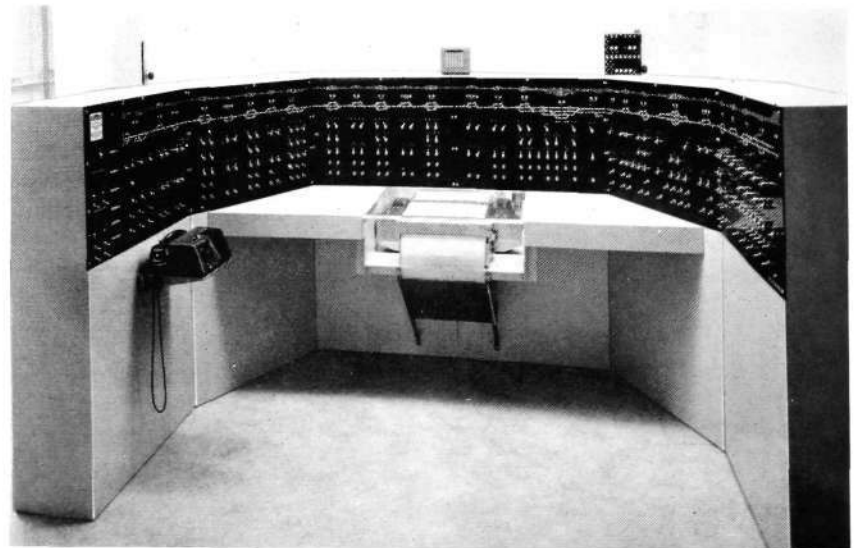


Fig. 11

X 8230

The C.T.C. system in Formosa was designed to American specifications with lever keys for individual switching of points and signals. The system comprises 26 field stations. The traingraph is seen in the centre.

control machine has individual lever keys. This was demanded in the Railway specification which was based on the American pattern. The system is equipped with a traingraph.

#### *Pakistan*

The North Western Railways in Pakistan had planned to install relay interlocking plants and block signal systems for the Karachi–Landhi line with indication of train positions at an office in Karachi. On L M Ericsson's recommendation, however, it was later decided to replace the indication system by a complete C.T.C. system. The line, which is double-track and carries both long-distance and local traffic, has at present about 50 trains per day. The traffic capacity needs to be increased, however, which will be achieved through the installation of C.T.C. Both tracks will be equipped with signals for reversible running. The C.T.C. office will be keyset operated and equipped with train category indication.

#### *Ceylon*

The railway traffic to and from Colombo is extremely heavy, and the capacity of the present double-track line is inadequate. The Ceylon Government Railways therefore decided to introduce C.T.C. over a distance of about 44 miles. The C.T.C. office will be at the capital and the system will permit reversible running on both tracks. The number of trains is expected to rise to 160 per day with a strongly directional bias in the mornings and evenings. The plant is to be successively installed during the years 1961–1962. It will operate on the Line-To-Line principle and be equipped with a traingraph.

## 4. Use of Keyset System

Anyone who knows the keyset system solely from descriptions and diagrams may have the idea that it is complicated and, above all, that the operator will have difficulty in remembering the numbering scheme, even though constructed on logical principles. A demonstration of a plant in operation, however, gives an entirely different impression, and people are often immediately convinced that the keyset system is simple and easily comprehensible. A new C.T.C. operator does, in fact, learn the system within a single day's duty and can thereafter perform 99 % of his operations with the same ease as a trained comptometer operator handles her machine, that is to say entirely automatically.

As already stated, the keyset system is employed by the Swedish Railways. L M Ericsson has also delivered keyset systems to Poland, Yugoslavia, Portugal and Pakistan. For India, L M Ericsson has constructed a model railway with complete C.T.C. for one of the railway universities. It is equipped both with keyset and Line-To-Line equipment in order that the Railway may acquire experience of both systems.

## 5. Need for C.T.C.

It is a fact that the railways of most countries in the world are finding it difficult to pay their way. This is due to the revolution in transport, with increasing use of air and road transport. It does not mean, however, that the railways are becoming superfluous. On the contrary they will retain and often increase in importance within certain categories of transport. Adaptation to the new conditions, however, requires investment and modernization of plant. One important measure is to increase the capacity of lines and to reduce train operating staffs. C.T.C. offers a suitable and comparatively cheap means of achieving this aim, and the railway administrations of almost all countries are now engaged in planning or installing C.T.C. Developments have naturally proceeded further in some countries than in others, but the tendency everywhere is the same.

# AB ALPHA — Yesterday and Today

A R A M N E B Y, A B A L P H A, S U N D B Y B E R G

UDC 061.5 Alpha  
LME 014

*AB ALPHA is one of the oldest members of the Ericsson group. Founded in Sundbyberg on the outskirts of Stockholm in 1888 by the well-known industrial pioneer, Max Sievert, it was incorporated into the Ericsson group in 1929. A short account of the growth and activities of AB ALPHA is given in this article.*

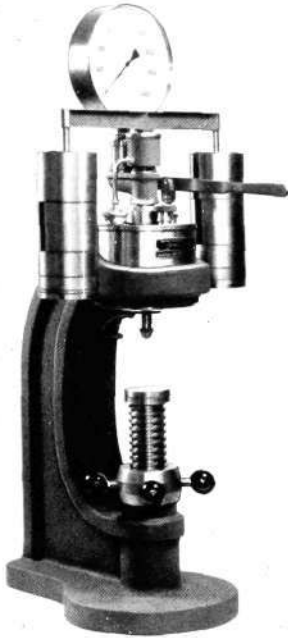


Fig. 1  
ALPHA Original Brinell Press  
The first presses were marketed in 1905.

X 2511

## Material Testing Machines

We may take as our starting point for this resumé the time around the turn of the century. It was then that ALPHA began to design and construct materials testing machines, the products which first carried the name ALPHA across almost the entire world.

The Original Brinell Press (fig. 1) for testing the hardness of metals by the method invented at the end of the 19th century by the Swedish metallurgist, Dr. J. A. Brinell, was brought out by AB ALPHA in 1905. The high quality, unflinching precision and reliability of this press made it a great success.

Inspired by the reception given to the Brinell press, ALPHA's technicians went ahead with their work on materials testing. After some years of intensive research ALPHA brought out a whole series of machines for the most common methods of materials testing, such as tensile, impact, bending and compression tests. This group of products was later followed, in 1918, by a special type of instrument, the ALPHA Carbometer (fig. 2) for electromagnetic determination of the carbon content in steel melts.



Fig. 2  
ALPHA Carbometer

X 8212

Another hardness testing machine, the ALPHA Durometer, for Rockwell tests, was added during the 1920's. Though the models of today are practically identical to the original design, these machines are still in good demand.

At the end of this year ALPHA will be introducing a new Durometer – the SEMATIC (fig. 3) – for use in Rockwell, Vickers and Brinell tests. The aim of the designers of this machine was especially to simplify the manual work involved and to eliminate all influence by the human factor on the test result.

With SEMATIC, which is equipped with an electric motor, every test is performed under exactly identical conditions. The electric motor makes the machine extremely easy to handle. The specimen is placed in position, a button is pressed, and the result read off – a hardness test with SEMATIC is simplicity itself.

A special SEMATIC finesse is the new dial of patented Swedish design with automatic zeroing of the pointer. Zeroing takes place simultaneously with the application of the minor load. Reading is facilitated by the large diameter of the dial and by its distinct graduations in yellow and green on a black background.

The SEMATIC weight system, which is entirely enclosed within the frame, comprises nine different loads. The choice of load is the work of a moment – by turning the milled weight-selector knob on which each load is distinctly marked. Loading time is simply and quickly set with a knob graduated from 0 up to 30 seconds.

A few other practical SEMATIC features are the telescoping sleeve around the table screw, the built-in non-dazzle spotlighting, and the new, robust clamping device permitting unobstructed observation, which enables the operator to position the impression exactly at the desired point.

The mechanism is well protected against dust and damage, being completely enclosed within the frame, which greatly prolongs the life of the machine.



Fig. 3 X 2512  
ALPHA's new SEMATIC Durometer



Fig. 4 X 8213  
The plastic housing of the Ericofon is an ALPHA product.

## Plastic Products

In the early 1920's ALPHA branched out into an entirely new line of production – the moulding of plastic products. From its outset this production was directed to industrial applications, especially to the high quality requirements of the electromechanical industry. ALPHA produces, for example, a large part of the plastic mouldings for L M Ericsson's telephone equipment. The Plastics Section has been successively expanded to cater for the growing demand for plastic products. The moulding shop, with some one-hundred modern presses, most of which were designed and constructed by ALPHA itself, is one of the largest in Scandinavia.

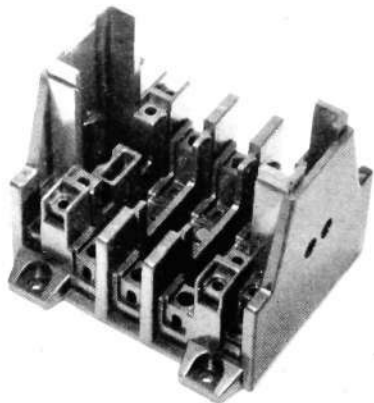


Fig. 5  
Plastic housing for contactor

X 2513

The production of plastics is not based on a standardized programme, but every product is made to the customer's specifications. The product range has thus become very extensive, including thermosetting and thermoplastic products of the most varying forms and dimensions.

The moulding shop has a special section for gramophone records, comprising all the most common types of record, including stereophonic. They are made in hydraulic presses (fig. 6) – again designed and constructed by ALPHA. These presses can be set either for semi-automatic or full-automatic operation and are equipped with a patented hydraulic reducing valve (fig. 7) with which the press tonnage can be easily adjusted for 17, 25 or 30 cm records. The reducing valve also enables the press tonnage to be adjusted to the special characteristics of the material in use on any occasion. This pressure regulating valve, which has a large field of applications in different hydraulic systems, is also sold separately and has met with a considerable demand especially on the European market.



Fig. 6  
ALPHA gramophone record press

X 2514

The ALPHA gramophone record press was originally made for the company's own production of records, the first machines having been installed during the thirties. Since then these presses have met with interest on the part of gramophone record manufacturers in different parts of the world. Particularly since the advent of stereo records this interest has grown very considerably, stimulated by the fact that ALPHA's type of press was designed specifically with these records in mind. Several of the larger and smaller European record producers now employ ALPHA presses, and some units have also gone to oversea markets such as the U. S. A. and Japan.

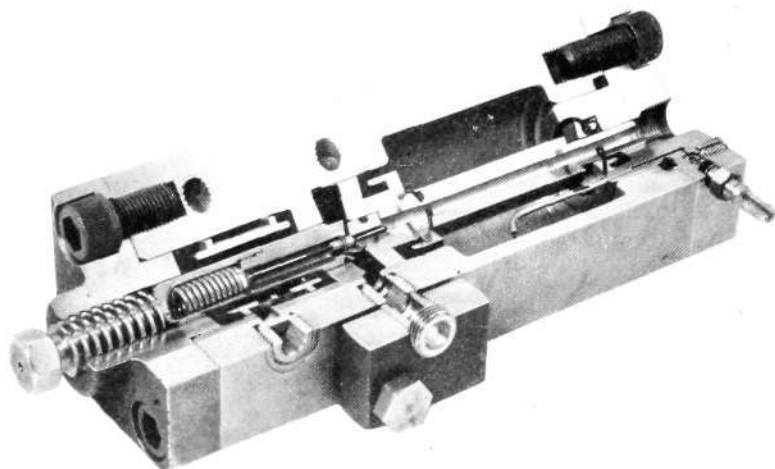


Fig. 7  
ALPHA hydraulic reducing valve

X 8214

ALPHA's well equipped materials and test moulding laboratory continuously follows the developments in the field of plastics. A machine shop with comprehensive modern machinery and a highly skilled labour force answers for the advanced forms of moulds required by ALPHA's special line of production.

## Electrical Installation Materials

For nearly 30 years ALPHA has been producing a wide range of electrical installation materials for telecommunication purposes. Some of these products are briefly presented below.

The PELLO switch for alternating current was introduced in Sweden a few years ago. What strikes one in the new PELLO switch is its sobre design, which is particularly accentuated by the small, finely formed push-buttons. These are made of *polyamide* and are internally shaped as a resilient tongue which forms the primary organ for the entire mechanism. When the button is pushed, the tongue (spring) directly actuates a self-locking rocker. The entire secret in this design lies in the very simple and dependable mechanism: silver contacts ensure satisfactory operation of the PELLO switch even under such exacting conditions as exist in fluorescent lighting installations with a power factor between 0.6 and 0.3.

ALPHA's wall sockets are all too well known to require further mention in this connection. The demand for them is constantly increasing.

Another group of products which have found wide usage owing to their solid workmanship and attractive design are ALPHA's plug and socket units.

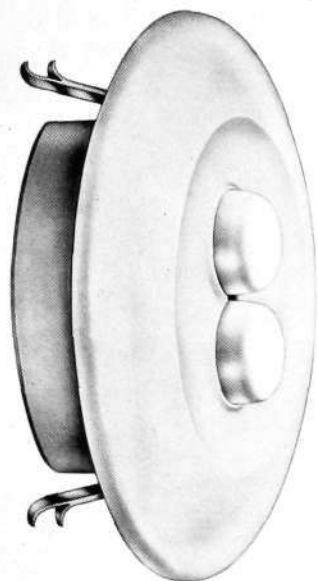


Fig. 8 X 2515  
ALPHA's new PELLO switch for a.c.

Fig. 9 X 7782  
Some of the plug and socket units made by ALPHA

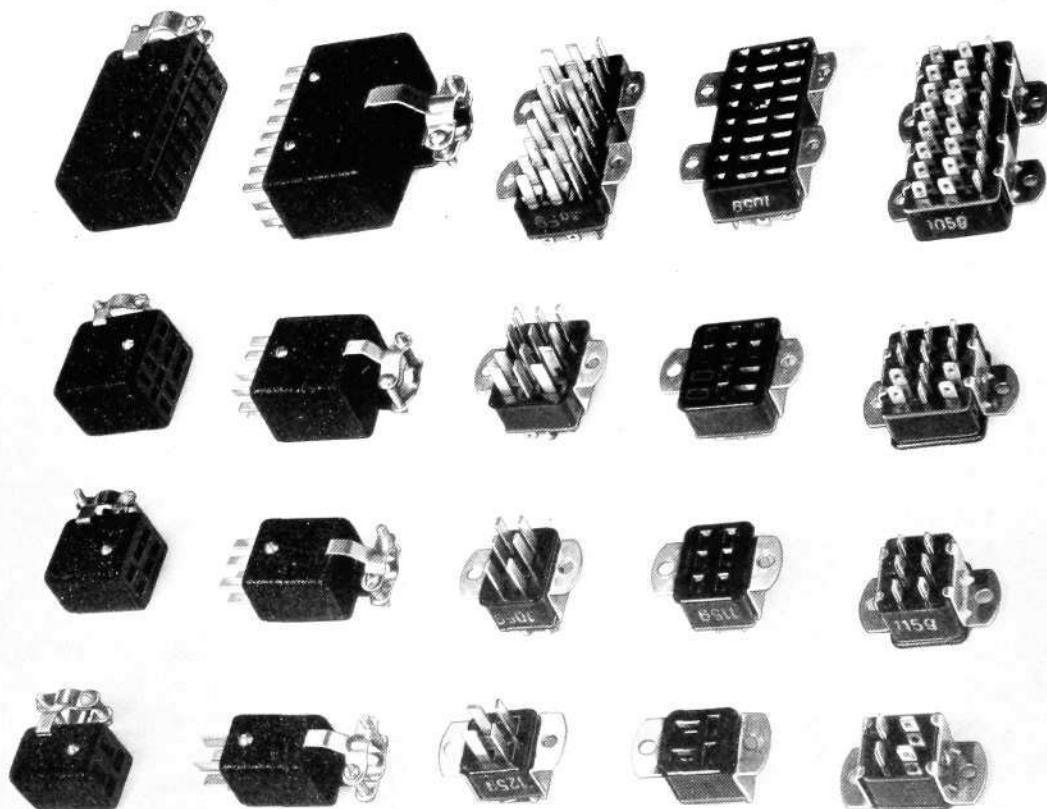
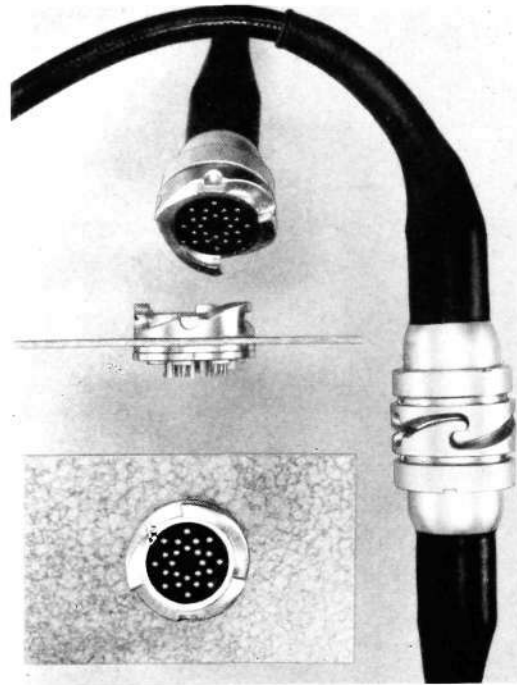


Fig. 10  
Multipole bayonet plug and socket

X 2516



These units solve many connecting problems, especially in radio and telecommunication engineering, in a simple and effective manner. They are made in two series, the L and M series. Designed to the standards of the Swedish Electrotechnical Commission, they have bases of black woodflour-filled phenolic. The L series is also made in a non-tracking design with alkyl base. Both types, L and M, are made for cord grip and panel mounting.

During the past two years ALPHA has been making a special type of connector, a concentric 24-pole bayonet plug and socket (fig. 10) for telecommunication purposes and for cord grip and panel mounting. The male and female members are identical. They have spring-loaded, gilded pins protected by a strong steel cylinder with bayonet holder. The two members are fitted together in a moment and provide a perfect, hermetically sealed and waterproof connection even after lengthy immersion in water. This plug and socket has so far been supplied only to the Swedish Defence Forces, but when production has come into full swing it will be introduced on the general market as well. Wherever quick and reliable connections are required in, for example, telephone circuits, this plug and socket meets a long felt need. It is extremely useful for military purposes, in emergency situations, on ships, at building sites, etc.

## RESULT Presses

This year has seen the appearance of two new production lines. At the beginning of the year ALPHA took over from AB RESULT the manufacture of hydraulic presses for the production of various powder metallurgy products, such as sintered carbides, explosives and uranium dioxide etc. At the same time ALPHA took over the manufacture of the automatic RESULT scales for composition weighing of all kinds of materials in powder form.

As will be apparent, ALPHA's production covers a fairly wide range and the marketing of its products calls for an extensive and active sales organization. The company has its own representatives in most European countries, in the U. S. A. and other overseas markets. ALPHA's products are also sold through the worldwide sales organization of L M Ericsson.

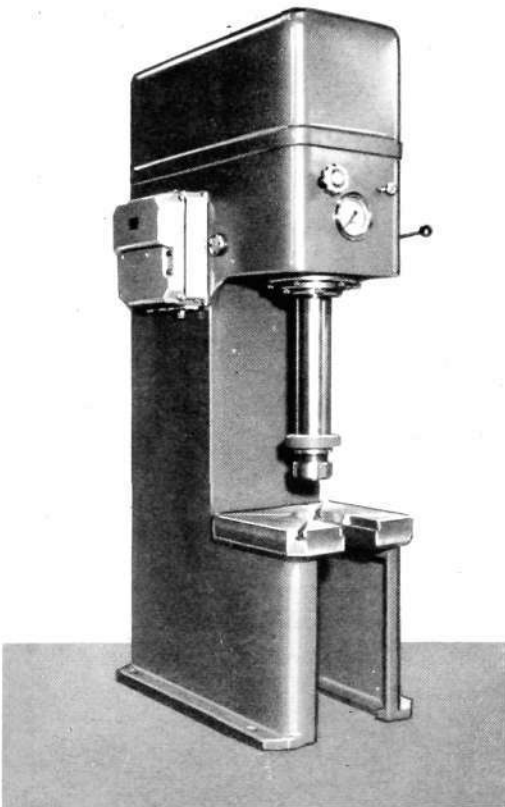


Fig. 11  
Hydraulic press, type RESULT

X 2534

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

Distinguished Visitors  
 from United Arab Republic



17 telephone engineers who are to be responsible for the Egyptian telephone network. In preparation for their task they are spending 6 months here to study especially crossbar switching techniques.

In the photograph (left) Dr. Khalil is seen testing an L M Ericsson telephone from 1878. At his side is the UAR Ambassador in Stockholm, Mr. Aboul Fetouh.

(Above) Dr. Riad signs his name in L M Ericsson's Visitors Book.

(Below) Dr. Khalil (right) is shown L M Ericsson's model railway in the Demonstration Room. With him are Mr. Sven T Åberg, president of LME, Mr. J Thyberg of the Swedish Department of Communications, Mr. Fetouh, and Mr. M Patricks, vice-president of LME.

L M Ericsson recently received a distinguished group of visitors from the United Arab Republic (UAR). Dr. Mostafa Khalil, Minister of Communications for the Egyptian region of UAR, was in Sweden from July 28 to August 5 to inspect certain telephone installations and to visit L M Ericsson's head factory at Mid-sommarkransen. He was accompanied by, among others, the Director General of the Egyptian telecommunication service, Dr. Mahmoud Mohamed Riad. Visits were also paid to Sieverts Cable Works and to L M Ericsson's installations in Copenhagen.

More permanent visitors to L M Ericsson from UAR are the group of





## Cut-over of First Crossbar Exchange in Australia

The Toowoomba crossbar exchange, the first in Australia, was cut over in September. For coming requirements the two Australian companies which are manufacturing L M Ericsson equipment on licence, Standard Telephone & Cables and Telephone & Electrical Industries, have ordered complete crossbar rack units and components for altogether 40,000 lines.

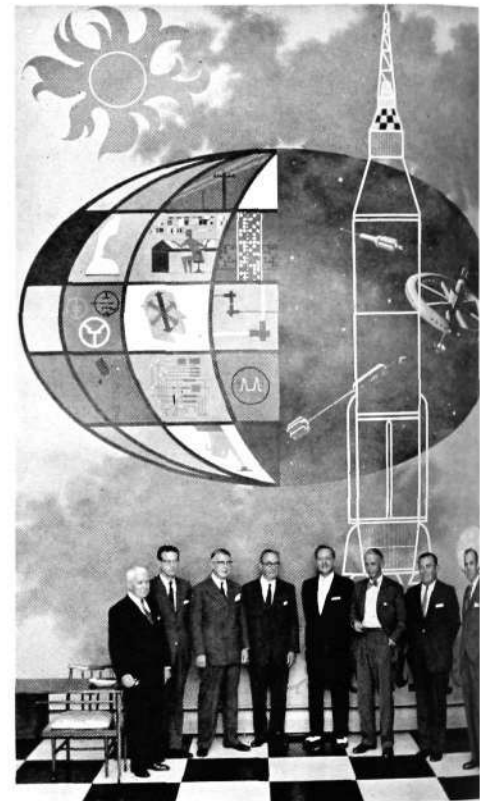
## New L M Ericsson Exchange Opened in Panama

In September the fifth 500-selector exchange operating on the AGF system was opened in Panama City. The installation work was again carried out by Cía Panameña de Fuerza y Luz. The new exchange adds a further 3,000 telephone lines to the Panama City area.

Panama comes fourth in respect of telephone density among Central

American countries with more than 20,000 telephones. At the head of the list is Trinidad, followed by Puerto Rico and Cuba.

(Above) The new telephone exchange is opened by the Minister for Public Works, Mr. Victor C Urrutia. With him are Monseñor Bechman, Mr. W A Daniels, Mr. Hogland, and Mr. T V Oglesby, president of Cía Panameña de Fuerza y Luz.



North Electric Company, L M Ericsson's U.S. affiliates, recently erected a large research centre at Galion, Ohio. Under the imposing mural are seen (from left) Mr. Dienner, member of the board of NEC; Mr. Burchhalter, solicitor; Messrs. Faulkner and Kingsley, members of the board of NEC; Mr. William Tucker, chairman of the board and president of NEC; Mr. Sven T Åberg, president of L M Ericsson and member of the board of NEC; Mr. Nils Sterner, vice-president of LME and member of the board of NEC; and Mr. Gunnar Svala, head of research at NEC.



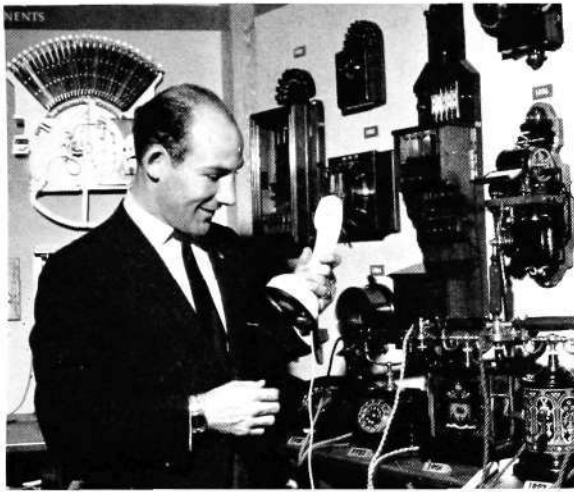
In conjunction with the RITAL congress at Mexico City, at which various questions concerning the Latin American telecommunications networks were discussed, there was an international exhibition of telecommunications equipment in which L M Ericsson took part.



(Above) General Phachern Nimibutr, head of the Thailand Signal Corps, Director General of the Telephone Organization of Thailand and second-in-command to the Minister of Communications, was the guest of L M Ericsson from Sept. 6—16.



Among the participants at the seventh international electronics and atomic energy exhibition at Rome were L M Ericsson's Italian affiliates FATME and SIELTE. Their stand was visited by President Gronchi. (From left) the President of FATME, Luigi Baggiani, President Gronchi, and the Inspector General of the Italian Telecommunications Department, A Antinori.



The British racing motorist, Stirling Moss, visited L M Ericsson in August. His guides were hard put to it to answer Mr. Moss' many penetrating questions.



A group of Argentinian economists from the School of Economics in Buenos Aires on a tour of L M Ericsson's head factory in Stockholm.



L M Ericsson's Driftkontroll AB (DKB) has introduced on the Swedish market a new data processing machine, ICT 1301, which can make 37,000 additions per second. DKB's sales manager, Stig Bartoft, dem-

onstrated the new machine to the press (left). The Ericofon has featured in a number of films, both Swedish and foreign. The photograph above is from a Spanish film.

Vehicle-actuated road signals at Riddarhustorget, Stockholm (left).

## Ericsson Technics No. 1, 1960


The latest issue of Ericsson Technics, No. 1, 1960, contains five papers. The first, "Some Problems Concerning Noise in Wide-Band Carrier Systems", by S. Janson and V. Stending, gives general formulae for intermodulation noise of the second and third order; certain optimum conditions for noise are derived. It ends with the working out of a practical example.

The second paper, "Oscillations in Long Electron Beams" by B. Agdur, deals with instabilities in long electron beams which pass through gas at low pressure.

"On Microwave Propagation in a Plasma-Filled Coaxial Line" by B. Enander describes experiments in the propagation of microwaves in a plasma-filled coaxial cable.

The fourth paper is by B. T. Henoch and is entitled "Aspects on Wide-Band Parametric Travelling-Wave Amplifiers". Parametric amplification by mixing of signal and pump oscillations in a non-linear reactance can be effected on a wide-band basis by mixing signal and pump waves in a filter ladder containing non-linear reactances. The filter ladder must fulfil certain conditions relating to phase and dispersion. On the basis of the specific characteristics of such systems, it is possible to design filter structures suitable for parametric travelling-wave amplifiers. Several filter structures of low-pass and band-pass type for different frequency ranges are dealt with. Finally the effect of losses and the generation of noise are determined. Various measures for reducing the noise factor are discussed.

P.-O. Brundell, in "Transient Electromagnetic Waves around a Cylindrical Transmitting Antenna" calculates the electromagnetic field from a cylindrical transmitting antenna fed by a voltage of arbitrary and non-sinusoidal time variation. The field is shown to be the sum of elementary travelling waves reflected at the antenna ends. These elementary waves are determined and related to Hallén's travelling wave theory for antennae.



## 200th Vehicle-Actuated Road Signal Installation delivered by LM Ericsson

L M Ericssons Signalaktiebolag supplies chiefly railway signalling plant and equipment, but road signalling equipment is also an important line. During 1959 invoicing of road signal equipment amounted to nearly 1 million kronor.

There are many different types of road signalling plant. The most advanced types are those actuated by the vehicles themselves. They permit the maximum capacity at traffic crossings and the shortest hold-up of passing vehicles.

The first vehicle-actuated plant supplied by L M Ericsson was installed at Götgatan-Högbergsgatan in Stockholm in 1949. The important new feature was the use of inductive vehicle detectors in the form of cable coils embedded in the carriageway. These detectors required no maintenance and were entirely reliable in all weathers. Since then they have been further improved and are now made with plastic cables.

In the past two years the company has supplied two large and com-

plexed plants for the city of Stockholm, at St. Eriksplan and at Riddarhustorget. Each of these installations comprises a number of street junctions, the signals of which are coordinated. The relay equipment is centrally located in a convenient building.

The Riddarhustorget plant was completed in June this year. The signals being vehicle-actuated, the green periods vary with the traffic. The signals are so coordinated, however, that vehicles in the main directions of traffic which meet green light at the first signal continue to meet green light, as far as possible, at the following signals and so need not stop. The plant has a number of finesses such as an equipment which counts the total traffic volume at the crossing and successively corrects the signal periods to the volume at any particular moment.

Since 1949 L M Ericsson has supplied some 200 vehicle-actuated signal plants, mostly for Sweden, but large numbers also for Norway, Denmark and Finland.

UDC 621.395.347.3  
654.153.3 (480)  
LME 410, 83

**HÄVERINEN, V:** *The Development of Automatic Long Distance Traffic in Finland.* Ericsson Rev. 37(1960): 3, pp. 70—83.

The Finnish telephone system is being rapidly converted to automatic operation, based chiefly on L M Ericsson's automatic trunk exchange systems ARM 201 and ARM 503. The present article starts by describing the special conditions applying to the Finnish telephone service and the requirements imposed on full automatic long distance traffic. There follows a survey of the development of automatic working and of the systems employed, and the article concludes with a few words on the experience of operation hitherto.

UDC 656.259.12  
LME 86

**BOBERG, I:** *LM Ericsson's C.T.C. Makes Headway.* Ericsson Rev. 37(1960): 3, pp. 84—91.

L M Ericsson's C.T.C. systems have been described in Ericsson Review Nos. 4, 1954 and 2, 1958. The traingraph used with the C.T.C. system was described in Ericsson Review No. 2, 1956. This article will present a summary account of the characteristic properties of L M Ericsson's C.T.C. systems, followed by brief descriptions of the major plants sold in recent years.

UDC 061.5 Alpha  
LME 014

**RAMNEBY, A:** *AB ALPHA — Yesterday and Today.* Ericsson Rev. 37(1960): 3, pp. 92—96.

AB ALPHA is one of the oldest members of the Ericsson group. Founded in Sundbyberg on the outskirts of Stockholm in 1888 by the well-known industrial pioneer, Max Sievert, it was incorporated into the Ericsson group in 1929. A short account of the growth and activities of AB ALPHA is given in this article.

# The Ericsson Group

## Associated and co-operating enterprises

### • EUROPE •

#### Denmark

L M Ericsson A/S København F, Finsens Vej 78, tel: Fa 6868, tgm: ericsson

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

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

#### Finland

O/Y L M Ericsson A/B Helsinki, Fabianinkatu 6, tel: A8282, tgm: ericssons

#### France

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

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

#### Germany

Ericsson Verkaufsgesellschaft m. b. H. Düsseldorf 1, Worringer Strasse 109, tel: 84 461, tgm: ericstel

#### 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

F. A. T. M. E. 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: ericstel  
den Haag—Scheveningen, 10, Palaeestraat, tel: 55 55 00, tgm: ericstel-haag

#### Norway

A/S Elektrisk Bureau Oslo NY, P.B. 5055, tel: Centralbord 46 18 20, tgm: elektriken

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

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

AB Ermi Bromma 11, tel: 262600, tgm: erimbolag-stockholm  
AB Rifa Bromma 11, tel: 26 26 10, tgm: erlifa-stockholm  
AB Svenska Elektronör Stockholm 20, tel: 44 03 05, tgm: electronics  
L M Ericssons Driftkontrollaktiebolag Solna, tel: 27 27 25, tgm: powers-stockholm  
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Sievert's Kabelverk AB Sundbyberg, tel: 282860, tgm: sievertsfabrik-stockholm

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

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Bombay, Manu Mansion, 16, Old Custom House, tel: 254130 tgm: inderic

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

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#### Vietnam

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Corp. Sudamericana de Teléfonos y Telégrafos S. A. Buenos Aires, Casilla de correo 3550, tel: 332071, tgm: cartefe

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

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

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

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

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

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

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

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

#### Mozambique

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

#### Nigeria

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

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#### Cuba

Mc Avoy y Cia Habana, Apartado 2379, tel: 7-2527, tgm: macavoy

#### Curacao N. W. I.

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#### Dominican Republic

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#### Guatemala

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Teléfonos Ericsson C. A. Quito, Casilla Postal 2138, tel: 33777, tgm: ericsson

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Industria de Telecomunicaciones S. A. de C.V. México 6, D.F., Calle Londres No 47, Colonia Juárez, tel: 250405, tgm: industel

#### Peru

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Soc. Telefónica del Perú, S. A. Arequipa, Casilla de Correo 112, tgm: telefonica

#### El Salvador

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

#### Uruguay

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#### USA

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

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

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

### • AUSTRALIA & OCEANIA •

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L M Ericsson Telephone Co. Pty. Ltd. Melbourne C 1 (Victoria), 20 Collins Street, tel: MF 5646, tgm: ericmel

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#### Jamaica and Brit. Honduras

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#### Panama

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#### Surinam

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

#### USA

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

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#### Ireland

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#### Iceland

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

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Merkantile Inozemna Zastupstva Zagreb, Pošt pretinac 23, tel: 25-222, tgm: merkantile

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#### Syria (UAR)

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

#### Vietnam

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

### • AFRICA •

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

#### Congo

Société Anonyme Internationale de Télégraphie sans Fil (SAIT) Bruxelles (Belgique), 25, Boulevard du Régent, tel: 125070, tgm: wireless (For maritim radio and carrier)

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#### Ethiopia

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#### Ghana

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

#### Morocco

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

#### Mozambique

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

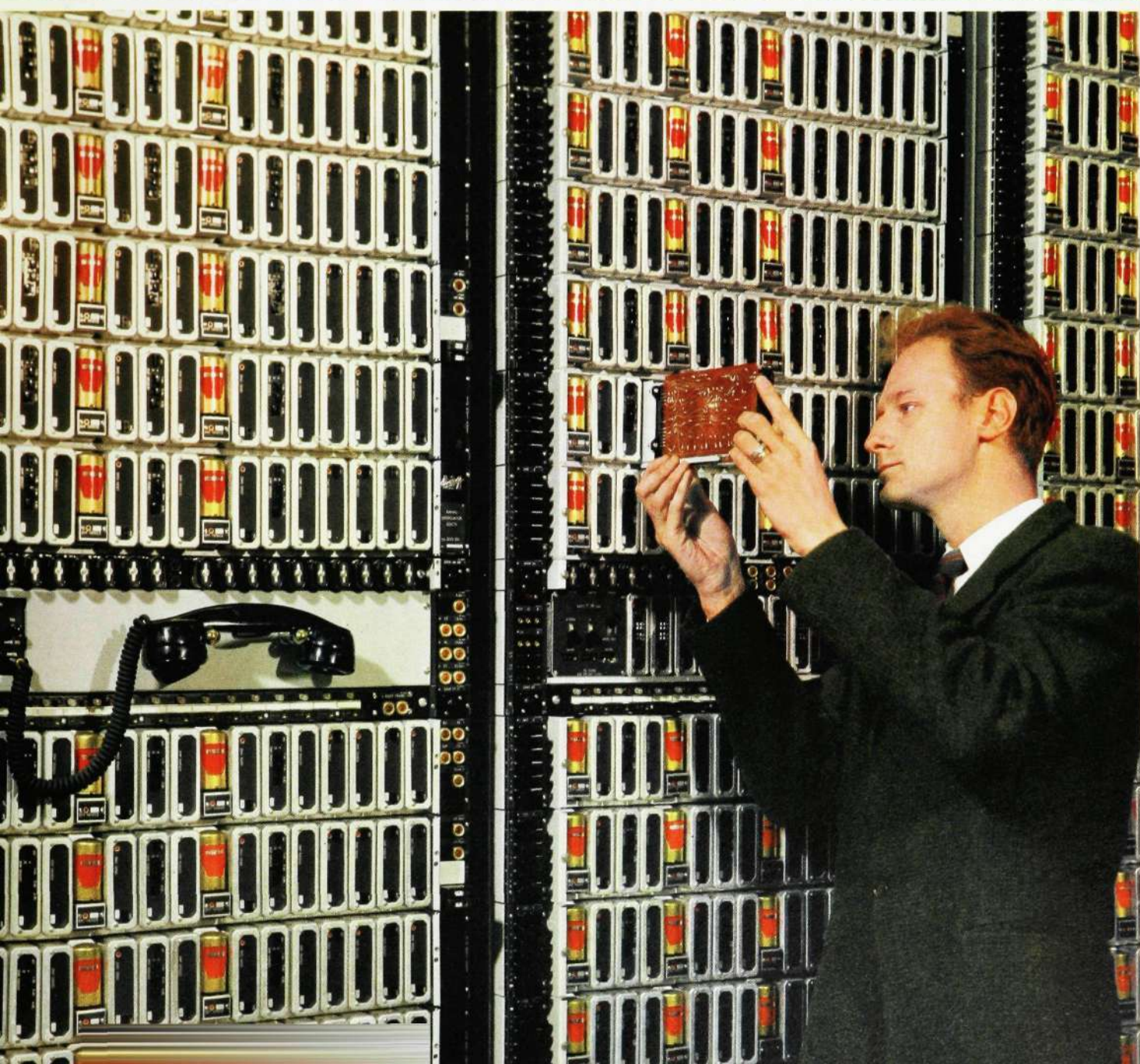
#### Nigeria

Scan African Trading Co. Yaba-Lagos

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1960

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On cover: Channel Translating Bays for L M Ericsson's New Transistorized Carrier Frequency Systems.

# Trends of Development in Telephony

C JACOBÆUS, TELEFONAKTIEBOLAGET LM ERICSSON, STOCKHOLM

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*This article sums up the present situation in different fields of telecommunications in the light of the developments in telephony during the past decade, going on therefrom to what may be expected during the sixties on the basis of the advances in fundamental sciences and in technology. The article is adapted from a lecture given to the Swedish National Association of Electrical Engineers on September 9, 1960.*

The time that has elapsed since the second world war has been one of dynamic developments in telecommunications. Advances in theory, in technology and in equipment design have led to the creation of new products which, in many important respects, have changed the conditions of people's lives and had an influence on many of the functions of society. Telecommunications have been an important factor in the growth of production in general. They have also placed a number of new tools at the disposal of researchers, so contributing to the advances in the whole of our cultural life. The telecommunications industry has itself been among the most expansive during the postwar period.

Telephony is one of the oldest branches of telecommunications. It had reached a high engineering level even before the last war and, in terms of output, predominated over all other branches of telecommunications. In matters of technology, telephony has made a number of important advances since the war. The production of telephone equipment has risen considerably, though not as much as in several other branches of telecommunications. New production units have also been established in countries which had earlier had to rely on imports.

In considering the trends of development in telephony, we may take as our starting point what has emerged during the fifties. We should perhaps first consider the situation as it appears to subscribers. For them the past ten years have perhaps not been particularly dramatic, but the advance has been on a broad front. One important event is the continuous expansion of subscriber-dialled long distance calls. Another is the relative lowering of telephone rates as a result of the progressive rationalization of manufacture, installation and operation. The quality of service has at the same time been greatly improved. Internal communication systems of different kinds are being increasingly used. The transmission performance of telephone sets has been raised. New types of set have been evolved, and parallel sets for residential use are becoming increasingly common. New and better public call box apparatus has been designed; telephone answering machines have proved a valuable addition to the service facilities. Finally, the perhaps greatest engineering feat within the field during the fifties, the Atlantic cables have perfected the quality of transmission on conversation across the Atlantic.

If we now peer instead into the future and wonder what new developments we may expect in the next ten years, we must first – if we are to keep to really revolutionary matters – consider the advances in the fundamental sciences of physics, chemistry and mathematics, which have not yet reached the

application stage. To be sure, the effects are not likely to be so radical as to alter the entire face of telephony or even a major part of it. From the subscribers' viewpoint no very sweeping changes will be made. The concept of telephoning will have the same implication as it has now.

But we can be quite certain that the specialists in all branches of telephony will have their hands full during the sixties. A wider register of physical and chemical laws will be available. Technology will develop new components for use in telephone plant. Telephone materials must be designed to meet new functional requirements. Operating methods need to be rationally reexamined, and so on. On the basis of the situation as it exists today, I shall try to give some idea of what we may expect to see happen during the sixties.

## Components

The fifties have seen the birth and, one may say, the coming of age of the semiconductors. They have had a quite revolutionary influence on telecommunications as a whole and, as regards telephony, have meant, among other things, that one can give serious thought to electronic switching. They have also had a great influence on telephone design and transmission technology.

The most probable development in semiconductors during the ten years ahead is a continued growth in their reliability. Even now diodes and transistors are very dependable elements with a satisfactory life span. Research is in progress throughout the world, relating particularly to surface phenomena in semiconductors. It is thought that therein lies the key to the life problem. We shall undoubtedly see solutions to these problems, involving simpler encapsulation and so cheaper units.

The diffusion method will be developed, and in that connection an inexpensive method will be found for attaching the leads. Silicon will gradually secure a stronger footing, but this will take some time. The properties of silicon are not as a whole greatly superior to those of germanium, so that the price will be an important factor. Only when the diffusion method is established on a broad basis will silicon elements be cheaper.

Table I. Relative costs of transistors (The Western Electric Engineer, July 1959, October 1959, January 1960)

	<i>p-n-p</i> germanium alloy	<i>n-p-n</i> germanium grown	<i>p-n-p</i> germanium diffused alloy	<i>n-p-n</i> silicon mesa diffused	<i>p-n-p</i> germanium mesa diffused
Slice, clean, etch wafer . . .	11	73	17	3	2
Form junction with wafer or bar . . . . .	27		38	6	11
Lead attachment . . . . .	2		3	15	21
Package piece parts . . . . .	17	34	24	11	16
Piece parts processing . . . . .	10	21	12	6	14
Sealing . . . . .	7	7	7	3	5
Test . . . . .	20	12	13	3	3
Process inspection . . . . .	6	3	6	3	3
	100	150	120	50	75

As regards electrical properties, the trend is towards higher frequencies and higher powers. This trend may be expected to continue. Electrical properties can clearly be built into semiconductors almost at will. But special types can hardly be expected to be evolved for telephony purposes apart from exceptional applications – the market would be too small.

Within the component field the ferrites have attained very wide usage during the fifties for inductance elements. Their permeability has been successively raised to a very high level without increasing their losses. A continuation of this trend may be expected, although hardly to the same extent as during the past decade.

For electronic exchanges the memory technique has come into the foreground. Several new memory elements have been evolved. New memory tubes, magnetic memories of different kinds and dielectric memories have been suggested. During the sixties it is likely that technology will take a definitive direction, with only a few types of memory as realistic alternatives. For certain requirements, especially for semipermanent memories, there is at present no satisfactory solution, and we look to new inventions in this sphere.

## Telephones

The main evolution in telephone sets has been the successive improvements in reference equivalents for sending and receiving. This has permitted higher attenuation in local networks, so longer local lines and smaller diameters of wire. As regards the transmitter, the type that was patented in 1890 still stands, though, of course, improved in all details. The carbon granule transmitter has the advantage that it is itself an amplifier—about 25 db—and that it is cheap. This must be paid for in terms of high harmonic distortion, which gives the telephone voice another timbre. The output of the carbon granule transmitter has been increased in recent years by about 5 db, and a few additional decibels are perhaps within reach in the near future.

The electromagnetic receiver principle originally evolved by Bell is still used to a large extent. By the use of improved materials the efficiency of receivers has been increased by about 8 db within the past few years. The electromagnetic receivers of balanced type add a further 2 to 3 db. No particular improvement over these figures is likely in the near future.

Thus, all in all, the efficiency of telephones has been increased by some 15 db, but differently distributed between sending and receiving, so that a redistribution of the attenuation must be made in the differential coupling of the telephone from sending to receiving.

But the greater efficiency in sending and receiving has had certain drawbacks. On short lines the volume has become unpleasantly high, severer requirements must be placed on sidetone attenuation, and the requirements on crosstalk attenuation in exchange and cables have also had to be accentuated.

With modern telephone sets the system reference equivalent may lie within the range  $-10$  to  $+40$  db. The most agreeable range as regards volume is between  $+10$  and  $+25$  db. For system reference equivalents below 0 the volume is definitely annoying. Measures should therefore be taken to damp the signal. In the U.S.A. (Bell System) and in the U.K., non-linear elements, whose attenuation of the signal is a function of the line current, have been introduced into the transmission circuit of telephone sets. Bell System employs

varistors and the British Post Office Counter-coupled rectifiers, the bias and, therefore, impedance of which is varied by a resistance which varies greatly with the line current.

The advent of transistors has made it possible to introduce amplification into telephone sets, the amplifier being powered from the exchange. This would make possible the use of a better quality transmitter. The attenuation in local networks could be increased still further, though this would lower the cost of line plant only to a limited extent.

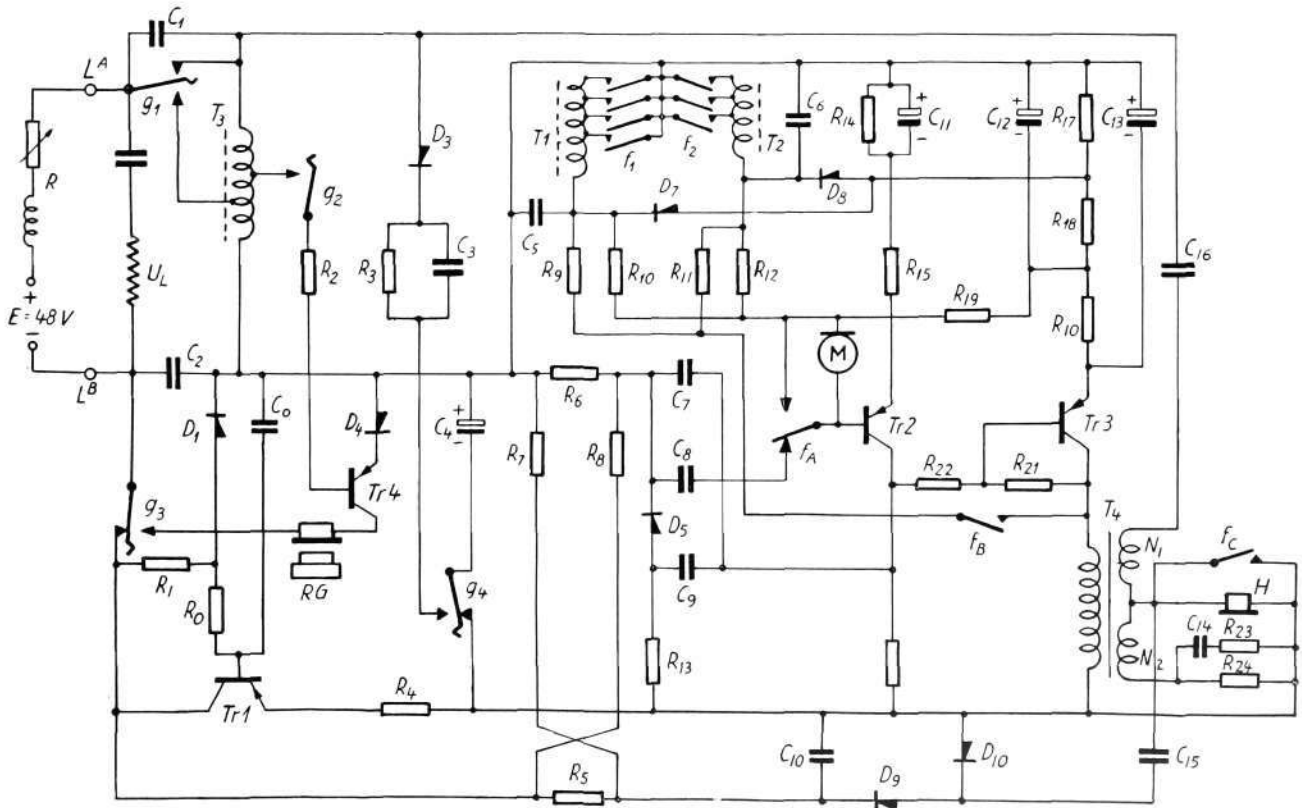
The signalling element in the telephone set has presumably always been a low-frequency a.c. bell, which is now made with mechanical volume regulation. There is every reason to believe that the same form of bell will be used in future. An alternative exists, however, which has certain advantages. It is a transistor converter of the ringing current to a v.f. current which operates a signal generator, possibly the receiver itself. The ringing signal has a more pleasant sound than the present one and is equally audible. But the price would perhaps often appear prohibitive.

It may be definitely predicted that the sixties will see dials replaced by keysets on a broad front. Actually it has taken unexpectedly long for this invention to break through. The Bell group in U.S.A. has now made a proposal for a keyset signalling system. It is a v.f. system, each digit consisting of two frequencies, each from two groups of four frequencies. This system appears to be the best devised hitherto, being insusceptible to interference by speech and not requiring reversal of polarity in keying position. In the U.S.A. consideration is being given to the question of a higher charge for keyset telephones. There is little doubt that many subscribers would be prepared to pay the moderate additional fee which would make keyset systems an economic proposition for administrations. Keying is more convenient than dialling and saves time.

Fig. 1  
Suggested diagram of telephone set for electronic system

X 7793

- |   |   |
|---|---|
| RG  | Signal generator  |
| Tr 4  | Transistor for amplifier for RG                             |
| Tr 1  | » » stabilization   |
| M   | Transmitter   |
| Tr 2 }<br>Tr 3 }                              | Transistors for transmitter amplifier and for digit sending |
| T1, T2 }<br>f <sub>1</sub> , f <sub>2</sub> } | Keying signal circuit                                       |
| T4  | Telephone transformer                                       |
| H   | Receiver  |
| g   | Switchhook  |



These new features – speech amplification, call signalling device and keyset impulsing – are characteristic of the telephone sets for electronic systems which are now at an advanced stage of study. Amplifying and active units must be provided for calling and impulsing, the former because an electronic exchange cannot send ordinary ringing current but only v.f. current. It was therefore a natural step to introduce transmitter amplification as well. As is seen from fig. 1, the requirement of material is fairly large.

Loudspeaking telephones have every prospect of a bright future. Their design is perhaps not yet ideal, but when they have been perfected in that respect at a reasonable cost, they should find their way to many homes.

As regards the external design of telephone sets, the fifties have been a revolutionary period. Coloured sets have become common – most being of thermoplastic. In U.S.A. there are two-colour sets, the case and handset being of different colours, so avoiding the differing discolouration of these two parts during the life of the set. The fifties saw the birth of the Ericofon, which has been very well received by subscribers. During the sixties people may well come to think of the telephone as an integral part of the furnishing of their home. Administrations and manufacturers must be prepared to provide the public with elegantly designed sets in many different colours, and to adapt their colour range to the dictates of fashion. We may have to produce new types of set fairly often. There is even a risk that less scrupulous manufacturers will sell telephones direct to subscribers for plugging into their wall sockets.

## Line Plant

The line plant is the most costly part of a telephone network. Creditable efforts have been made to reduce this cost. The principal items are cable and installation work. The main striving has been to lower the cost of cable and wire through use of the new materials that have become available. Secondly, methods of installation have been rationalized. And only in the third place have technical developments been drawn upon for the modernization of line material such as cable fittings, protective equipment etc.

During the fifties plastic cables took a big stride forward. This tendency may be expected to continue during the sixties, line materials being successively adapted to suit plastic cables.

For local line plant, even in the forties, 0.4-mm wire began to oust larger gauges of wire wherever the attenuation conditions permitted. A further development in this direction—to 0.3-mm wire—is proceeding in some places. The problems of manufacture and jointing are troublesome, since 0.3-mm wire is rather fragile. The line equipment must also be reconstructed to fit the new wire.

The replacement of copper by aluminium in local cables does not appear so attractive. From the attenuation point of view this would often be possible, but aluminium is difficult to joint. It also involves problems of manufacture because of its lower strength and ductility. Considerable changes in cable-making machinery would probably be necessary. Aluminium cables are thicker than copper cables, moreover, which is undesirable in local plant. Any general change from copper to aluminium will depend on the price factor.

Gas pressure is being increasingly employed to maintain the insulation of cables. An overpressure is applied in the cable which prevents the entry of moisture in the event of a leak in the sheath. The method has been used for thirty years in paper-insulated lead-covered cables, at the outset mainly on long distance cables, and latterly also on local cables. The use of gas control on plastic cables is under development. Some advantages would be gained, for example in jointing.

## Transmission

As regards the carrier systems the trend has been towards the use of larger bandwidths in the coaxial cables. Systems now exist for up to 12 Mc/s. When this figure will be exceeded is uncertain, but within a few years there should be technological and economic possibilities of perhaps 36 Mc/s transmitted bandwidth.

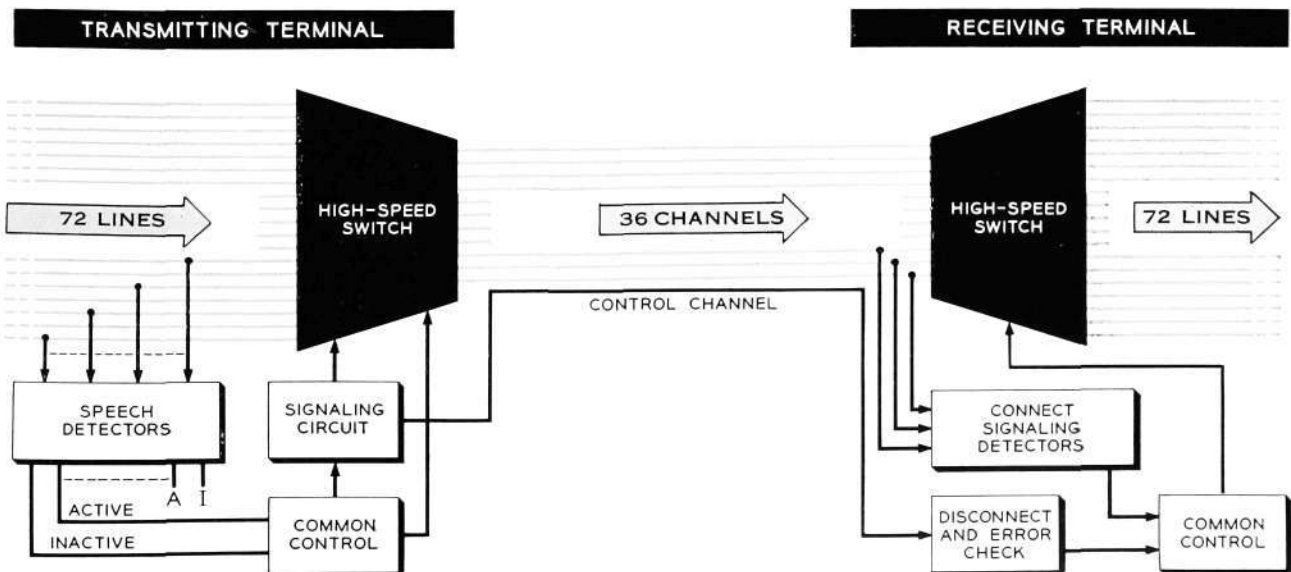
From the equipment point of view the carrier systems are being progressively transistorized, and this will undoubtedly continue. Amplifiers with transistors for coaxial systems for 12 Mc/s are within reach. The only doubt is concerning the shock resistance of high frequency transistors. Transistor amplifiers have many advantages, especially in the matter of power requirements. Transistorized systems also appear to be cheaper than tube systems.

Even if bandwidth has on the whole become cheaper, there is a tendency to cut down the bandwidth on expensive circuits. On the Atlantic cables the compromise of 3 kc/s instead of 4 kc/s spacing on the telephone channels is to be accepted, which may seem a step backwards. In the TASI system – Time Assignment Speech Interpolation – (fig. 2), which is on the verge of switching technique, the number of channels has been doubled. In this system a channel is seized only if there is speech on the line. Energetic work is being done on various Vocoder systems, which would permit a radical reduction in bandwidth. But in view of their cost, it is doubtful whether such systems will be usable in commercial telephony.

Fig. 2 Σ 7797  
TASI system (Bell Laboratories Record, March 1959)

The system concentrates the traffic on 72 lines to 36 channels. To each line on the transmitting side is connected a speech detector, which indicates whether there is speech on the line or not. If there is, the line is connected by the switch to a free channel; at the same time the receiving end is informed over a control circuit of the connection that has been established and the receiving switch is operated accordingly. When there is no speech on a line, the line is disconnected from all channels.

There has been much talk during the fifties of short-haul carrier systems, which would supersede the usual method of loaded cables. Here, it must be said, the results have been disappointing. It seems impossible to cut the cost below a certain level, and there would be no gain in economy at distances



below about 40 kilometres. Among the cost items must be counted signal receiving equipment for the line signals, which, of course, must be sent at levels which can be transmitted over the system. These levels are an order of magnitude or so too low for operation of the relays and other equipment in the exchanges. Unless some radically new idea emerges, there seems little hope of any real short-haul system being produced.

Two other transmission systems that have been much discussed for short-haul purposes (though "short-haul" is not an adequate description of them) are the TJ and PCM systems.

The TJ system is a radio link system for the frequency range 10,700–11,700 Mc/s, 240 telephone channels or one TV channel, base band 5 Mc/s, FM modulation, output 400 mW direct from a klystron. Maximum length of entire link 500 km. Transmission: line of sight propagation between relay stations, which are 40–60 km apart. Otherwise the system is based on the same principles as the TH system and, purely technically, TJ may be said to be an intermediate step between the TD and TH systems.

The PCM system T-1 is a 24-channel time-division multiplex system with the bit frequency 1,536 Mc/s. Total length: 200 km (for system planned). Transmission: four-wire in cables. Repeater spacing: about 2 km. Existing cables can be used. As in all digital systems, the terminal equipments are fairly complicated, while the relay stations are very simple. It is doubtful when a PCM system will become profitable. The present prices of semiconductors are at all events too high to make it an economic proposition.

Table 2. Basic data for long-haul system

	1950s	1960s	1970s
Designation.....	TD-2	TH	
Frequency.....	3700–4200 Mc/s	5925–6425 Mc/s	35000–75000 Mc/s
Number of radio channels (broad band).....	6	8	80
Bandwidth of broad band channel (base band).....	5 Mc/s	10 Mc/s	10 Mc/s
Number of telephone channels per broad band channel	600*	2220**	2220
TV channel with colour...	1	1+780 tele- phone	1+780 tele- phone
Modulation.....	FM	FM	PCM
Frequency swing (or bits/sec)	± 3 Mc/s	± 4 Mc/s	160 Mc/s
Transmitter output.....	0.5 W	5 W	abt. 0.01 W
Transmission medium.....	straight line through air	straight line through air	2" wave guide
Noise factor, receiver.....	13 db	8–9 db	abt. 18 db
Essential new technique....	planar triode amplifier tube	TW tube "uniline"	mm wave tube

All these systems are based on frequency separation of the telephone channels.

\* Originally 480 telephone channels.

\*\* Initially 1860 telephone channels.

TD-2 in commercial use first in 1950.

TH » » » » » 1960.

In the field of radio link and waveguide systems the A.T.&T. group in the U.S.A. has been paramount. It is perhaps especially in this field that the enormous American resources have achieved their most unique results. The table 2 presents the data of the systems of current interest. The chief elements that have made possible the new TH link are travelling-wave tubes with 5 W output, ferrite isolators and the horn reflector antenna. Practically all other components have at the same time been greatly improved.

As regards the waveguide systems, the critical question is whether mm wave generators can be built sufficiently cheaply (klystrons or backward-wave oscillators). There are likewise certain problems involved in the travelling-wave tubes for the regenerative amplifiers. It is possible that tunnel diodes might be used for this purpose.

During the fifties the requirement of broad band transmission over longer distances past geographical obstacles led to the development of the scatter circuits. The scatter technique has been made possible by the development of powerful transmitter tubes and large antennae for transmitters and receivers. In the late fifties came parametric amplifiers and masers, as a result of which more sensitive receivers can now be built.

Table 3. Basic data for scatter and satellite systems

	1950s	1960s
Designation.....	Scatter circuit	Satellite system
Frequency.....	2000 Mc/s	6000 Mc/s
Base band.....	600 kc/s	5 Mc/s
Number of telephone channels (frequency multiplex) ..	60	600
Number of TV channels....	0	1
Modulation.....	FM	FM with negative feedback
Modulation index.....	2	0.1
Transmitter output.....	1 kW	10 kW
Antennae.....	10 m parabola	30 m parabola
Number of satellites.....		24 in 5000 km orbit
Satellite diameter.....		100 m
Noise temperature of receiver	3000° K	25° K
Transmission.....	scatter	free space propagation
Range.....	300—400 km	6000—8000 km
Essential new technique....		masers, satellites

The aspiration to enter outer space has, as we all know, also led to epochal results in its bearing on long distance communication. Satellites for this purpose may be divided into two categories: active, with the same functions as a "normal" relay station, and passive, which function simply as reflectors. A system with active satellites and global coverage requires three satellites in fixed positions at an altitude of 36,000 km, while a system with passive satellites requires 24 satellites in a roughly 5,000 km orbit. Obviously a system with active satellites requires very much more of the satellite and its equipment in respect to useful load and operational reliability than a system of passive satellites in which the actual satellite is of the simplest imaginable construction and also very light. The active satellite will also be very difficult to steer into its proper orbit. Presumably, too, it would be easily disturbed by a powerful radar beam. At least during the first half of the sixties, the passive satellite must be expected to be the predominant type for purposes of civil telecommunications.

## Automatic Switching

The past decade has been characterized by the breakthrough of the crossbar systems on a broad front. The crossbar switch has remained essentially unchanged for more than 40 years – the only modifications, virtually, having been in its adaptation to other manufacturing methods. The systems have attained a high degree of perfection. Their build-up has been governed to a large extent by considerations purely of system engineering, with a sound economic compromise between functions and components. It may appear strange that nowhere in the world has a cheaper switch been developed equal in performance to crossbar. The reason has naturally been that the whole direction of developmental work has been towards electronic systems. The opinion propounded by the American Bell group and accepted by many others, that electronic systems will fairly soon supersede electromagnetic, has detracted from any major efforts on the latter. Yet it would be surprising if some new electro-mechanical system were not evolved, should electronics prove to be still far from the stage of economic superiority. Under all circumstances electronics will have a great influence on future developments. Signalling systems, number groups and translation equipment are examples of what can be advantageously electronized.

The interest in electronic exchanges was stimulated by one of the great inventions of our time, the electronic computer. The techniques are in several respects alike. Yet the introduction of electronic exchanges would by no means be an event of such epochal significance as the data processing machines have been. The advocates of electronic exchanges claim that they will provide better traffic facilities, greater flexibility in interworking with other systems, and cheaper maintenance. Their volume and weight will be smaller. The developmental work on electronic exchanges has now reached the point at which the first field trial at Morris, U.S.A., has been started. Next year military systems will be put into operation, the functional requirements of which are no less exacting than for civilian use. Experience from these and other field trials, especially in the U.K., should fairly soon give a better idea of the spheres for which electronics are most suited. But it is already clear that, apart from military applications, for which electronic equipment is for special reasons often preferable, the future of electronics is rather a question



Fig. 3

X 2502

Ferreed with windings removed

(The Bell System Technical Journal, January 1960)

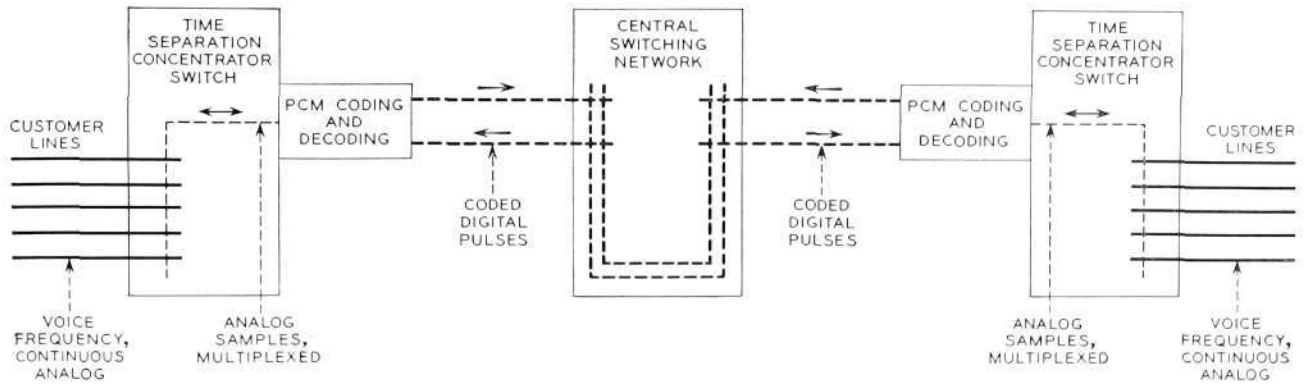


Fig. 4 X 7798  
**Integrated time-multiplex communication system**  
 (The Bell System Technical Journal, July 1959)

of price than of new and improved functional facilities. A handicap in the introduction of electronic systems is that they would require entirely new telephone sets. This might be compensated to some extent if keyset telephones were in any case to be made available.

The very fact that new telephones will be required, and that no suitable semiconductor has been found for the switching network, is the reason for Bell's production of the ferreed. This is a relay with magnetic lock built on a core circuit of square-loop ferrite (fig. 3). The relay has two make contacts in two separate glass tubes. These relays are used in the switching network, while memory and logic units will be all-electronic. The relay is extremely rapid and requires only one pulse of about 60  $\mu$ s to operate, so enables use to be made of the speed of the electronic marker. At the same time still more relays must be introduced for transmitter feed, ringing, ring-trip and clearing; the equipment is therefore quite far removed from all-electronic systems.

Which way development will take – towards conventional systems with a limited interspersing of electronic elements, bastard systems such as the ferreed system, or all-electronic systems – is not easy to say. There is still another possibility, namely an integrated switching and transmission system. A system of this kind has been presented by Bell Telephone Laboratories under the name of ESSEX. It has time division multiplex throughout (fig. 4) with line concentrators based on pulse amplitude modulation (PAM). In the line concentrator a change is made to pulse code modulation (PCM), and all other communication in the system is on PCM basis.

A more radical system has been proposed from Sweden. This system also employs time division multiplex with PCM transmission between exchanges. In principle the subscriber's line network also works on a four-wire basis. On grounds of cost, however, four wires cannot be used physically, but ordinary analog transmission is used in one direction and delta modulation transmission in the other. The delta modulation takes place in a central data processing equipment which stores the last amplitude value for each conversation. The difference between the present and the stored amplitudes constitutes the value in the delta modulation sequence, which is forwarded to line concentrator and telephone set. The telephone set demodulates the signal and the latter impinges on the receiver. It is thought that the system might embody the TASI method entirely, so achieving a radical saving in circuits. This system may be said to be the first integrated system in the full sense.

The integrated systems have certain advantages, which unfortunately, however, only become noticeable if fairly large portions of a telephone network operate on this basis. The advantages derive from the fact that the same information carriers are used throughout the system. The conventional switching technique with space separation may be said to be integrated with ordinary physical circuits; if from there we proceed to multichannel systems, the exchanges as well should be electronic; and for the whole communication system to be integrated, the same information carriers should be used throughout, which in practice would involve pulse systems.

Within parentheses it may be remarked that integrated systems on a frequency separation basis would require electronic exchanges on the same basis. This is not practicably possible without easily switchable filters, of which at present there seems to be no prospect.

## Advances in System Engineering and Analysis

The enormous advances in the field of mathematics during the last decades will bear fruit also in telephony. Mathematical statistics in particular will find progressive applications. First there is traffic research, a classic field for mathematical statistics. With the breadth that this research now has in the world, many a long-debated problem may well find its solution. The nature of telephone traffic will undoubtedly be further elucidated. Some practical problems which will be cleared up are minimization of the number of switching points in switching networks, and queuing problems with different types of interworking markers. Catalogues will be issued of gradings and so on. Digital computers will be used to a greater extent for different problems of telephone traffic analysis.

A related sphere of applied mathematics, operations analysis, will also have wide applications. Certain fundamental problems are likely to be dealt with. One such problem, with wide implications, is the analysis of whole telephone plants in order to obtain uniform dimensioning in every respect, as regards congestion, attenuation and fault rate. The common denominator, so to speak, will be the inconvenience or cost to the subscriber or nation resulting from these inevitable imperfections. Different types of fault will be evaluated. Digital computers provide an entirely new means of analysis of alternative solutions for the planning and location of exchanges. Maintenance, fault tracing etc. will be dealt with by operations analysis.

It was thought that the rediscovery of Boole's algebra in the forties would provide a short-cut in the design of relay circuits. This hope was disappointed since the setting of the problem is as difficult as the finding of the solution. Boole's algebra, moreover, does not appear to be sufficiently flexible when relay times as well enter into the problem. Another approach will probably be tried, by programming a digital computer to solve the problems. This would undoubtedly be no easy task and would take a considerable time to develop. It would be easier to check a found solution in a digital computer. For problems of this kind the computer technique with programmed logic has certainly had a great influence on the design of markers and similar equipment.

Digital computers have for a long time been used in an entirely different field, for the computation of filters. Even very complicated filters can now

be calculated at a reasonable cost. One problem which has hardly been possible to attack earlier, for filters with many components, is to calculate the tolerances that can be accepted consistent with the requirements on the filter. This is manifestly of great economic importance. Clearly we are at the initial stage of a development which will give us better and cheaper products for a lower engineering effort.

The analog computers also have their given sphere of use: the preparation and dimensioning of analog systems such as amplifiers and servo systems, e.g. for pilots in carrier systems.

These are some gleanings of what we may look to in telephony during the near future. They represent an extrapolation of the existing situation, with a personal colouring which can undoubtedly be contradicted on many points. In one respect we can be quite certain that the future will differ from our prophecies today. New inventions, at present unknown or still in their birth-throes, will give a richer spectrum to telephone engineering. Warrant of this is the growing cadre of able technicians working in telephony throughout the world, as also the growing market for telephone service which is a source of satisfaction for administrations and for industry alike.

# A New Method of Construction for Transmission Equipment

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UDC 621.395.44:62.002.2  
LME 102, 84

*The article and the subsequent one in this series will deal with L M Ericsson's new method of construction for transmission equipment. A short survey is given in this introductory article of the crucial factors in the decision to carry out a new design. Primarily, the desire has been to obtain an efficient method of construction for the new transistorized group and supergroup equipment. Furthermore, the article describes the general mechanical features of L M Ericsson's new transmission equipment: design details, however, are only gone into where these are of importance for the mechanical or electrical functioning or for maintenance.*

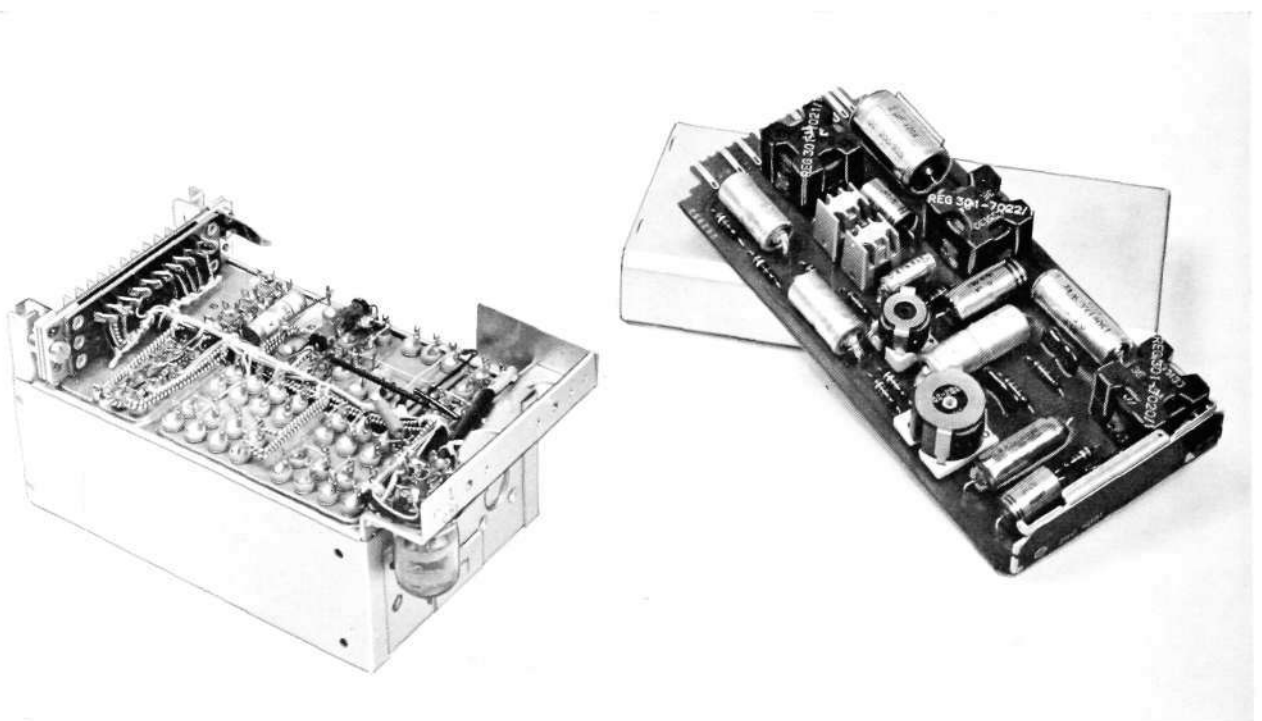
## I. Background to Design

The development of the toll telephone network which has taken place in the last decade has everywhere been characterized by a violent and continuously intensified expansion. As an example of this, it can be mentioned that for the Swedish national network during the decade 1948–1958, the number of circuit kilometres has increased threefold. It should here be added that no less than 50 % of the increase of the line network occurred in the latter third of the period and that the proportion of carrier lines in the increase was over 60 %.

Another sign of the development which has taken place as regards the volume in the field of telecommunications is that carrier systems for up to 2 700 telephone circuits per system have been standardized by CCITT and these have in fact been found by telephone administrations to be economi-

Fig. 1  
Channel amplifier of earlier construction (left)  
and new construction

X 7786



cally attractive. This means that much carrier equipment has shown the same large increase. In this way it has become more and more necessary for telephone administrations to demand that equipment, while retaining its performance as far as possible with reasonable technical outlay, fulfils the following requirements:

1. Occupying small space
2. Consuming low power
3. Needing little maintenance

Point 3 has gained further current interest due to the ever-increasing lack of technically qualified staff.

In 1958, the main features of the mechanical framework of L M Ericsson's new method of construction for transmission equipment were ready for production. The method of construction is primarily intended for those parts of the carrier terminals where telephone channels are assembled into groups and supergroups, i.e. for transmission equipment whose frequency does not exceed 0.5 to 1.0 Mc/s.

The reason why L M Ericsson have decided on carrying out the work of a comprehensive new design only 10 years after the previous revision of the method of construction took place, is to be found in the very great advances which have occurred in the last decade, especially in the field of components.

If these improvements were to be exploited to the full, this exploitation had to occur in a rational and methodical manner. Only in this way could full justice be given to the requirements laid down for space occupied, power consumption and maintenance. The desired result would not have been obtained by merely building in new components and using new manufacturing techniques in the earlier method of construction.

As a crude simplification, it can be said that two components especially have been decisive in determining the commencement of the work of new design; these are the transistor and the etched wiring board.

As far as the transistor is concerned, this component offers many advantages when compared with the electron tube. The transistor has small dimensions and low power consumption, which means a correspondingly low dissipation and thereby provides the possibility of having a more compact method of construction. It is a fact that in designs containing electron tubes, it is not always possible to utilize the miniaturization which has occurred generally in the field of components, just because the heat dissipation per bay side in such a case would exceed the permissible value.

It should be remembered that the transistor could not be considered as a design element in complex telephone systems before the problem of operational reliability and effective life was solved in a satisfactory manner. So far, no theoretical limits to the life of the transistor or the semiconductor diode have been found. With progress in the field of semiconductors, this should lead to the possibility of producing transistors whose life is of the same order of magnitude as that of passive components.

Progress has not yet gone so far. The arrival of types of transistors which are more suitable to mass production such as transistors of the alloy type or diffused type, together with an ever-increasing experience in the various manufacturing processes, has however already resulted in long-life transistors having a better average life than that normally obtained with electron tubes. Thus the way is open to make full use of all the advantages of the transistor in the field of telecommunications.

As mentioned previously, the demand for carrier equipment is ever increasing. This also naturally affects the production of this material which must be put into larger and larger production runs. The introduction of etched wiring for the apparatus units is a necessary step to a more rational manufacture. As a by-product of this technique, a product is obtained which

has a more even quality and is more consistently reproducible; this is of importance having regard to the stringent requirements which have been placed on the individual apparatus units. The work of assembly, especially soldering, is greatly simplified, as all soldering points lie in one plane easily accessible for the soldering tool and clearly visible when inspection is carried out. In this way, an appreciable improvement in the quality of soldered joints can be expected.

The etched wiring board places completely new mechanical demands on the electrical components. For example all the inductor and transformer types have been redesigned so that they are suitable for this new wiring technique. The plug and socket connexion between the wiring of the apparatus unit, viz. the etched wiring board and the bay cabling has also had to be redesigned owing to the introduction of the etched wiring board. In short, it can be said that starting from the etched wiring board, the design of the apparatus units has been completely changed.

The miniaturization which is provided by the transistor, and to which of course contributions have also been obtained from other steps forward in the field of components—for example, better ferrite material—has meant a reduction of space requirement to a third of that for the earlier method of construction. This means that the optimum bay is no longer a tall double-sided bay but is a single-sided bay of approximately half the depth. A logical treatment of all the new points of view coupled with the experience obtained, for example as regards maintenance, from the earlier method of construction has led to a completely new design of all the mechanical details, even as regards bay design, which are used in carrier systems.

We are convinced that by dealing with problems consistently and by avoiding unsatisfactory compromises between earlier and new methods, a design of transmission material has been successfully obtained which does justice to all the demands placed by the customer and by a rational production on a modern method of construction.

## II. Mechanical Design

### General

For a layman, the mechanical design problems associated with the development of a new construction technique for transmission equipment may appear relatively simple compared with, say, those in selector switch design, where the mechanical parts, mostly moving parts at that, are directly included in the signal path, whereas in transmission equipment their main function is only to support and contain the electrical components and their wiring.

That is correct as far as it goes, but the design problems are of quite a different kind. Transmission technique uses considerably higher frequencies than exchange technique, so that in the mechanical design much greater account has to be taken of electrical requirements, such as for instance screening between different pieces of equipment or units. A further example is that by its nature transmission equipment is composed of a great number of different types of products, so that for a design to be economically competitive it must fulfil stringent requirements for flexibility and universal applicability of its component parts.

### *Previous Mechanical Design Principles*

The earlier construction practice for transmission equipment was to use a double-sided 19-inch rack with a maximum height of 2 590 mm (8' 6"). The

units were either connected by plug and socket or built up on panels of the full width of the rack, with appropriate dust covers.

Because of the large number of sub-units, this construction was relatively costly to produce, while at the same time its exploitation of available space was not very high by modern standards.

### *Aims for the New Mechanical Design*

The aims in designing for the new construction technique can by and large be summarized as follows:

- a) Transistors should be used where feasible instead of electron tubes.
- b) The units should be simple to manufacture and involve as few production steps as possible. This can be achieved by using printed wiring techniques, which moreover results amongst other things in a more uniform and compact product; at the same time sub-units are avoided.
- c) The mechanical construction of the equipment should be so arranged as to permit a sub-division into functional units from the electrical point of view. For the sake of greater flexibility these units should be of plug-in type and therefore replaceable.
- d) Space utilization should be high, i.e. the design should be compact, but not at the cost of reduced accessibility (e.g. for repairs) or excessive weight. The weight could, however, be kept low by using light alloys in large measure as constructional material.
- e) The bay should be single-sided for increased flexibility in station planning, and should keep within certain maximum dimensions. Nevertheless, it should be possible to accommodate channel modems, signalling and power supply equipment for 60 telephone circuit terminals on a single bay side.
- f) The number of mechanical components in the design should be as low as possible, and as a consequence the field of application of each mechanical component should be as wide as possible.
- g) Routine maintenance measurements on the equipment should be possible without having to remove any dust covers.
- h) The equipment when mounted in the bay should as far as possible be protected from dust and electrically screened.

### *Principal Dimensions and Modular System*

A design which fully meets both the essential requirements and the desiderata set forth in the above aims has been realized in the new construction technique.

The design work has resulted in a bay construction in which the principal dimensions of the tallest type of bay are  $2\,743 \times 670 \times 236$  mm ( $9' \times 26.4" \times 9.3"$ ). A bay with this height is sub-divided vertically into 73 height modules of 36.5 mm (1.43"): the height module previously used was 44.4 mm (1.75"). Sub-division horizontally into width modules depends entirely on the unit construction principles and is described in conjunction therewith.

The rack and dust-covers are finished in pale blue-green stove enamel.

Compared with the earlier construction practice, the new technique has involved a complete re-design. As an example of the result, the new channel

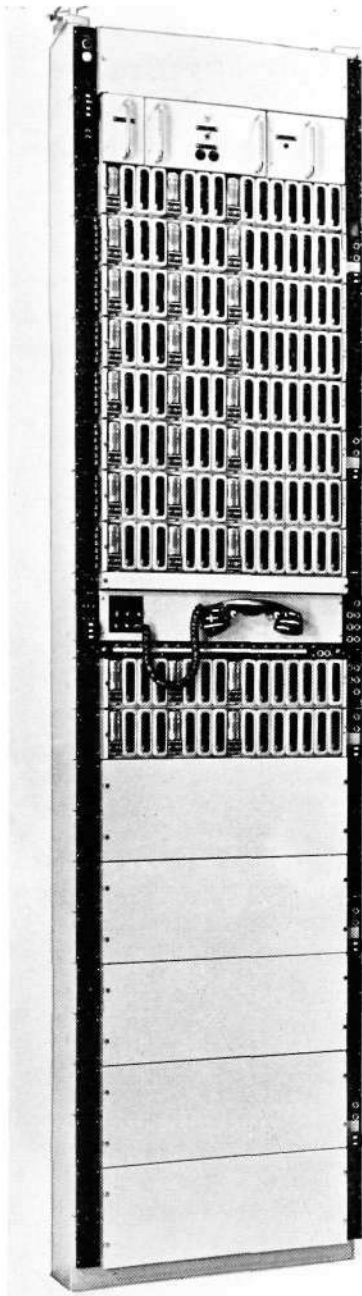


Fig. 2  
Channel translating bay, type ZDG 801  
with some of the cover plates removed



**Fig. 3**  
**Channel demodulator ZHP 10103/2**  
 left, completely assembled  
 right, case and back plate removed

X 8231

translating bay (type ZDG 801), whose dimensions are as given above, is shown in fig. 2.

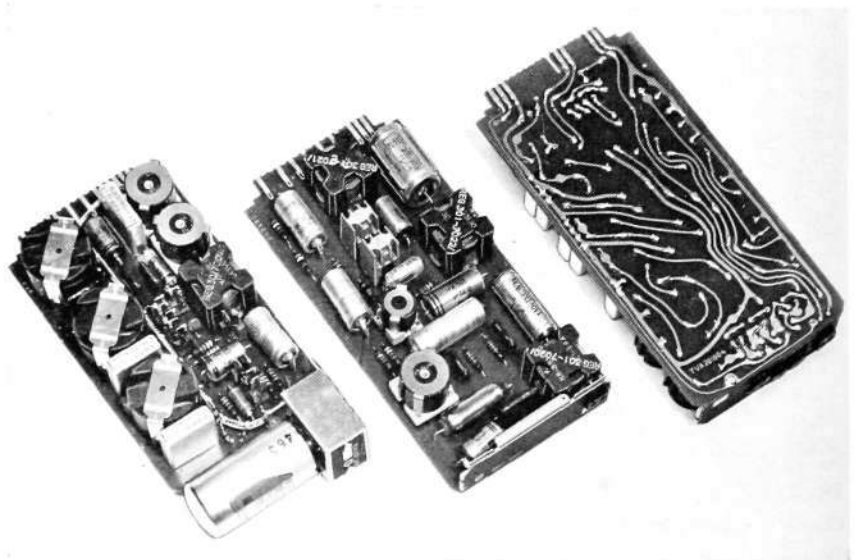
### *Unit Construction*

Despite the desire to have components for universal use, units of very different nature electrically must often unavoidably have different mechanical character. For this reason two different types of unit construction can be distinguished in the first place:

- 1) for units mainly with printed wiring
- 2) for power supply and alarm equipment

### *Units Mainly with Printed Wiring*

This type of units is illustrated in figs. 3 and 5. The electrical components in these units are to a great extent mounted on a printed wiring card, type TVA 201-209. This card has dual functions as a chassis for mechanical assembly and as the wiring between components, in the form of connexions etched out of a layer of copper foil on one side. To connect the components to the foil



**Fig. 4**  
**Units occupying a single width module**  
 (less cases and back plates).  
 Left, signalling receiver and relay  
 centre, channel amplifier  
 right, channel demodulator (printed wiring side)

X 8232

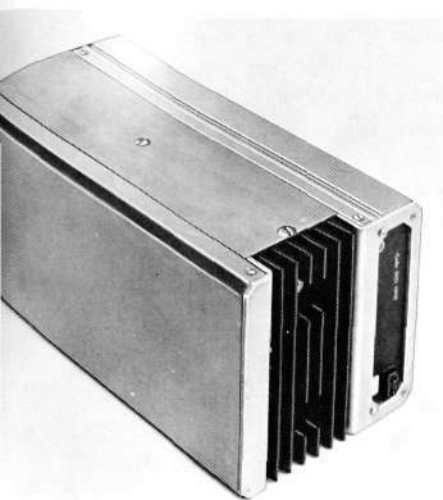


Fig. 5 X 2527  
 Unit occupying 3 width modules  
 This particular unit has cooling fins for power transistors.

wiring, their soldering tags or leads are passed through holes in the card and bent over, after which they are soldered to the foil. This bending and soldering also serves to fix components of normal size to the card: heavier components are further secured by means of clips, retaining clamps etc.

Fig. 4, right, shows clearly how the rear edge of the card is shaped as a plug strip to which the printed wiring is taken, and whereby the unit is connected to a socket strip (type *RNV 212*) which is fixed to the bay where the unit is to be placed. The unit cannot be plugged into the bay the wrong way round, as the plug and socket are made non-reversible through an unsymmetrically placed notch in the card and a corresponding protrusion in the socket. Every plug connexion has a gold-plated contact bent round the edge of the card and soldered to the printed wiring (see *Ericsson Review* No. 4/1958, page 126, fig. 4); this prevents the socket contacts wearing away the wiring foil and ensures good electrical contact on both sides.

A bracket is fixed to the front edge of the card: this bracket

a) supports any controls or such things as sockets for measuring points needed for fault location,

b) supports the front nameplate giving among other things the unit's code number, and

c) provides fixing points for the case. This type of bracket carrying sockets but without nameplate can also be seen in fig. 14.

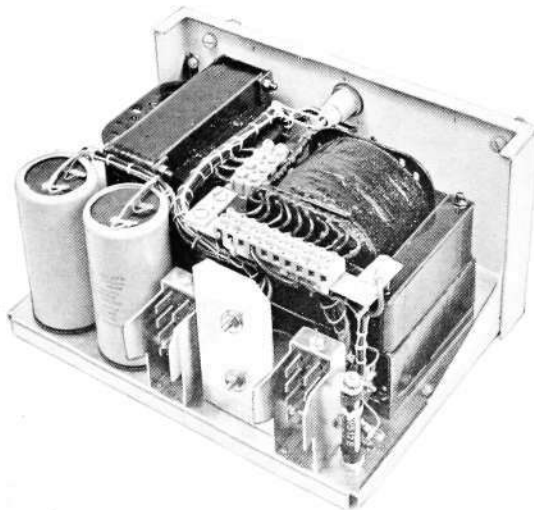
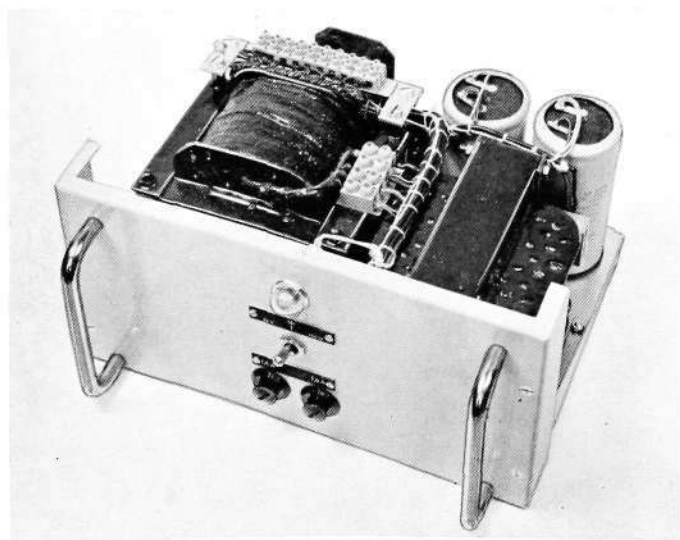
To provide electrical screening and to protect the unit from mechanical damage and from dust, the unit is surrounded by an aluminium case fixed to the front bracket. To close the back, a plate of polystyrene or polyester plastic of high impact strength is snapped into the back rim of the case, as may be seen in fig. 3. The case is produced by cold flow moulding and has longitudinal grooves internally into which the card slides.

A completed unit with the construction just described has dimensions excluding the plug strip of  $32.5 \times 101 \times 198$  mm ( $1.28'' \times 4'' \times 7.8''$ ). When placed on edge, 16 such units are accommodated within the width of the bay, and together with their supporting member occupy 3 height modules. The width module for this type of unit construction is 34 mm (1.34").

There are also certain possible modifications to this type of construction, for instance shorter units (see fig. 13, right) or special models such as the signalling receiver (fig. 4, left) in which the relay is placed outside the case.

The dimensions given above are naturally not always sufficient for every type of unit. Designs have therefore been produced for units occupying two

Fig. 6 X 7787  
 Power supply unit occupying 3 width modules  
 Left, front  
 right, rear



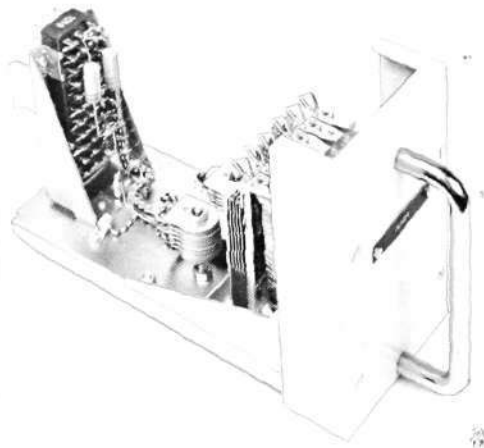


Fig. 7  
Alarm unit occupying one width module

X 2528

and three width modules. The construction is in principle the same as described above: the only significant difference is that these units can contain several cards clamped together, which thus also allows a greater number of external connexions. The fronts of these units can vary in appearance depending on what they contain; thus a unit might contain power transistors and require cooling fins, or it might include electron tubes which must be accessible from the outside. However, as in the smaller units, the front always carries a nameplate on the right-hand side. For 3-module units the cases are at present not manufactured by cold flow moulding for production reasons, but are fabricated from aluminium sheet and light alloy extruded section. An example of a unit of this type is shown in fig. 5.

### *Power Supply and Alarm Equipment*

Units with this type of construction are shown in figs. 6 and 7. These units are built up on a low chassis, beneath which there is practically only room for bolt-heads and nuts. A front panel, given the same enamel finish as the bay itself, is fixed to the chassis by brackets and is provided with a handle for removal of the unit. Plug-in connexions to the bay are provided by means of connectors of type *RPV 100-108* or *120*. The unit wiring is of conventional form.

The width module of 93 mm (3.66") for this form of construction has been obtained by dividing the total available bay width by 6. There are chassis etc. for 1, 2, 3 and 4 width modules. Four bay height modules are occupied by this construction.

### *Bay Frame and Fixtures*

#### *Bay Frame and Cabling*

The bay frame consists of two C-shaped upright members formed from sheet metal, held together by cross-members at the top and bottom: steel sheet has been chosen because of the large number of tapped holes in the upright members. The frame is enamelled and numbered in height modules from the bottom upwards along the edge bent inwards from the front (see fig. 9). The frame is provided with a number of tapped holes for each height module for fixing unit supports etc.

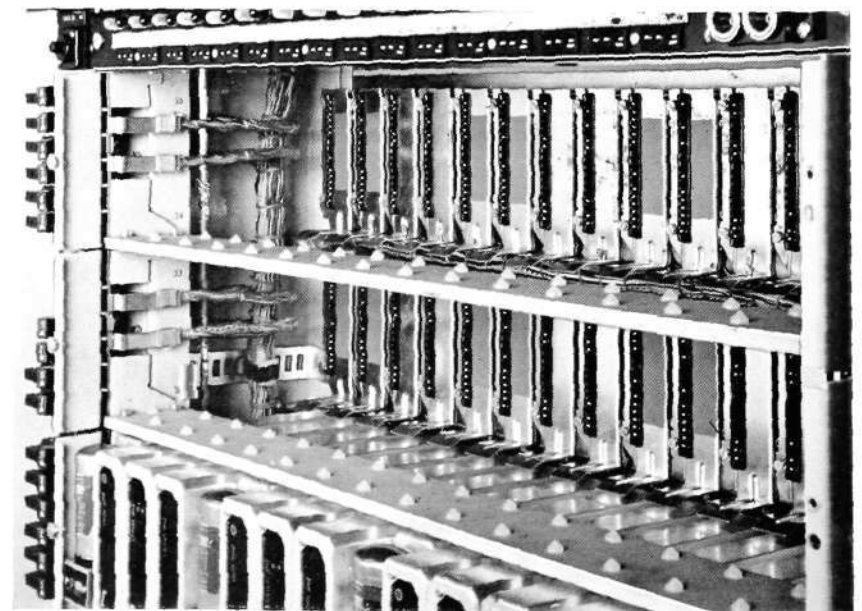


Fig. 8  
Shelf construction for units primarily with printed wiring  
The figure also shows how the bay cabling is run.

X 8233

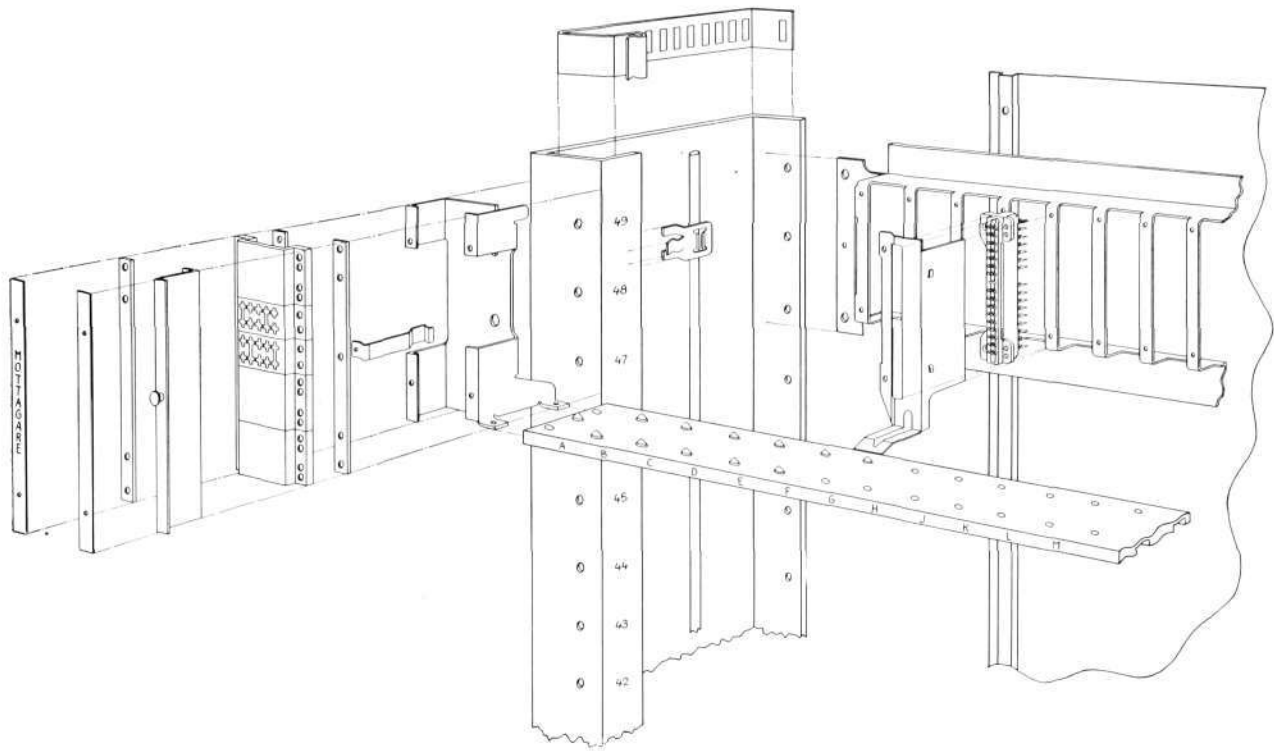


Fig. 9 X 7790  
Exploded drawing of the shelf construction of fig. 8

Inside the uprights of the bay frame run an earth busbar and vertical cable forms; the latter are secured at intervals to a number of perforated strips, in any of whose perforations a plastic-clad aluminium strap clip can be fixed and fastened round the cable form. Branch cables run from these vertical cable forms to the various unit sockets.

### *Shelf Mounting for Units*

This arrangement is shown in figs. 8–10.

As previously mentioned, units are placed in the bay with the card contact strips vertical. The contacts fit into corresponding sockets, type RNV 212; these sockets are bolted as required, each with a guide plate, onto a ladder-like transverse frame, which in turn is fastened to the bay.

The functions of the guide plate are to lift the rear of the unit so that the plug and socket mate correctly and also to provide shielding between adjacent sockets (fig. 10) by its backwardly-directed tongue.

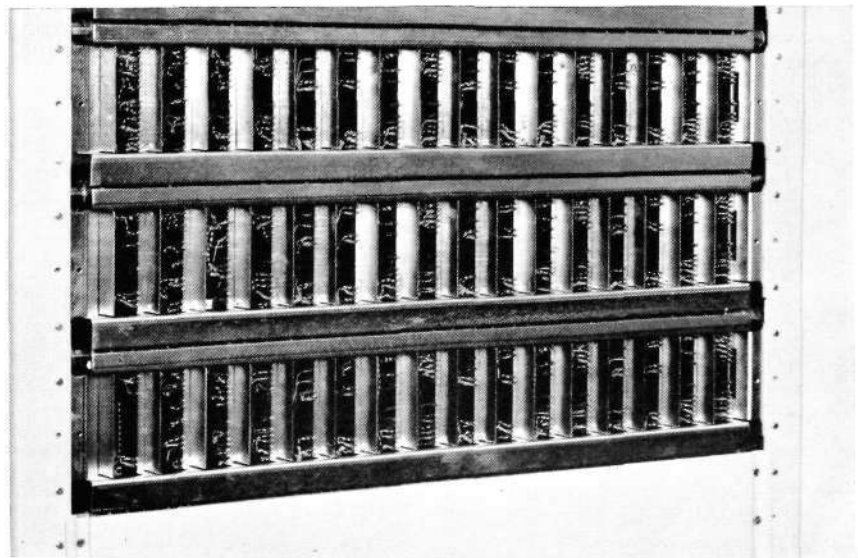


Fig. 10 X 8240  
Bay seen from the rear  
One of the covers has been removed to display the layout and soldering of the cabling and to show screening between adjacent sockets.

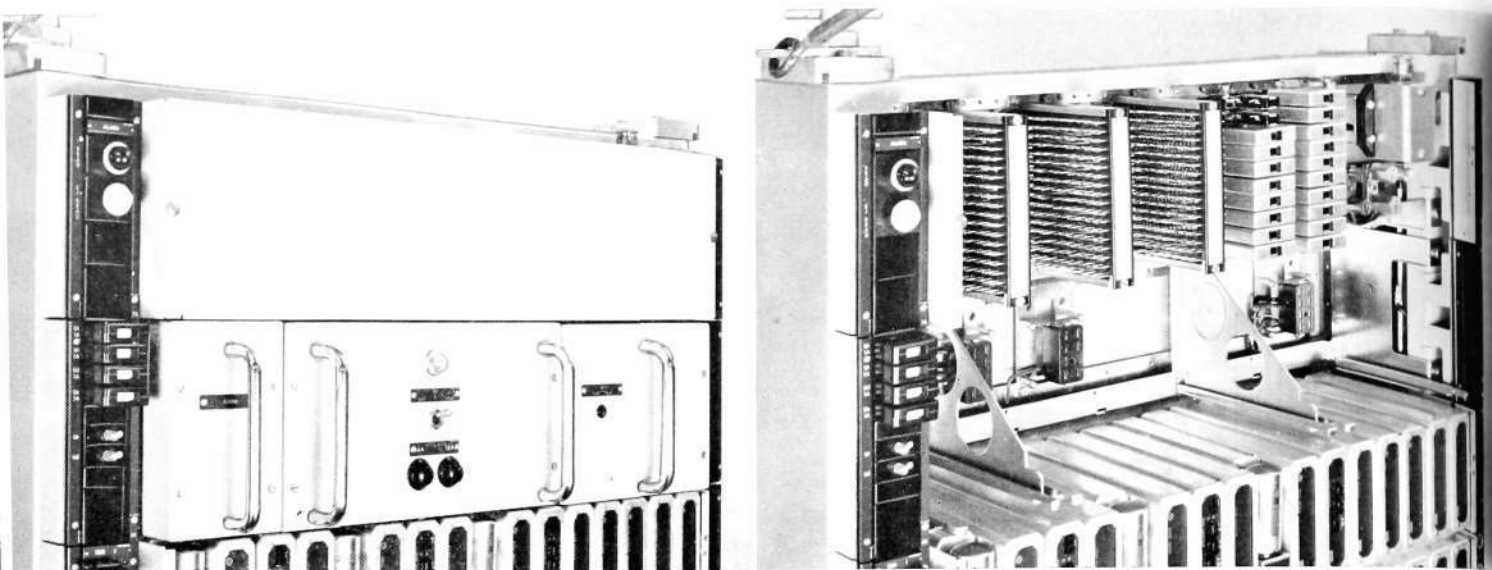


Fig. 11

X 7788

**Upper part of the bay**

Left, exterior of connexion field and power supply equipment.

Right, with covers and power supply units removed. Details of the connexion field and supporting brackets for the power supply units are visible.

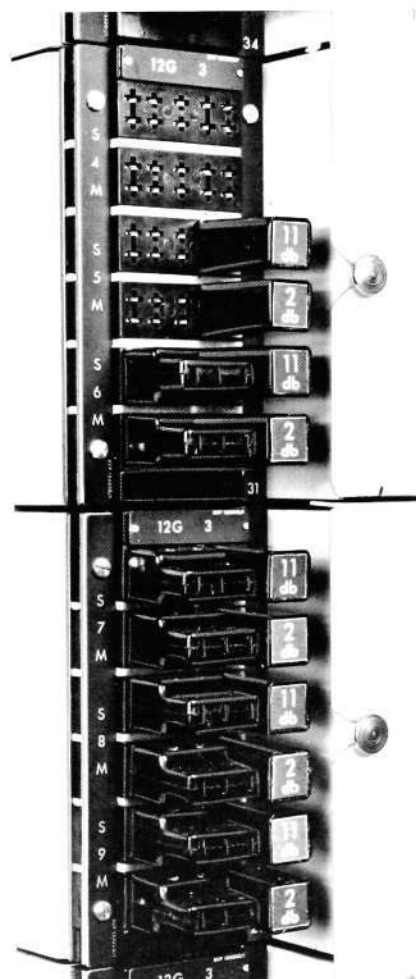


Fig. 12

X 2529

Details of bayside test blocks with U-links and plug-in pads

The horizontal branches of the bay cabling to each shelf run below the sockets and from there branch out upwards. By loosening the socket strips from the horizontal frame, the cabling and its soldered connexions are accessible from the front.

A light alloy bar, fixed to each side of the bay by a pressing, supports the units along their front edges. Along this bar there are conical plastic guide studs for every width module. These studs can be removed where necessary for units broader than a single width module. The bar is stamped along the front edge with the letters *A* to *S* for identifying the width modules.

*Supporting Brackets for Supply Units etc.*

The arrangements for supporting the plug-in units for power supply etc. can be distinguished in fig. 11, right.

The brackets have a groove along their lower edge in which the edges of the chassis run. They also have a limit stop so that the unit – usually rather heavy – cannot be completely withdrawn without lifting it out of the groove at the limiting position.

The cabling to the connectors is run along the lower edge of a horizontal frame of the same kind as described above for the shelf mounting.

*Arrangements for External Connexions*

For connecting the bay to the station cabling, a connexion field with an appropriate height dimension is built up by means of cross-members and bridge-pieces at the top of the bay. Except for power leads, only soldered connexions are used.

Fig. 11, right, shows some of the different connecting components which can be used in the connexion field. On the left are tag blocks of type *NEP 321*, each of which can provide for up to 180 connexions. To the right of these are tag blocks of type *NEP 401* for use with screened conductors: these blocks are provided with an aluminium screening can. There is a space for a label on the front of the block, visible through an aperture in the can.

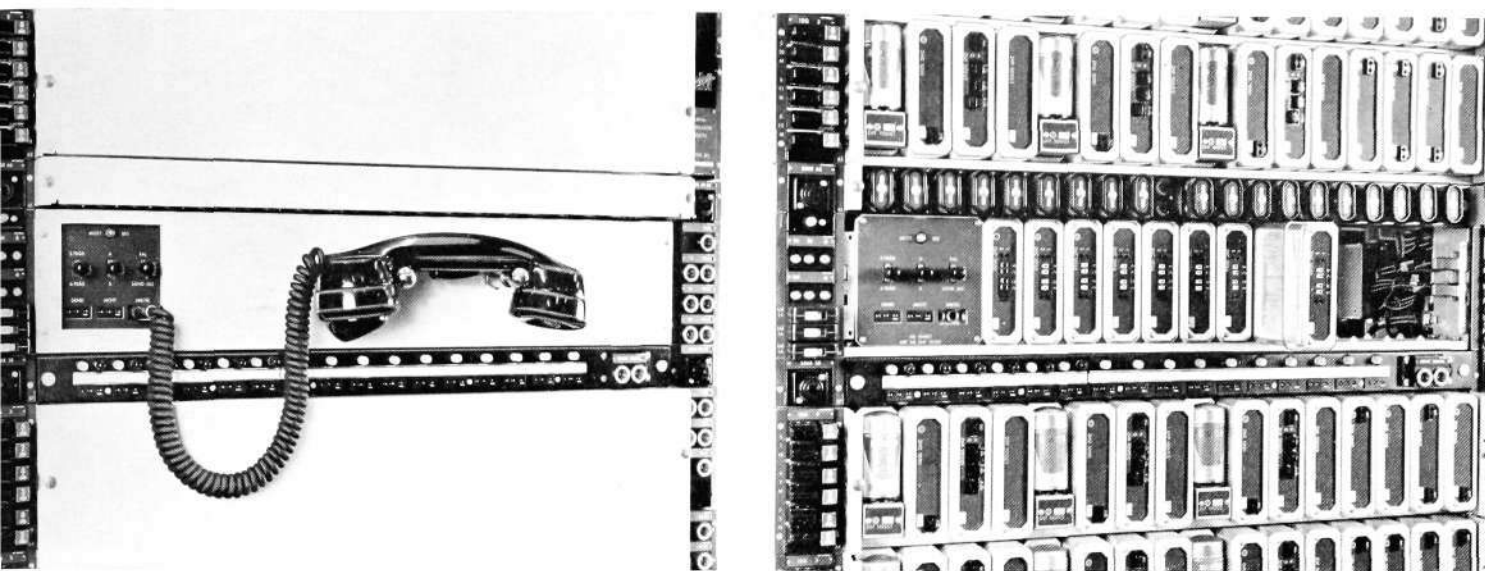


Fig. 13 X 7789

Central part of the bay

Left, exterior showing telephone and trunk panels. Right, same with covers removed.

The coaxial U-links above the telephone panel become visible; also, partly withdrawn, a shorter form of the standardized unit construction.

Above on the extreme right can be seen a mains power input connector with safety cover, and below this shrouded terminals for battery and earth connections.

*Bayside Testing Arrangements*

A large part of the fixtures for test facilities in the bay have been mounted on the upright members of the bay frame, as far as possible at a corresponding height to the units with which they are associated. These fixtures consist of lamps, fuses, U-links, measuring points, pads, etc., which either can be plugged into or are built in the form of strips which can be assembled into test-blocks of suitable height, e.g. 3 height modules. The assembled block is fixed to the same pressing which supports the horizontal bar for the shelf mounting arrangement. The cabling to the test block is run around the inside of the bay frame and is secured by a clip which also protects it from chafing when the units are plugged in. The arrangement can be seen in figs. 8 and 9. Details of an assembled block can be seen in fig. 12, and some of the possible constituent strips can be seen at the right in fig. 14.

*Fixed Panels*

Some of the test facilities can with advantage be placed on transverse members occupying the full bay width but only taking up a single height module. Two examples of this kind of design can be seen in fig. 13, right. The

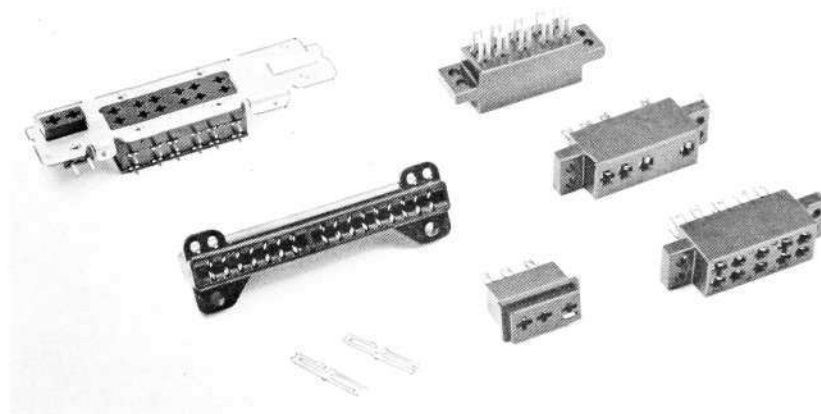


Fig. 14 X 8234

Various types of sockets

Left-hand row, from above: unit front bracket (RNV 21304), unit rear connector (RNV 21201), and 3-way socket with extra contact for busying out (RNV 21121).

Right-hand row, strips for bayside test blocks (RNV 21101—02).

Fig. 15  
 2- and 3-way U-links (type RPV 153), corresponding patch cord plugs (type RPV 171), and their component parts



upper panel carries a number of coaxial U-links; two plastic dummy inserts can however be seen in the centre of the panel. The lower panel provides outlets for bay and station trunks, with lamps for indicating when engaged, etc. The panels can be provided with a cover plate.

### Cover Plates

Mainly for aesthetic reasons, the front of the bay is equipped with cover plates except where there already is an enamelled front panel or where maintenance requirements introduce difficulties.

The cover plates are held in place by brackets on the bayside test blocks, and when removed can easily be stacked. In the left-hand edge they each have a slot which slips under a stud on the test block bracket, while on the right there is a snap fastening (see fig. 8).

Plates entirely cover the rear of the bay.

### Connectors and Accessories

The new mechanical design has also involved new designs of connectors, patch cords, fuses and other accessories. A few examples only of this are briefly described below.

#### Flat-contact Plugs and Sockets

To provide a flexible arrangement for unscreened connexions, gold-plated fork-shaped socket contacts are universally used; these together with some examples of their application can be seen in fig. 14. Flat-contact U-links and plugs designed to mate with these sockets are shown in fig. 15.

The connectors have in all cases been made irreversible by differences in the width and distance between contacts. The plug-in pads shown in fig. 16 also fit this type of socket.

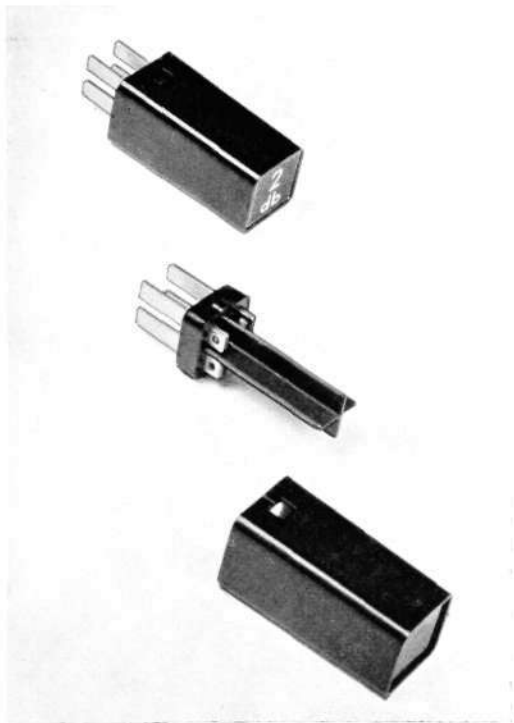


Fig. 16  
 Plug-in pad (type RER 424) and its mechanical components



Fig. 17

Fig. 17

X 8236

**Coaxial sockets (type RNT 149)**

First row from left: socket with two soldering tags for attachment of cable, and its screen.

Second row: socket for coaxial connexion, with panel fixing arrangements.

Third row: component parts of the latter socket.

Fourth row: component items of the fixing arrangement.



Fig. 18

Fig. 18

X 8237

**Coaxial plug (type RPT 159)**

with its component parts

### Coaxial Connectors

For flexibility in connecting screened conductors and coaxial cables, coaxial sockets have been designed for two-pole connexions and for connecting to both 8 mm and 5 mm coaxial cable – see fig. 17.

These sockets are designed to fit the coaxial plugs for 8 mm and 5 mm coaxial cable shown in fig. 18, and also the coaxial U-link shown in fig. 19. This U-link has been so designed that its components can also be used for a coaxial plug-in pad: it then carries a label giving the pad loss.

### Station Equipment

In a station the bays are assembled in suites back to back, and are held together by a dust-protected cable duct designed to carry the station cabling.

At either end of the suite there is a suite cabinet, one containing fuses and a power distribution board, and the other if so desired containing distribution arrangements for carrier supplies. One of the cabinets in addition contains common alarm equipment for the whole suite.



Fig. 19

X 8238

**Coaxial U-link (type RPT 160)**

Above, assembled; below, component parts

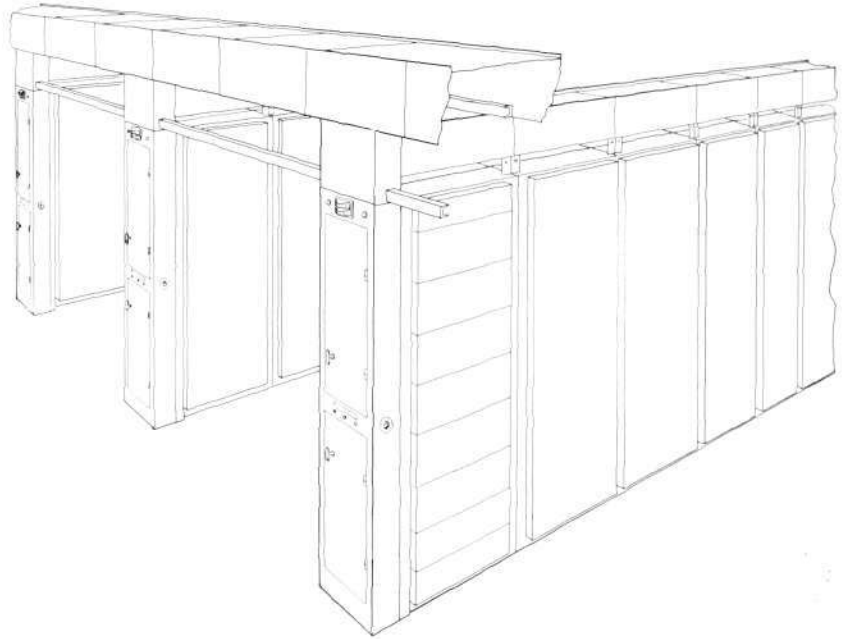


Fig. 20

X 8239

Perspective drawing of suites of bays in a station

This form of construction has the advantage that the station cabling can be set up before the bays are installed. A perspective drawing of the arrangement is given in fig. 20.

## Mechanical Data

### *Bay*

height, max.: 2 743 mm (9')  
 sub-divided into height modules of: 36.5 mm (1.44")  
 width: 670 mm (26.4")  
 depth: 236 mm (9.3")  
 weight:  
     exclusive of plug-in units, about 150 kg  
     fully assembled about 400 kg

### *Units with printed wiring*

height: 101 mm (4")  
 width:  $(n \times 34 - 1.5)$  mm  
 width module (16 modules to full bay width):  
     34 mm (1.34")  
 depth, max.: 198 mm (7.8")  
 weight, average: about 0.6 kg (1.35 lb)

### *Units for power supply etc.*

height: 144 mm (5.7")  
 width:  $(n \times 93 - 2)$  mm  
 width module (6 modules to full bay width):  
     93 mm (3.66")  
 depth: 210 mm (8.3")

# The Centralograph Used for Production Control of Punched Card Machines

L S Ö D E R B E R G, S V E N S K A E S S O A B, S T O C K H O L M

UDC 654.937.2:681.177  
LME 865

*For many years the Centralograph has been employed for supervising production in different branches of industry such as ironworks, textile factories, etc., where it has also been a planning aid.*

*More recently, the Centralograph has been used in Punched Card Departments to ensure improved utilization of the often expensive machines.*

*In the autumn of 1958, Swedish Esso installed a Centralograph system. In this article the supervisor of the Punched Card Department describes the experience gained.*

In order to be able to plan and improve the working processes in a Punched Card Department, its supervisor must coordinate three factors: the operators, the machines, and the processes.

Such coordination demands knowledge of several facts: machine occupation time, number of jobs, and the operators' capacity.

These facts are balanced against the volume of work and time factors. In general, the volume of work can be determined from experience without any special difficulties. The problem has been to obtain the necessary time factors in a way that is both simple and yet certain.

When punched card machines were installed at Esso, a scheme for obtaining time factors in the form of daily records of machine operations was created.

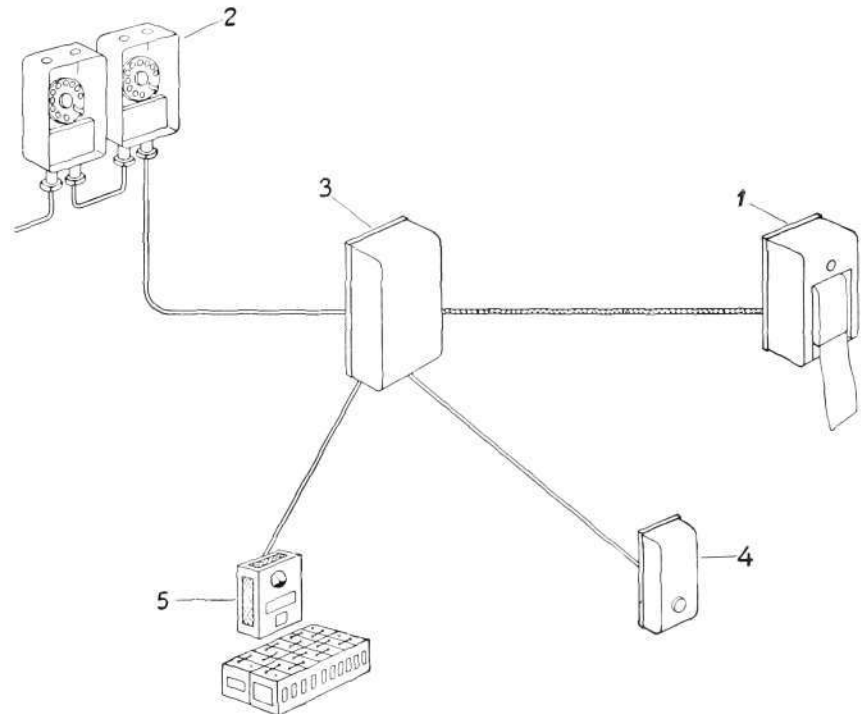


Fig. 1  
Diagram of Centralograph system

X 2215

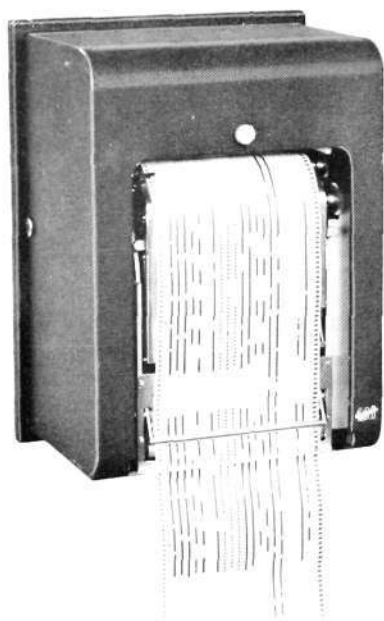


Fig. 2  
Centralograph recorder

X 2517

Each machine was allotted a form on which the operators recorded daily the necessary data such as job No.—operator No.—the time from start to finish of the operation performed, etc. Once a month these data were transferred to punched cards, from which summaries for analysis were produced by automatic machine processes. Analysing these statistics soon revealed certain deficiencies in the manual records. The operators either forgot to make records or made them up afterwards from memory. The impression gained was that the records had been adjusted, even if unintentionally. As a result of checking and supervision, improvements occurred periodically, but after a time the initial weaknesses again became apparent.

Another important disadvantage of these statistics was that no time factors existed for re-running, machine fault, repairs, etc.

The Punched Card Department tried, therefore, to discover a means of obtaining the required information more rapidly and with greater certainty.

In our opinion the Centralograph system has proved to be the solution to our problems. The system, installed by L. M. Ericsson in the autumn of 1958, consists of

1. Centralograph recorder
2. Dials
3. Relay set
4. Impulse transmitter
5. Power unit

The power unit, impulse transmitter, and relay set need not be discussed further in this connection. The all-important component is the recording instrument—the Centralograph itself, fig. 2.

This has 20 units which print short lines and digits on a continuously moving paper strip (the Centralogram). The principle of recording is the same as for a typewriter. The Centralogram is fed at a speed of 60 mm/h and is divided into 20 vertical columns (channels).

Ten machines are connected to each Centralograph via a network. When cards are being processed in the connected machine, electrical impulses are transmitted to the Centralograph recorder, which prints short lines on the diagram paper. Since the lines are printed under one another, the result forms a continuous vertical column, the length of which corresponds to the running time of the machine.

Digits are recorded on the Centralogram when the machine operator dials a code number, fig. 3. With single-digit code numbers, 20 machines can be connected to one Centralograph. Esso uses a two-digit code, however, so that 2 channels are necessary for each machine, resulting in 10 machines per Centralograph.

When processing starts and card feeding begins, the operator dials 2 digits corresponding to the job code, e.g., 56 = tabulating and summary-punching for billing.

When the job is completed, the operator dials a single code digit, e.g. 8, followed by the operator's number, e.g., 5 = 85, which then indicates that the processing is completed or that there is normal stoppage.



Fig. 3  
Report dial

X 2518

CODES FOR CENTRALOGRAPH

Main Groups:

General Accounting	01 - 14
Wholesale Accounts Receivable	15 - 19
Sales Records	20 - 44
Stock Records	45 - 54
Retail Credit Accounting	55 - 59
Salaries	60 - 69
Other Procedures	70 - 74
Misc. Operation Codes	75 - 76
Engineer's Codes	77 - 79: 00
Operator's Codes	80 - 99

Misc. Operation Codes:

75	Error Checking
76	Re-running

Engineer's Codes:

77	Repair of Machine
78	Inspection
79	Machine Repaired, Ready, resp.
00	Operator's Error

Instructions for Operation Codes:

- 1) Record Job No.
- 2) Begin Job
- 3) After about 5 min., record the current operation code. A 5 min. pause is necessary on account of the Centralograph's paper feeding.

Operator's Codes:

0	5
1	6
2	7
3	8
4	9

This operator's code, indicated in the example by X, is to be combined with codes 8 or 9 as below:

- 8X Normal Stoppage
- 9X Stoppage on account of Machine Fault

The operator's code is to be recorded when a process is completed.

Codes for the Different Jobs

2.

These codes shall be recorded when a process is started

General Accounting

Code	Frequency	Description
01		Zero Balancing
02		Dist. by Account
03		Trial Balance
04		Balance Sheet
05		Purchases and Sales Ledger - Product Turnover Ledger
06		Ledger for Misc. Accounts
07		Marketing Expenses Ledger
08		Summary of Marketing Expenses (Exh. 800)
09		
10	E	Exh. 802 - Expenses - Spec. of Transportation Costs
11		
12		
13	A	Statistics of Travel Expenses
14		Misc. Jobs

Wholesale Accounts Receivable

15		Prod. Invoice Summary Cards
16		Remittance Lists
17		Aged Trial Balance
18		
19		Misc. Jobs

Sales Records

20		Zero Balancing by Sales Report/Check List - Gang Punching of Master Data - Rep. of Sales Detail Cards - Sales - Balancing of Sapa's Sales
21		Pre-sorting for 650 - Procedure No. 1
22		Sales Entry Journal - Dist. of Trans. and Compensation - Spec. of Sapa's Wholesale Turnover - Spec. of Sales to Esso's Customers - Spec. of Esso's Sales of Lubricants
23		Energy Tax - Summary and Lists
24	E	Energy Tax - Lists
25		Sales Summary - SEE
26		Sorting Input-cards after 650 Procedure No. 1
27		Sales Summary - Exh. 100
28		Sales Statistics by District
29		Sales Statistics by Salesman and Product Group
30		Customer Records - DS
31		" - IS
32		" - CS
33		" - EK
34		" - SAFA
35		" - Petrochemicals/Asphalt
36		Sales by Product Code and Package Code
37		Sales of Fuel Oils
38		Package Balancing
39		Sales by Concern
40	A	Sales by Concern
41	A	Sales by Customer Code
42		
43		
44		Misc. Jobs

Stock Records

3.

Code	Frequency	Description
45		Zero Balancing by Transaction - Rep. Cards for Incoming T.-Tickets - Rep. Cards for Incoming Blendings - Producing Package Cards
46		Monthly Basic Reports - Blending Report - Summary of Own Consumption - Accumulated Differences - Inventory Report - Insured Stock
47		Stock Records by Company - Check List by Transaction
48		Stock Record by Bulk Plant - Checking against Stock Records by Company
49		Stock and Transport Differences
50	K	Stock and Transport Differences
51	A	Spec. of Product Name/Spec. of Product Stock by Product Code
52		
53		
54		Misc. Jobs
<u>Retail Credit Accounting</u>		
55		Zero Balancing
56		Tabulating and Summary-punching for Billing
57		Billing
58		Balance Lists, Remittance Lists, Dunning Letters
59		Misc. Jobs
<u>Salaries</u>		
60		Pre-jobs and Absence Statistics
61		Overtime Statistics
62		Check Procedure
63		Cost Dist. Procedure
64	T	Tax Procedure
65	A	Check List for Tax Authorities
66	A	Changes and Prep. of Master Files
67		
68		
69		Misc. Jobs

Remaining Jobs

4.

Code	Frequency	Description
70	K	Delivery Distribution Exh. 800 and 802
71	K	HIX - Report of Lubricants
72	A	Av. Bulk Deliveries
73		
74		

Remarks

Under the heading "Frequency" K refers to Quarterly Procedure  
T " " Tertiary Procedure  
A " " Annual Procedure

Where no code is given, Monthly Procedure is intended.

Example of the Recording of Codes

The machine in the example is a tabulator.

- 1) Insert box and record job No.
- 2) Set up the machine for running and run a test card.
- 3) Start the processing.
- 4) For fault checking or re-running, codes 75 or 76 shall be recorded after an interval of about 5 min.
- 5) If the processing has to be interrupted on account of machine fault, the operator's code shall be recorded combined with figure 9.
- 6) If the processing has to be interrupted for reasons other than machine fault, or if the processing is completed, the operator's code is to be recorded combined with figure 8.

Fig. 4

X 7799

Codes for Swedish Esso's Centralograph system

Fig. 5  
Centralogram

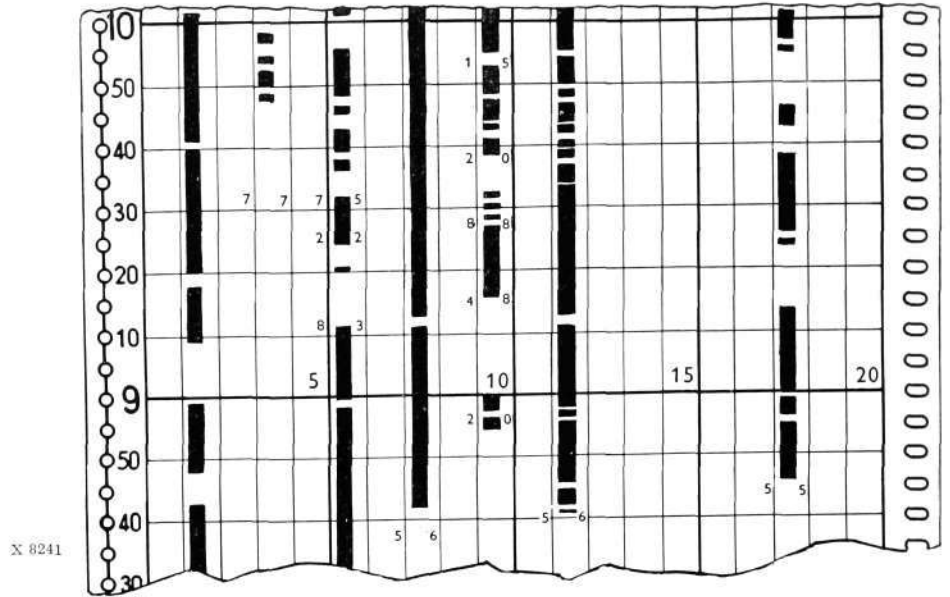


Fig. 6  
Summary of time factors and codes

X 7800

In this way the numbers at the beginning of a column show the particular job performed, while the numbers at the end of the column identify the operator and the reason for stoppage (completion of job, machine fault, and the like).

The Centralograph has enabled us to obtain absolutely definite control over the machine operations. The cards fed into the machine are immediately shown

SUMMARY FOR KEY-PUNCHING MACHINE ANALYSIS DATA										
Machine type	Year	Month	Week	Week-day	Machine code	Job No.	Mark X for code 75 and 76	Operator No.	No. of hours	
	Col. 1-2	Col. 3-4	Col. 5	Col. 6	Col. 7-10	Col. 11-12	Col. 13	Col. 14-15	Col. 16-17	Col. 18
<p><b>DIRECTIONS:</b> The Centralograph records the hour divided into six 10 min. periods. Since our statistics shall be suitable for the decimal system, the hour is divided into ten 6 min. periods; So the recording on the Centralogram must be read off on the scale.</p> <p><b>CODES:</b> Weekdays: Monday = 1 Tuesday = 2 etc.</p> <p><b>Machine codes:</b> Tab. No. .... = 4211 » » ..... = 4212 » » ..... = 4213 » » ..... = 4214 Reprod. No. .... = 5191 » » ..... = 5192 Calculator No. .... = 6021 Interpreter No. .... = 5521  Sorter No. .... = 0831 » » ..... = 0832 » » ..... = 0821 » » ..... = 0822 » » ..... = 0823 Collator No. .... = 0771 » » ..... = 0772 » » ..... = 0773</p>										

in that machine's "output" column. This means that time factors for productive time and idle time can be read off direct for each machine. In addition, these time factors for each machine have been supplemented by the coded data, dialled on the machine by the operators or service engineers. Fig. 5 shows the result of these for a limited period.

Every morning the previous day's recordings are analysed and processed as follows; with the aid of a rule graduated in hours and tenths of an hour, the time factors are measured for each machine and job. The codes indicated are

Fig. 7  
An example of monthly machine statistics

X 7801

LIST NO. 1 (per week)											
Job No.	Operator No.	NO. OF HOURS								Of which error checking & re-running	Week
		Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Total		
0.1	00	1 1		1 1	3 3	9 9			14 14		2
0.2	00	1 1		5 5	13 13	15 15			34 34		2
1.5	00	15 5	82 0						97 35		22
1.5	03	35 0	82						132		22
1.6	00	22 2	22	45 45	14 14	35 35			118 118		2

LIST NO. 2 (per week)											
Machine No.	Job No.	NO. OF HOURS								Of which error checking & re-running	Week
		Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Total		
0771	15			6						6	2
0771	22					2		2		4	2
0771	23			4						4	2
0771	24					9				9	2
0771	25							3		3	2
0771	29							2		2	2
0771	32				13	26				39	2
0771	36							17		17	2
0771	45							2		2	2
0771	46							3		3	2
0771	96	32		32						70	2
0771	98	29			20					57	2
0771	99				11					11	2
0771	99				44	51		29		229	2

LIST NO. 3 (per month)				
Job No.	Machine No.	REMARKS	No. of hours the whole month	Error checking re-running
0.1	4211		23	
0.1	4212		9	
0.1	4213		32	
0.1	5194		22	
			66	
0.2	0772		2	
0.2	0621		1	
0.2	0822		5	
0.2	0831		3	
0.2	0832		2	

LIST NO. 4 (per month)			
Operator No.	REMARKS	NO. OF HOURS	
		The whole month	Error checking re-running
79		29	1
80		163	8
81		65	2
82		50	1
83		93	6
84		230	7
85		81	6
86		115	7
87		165	0
88		149	8
89		82	5
93		1	0
96		1	4
		1229	53

checked and supplemented if necessary. Such amendments are seldom required but can be effected very easily since they are made the following day.

Time factors and codes are inserted manually on a summary (fig. 6) from which the cards are punched.

From these cards, the monthly machine statistics are produced by automatic machine operations. An example is shown in fig. 7. The weekly statistics show daily load, while the monthly statistics show total load.

What makes the statistics valuable for the Punched Card Department is the fact that they are based on reliable and correct time factors.

The statistics are analysed; from them the monthly summaries for the different runs are made, and diagrams for the most important types of machines are drawn. All this provides a basis for a punched card supervisor to plan and improve procedures, control and reduce costs as well as coordinate the three important factors:

operators—machines—processes

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

## Millionth 500-Line Selector Gift to Designer

At a ceremony at the Söderhamn factory of L M Ericsson on Wednesday, October 12, 1960, the millionth 500-line selector passed along the assembly line to its final testing station. Among those present were Messrs Sven T Åberg, Knut Kåell, Malte Patricks and Hans Werthén.

In a speech to mark the occasion Mr Åberg thanked all those who have brought the company's products to the position they occupy on the world market today. His remarks were addressed especially to Mr Kåell, the designer of the 500-selector, which had now reached the million mark. Mr Åberg presented the jubilee selector to Mr Kåell as a memento.

The basic principle of the 500-selector is the bare wire multiple invented in 1913 by Axel Hultman, Telephone Director of the Swedish Telecommunications Administration.

In 1918 Knut Kåell made a study of the most suitable size of selector in relation to cost and volume, and found that a 500-line selector would best meet the requirements. In co-operation with David Lienzén he designed a prototype of the 500-selector with bare wire multiple, which L M Ericsson still manufactures.

The first exchange operating on this system was opened in Rotterdam on May 10, 1923, being followed by exchanges at Hamar and Kristiansund in Norway in the autumn of the same year, and at Stockholm, Norra Vasa, at the New Year 1924. Orders thereafter flowed in in rapid succession. By the end of 1949, 500,000 of the selectors had been made at the head factory in Stockholm.

The 500-selector of today is still based on the original ideas, though certain parts have been redesigned and

improved in the course of the years. New production methods, new materials, and the severer operating requirements of exchanges have been the guiding factors.

All in all, at the year end 1959, 3,111,940 lines were connected to L M Ericsson 500-selector exchanges, and 401,110 lines were on order. Some exchange equipments have been manufactured by subsidiary companies, Elektrisk Bureau in Norway and FATME in Italy. The oldest exchanges are still operating with the original selectors.

(Above) Mr Sven T Åberg, president of L M Ericsson, presents the millionth selector to the designer, Mr Knut Kåell.

(Below) Messrs Kåell and Patricks, John Ericsson, Manager of the Söderhamn factory, Gösta Eriksson, foreman, and Mr Werthén follow the selector on its passage along the assembly line.





(Left) The signing of the contract in Belgrade. Sitting, from left: M Bulajić, Director General of Elektroveze (P.T.T. Purchasing Dept.), and N Berglind, L M Ericsson. Standing, from left: R Pašić, president of Merkantile Inozemna Zastupstva (L M Ericsson's Yugoslavian agents), F Sundkvist, L M Ericsson, N Bonetti, Merkantile, the legal adviser of Elektroveze, and A Mijušković and S Pejić of Elektroveze.

## L M Ericsson Exchanges for Yugoslavia *Trunk traffic to be automatized within two years*

In the face of hard international competition L M Ericsson has obtained orders from the Yugoslavian Telephone Administration for a large number of trunk and telex exchanges to an amount of 20 million Kronor.

Some twenty Yugoslavian towns are to be equipped with modern long distance exchanges and telex terminals operating on the crossbar system. This means that within two years the entire trunk network will be automatized

and that the present telex network will have tripled in capacity.

Some of this equipment will be supplied from the Yugoslavian telephone factory, Nikola Tesla in Zagreb, which since 1954 has been manufacturing L M Ericsson crossbar exchange equipments on licence. Up to now crossbar exchanges serving about 40,000 lines have been installed in about thirty Yugoslavian towns, and exchanges for another forty towns are on order and under production.

At Kitty Hawk, North Carolina, U.S.A., where the brothers Wright made the first motorized flight 53 years ago, there stands today an American national monument. For this monument L M Ericsson's affiliates, North Electric Company, Galion, Ohio, donated two busts of Orville and Wilbur Wright by the well-known American sculptor, Oskar J W Hansen.

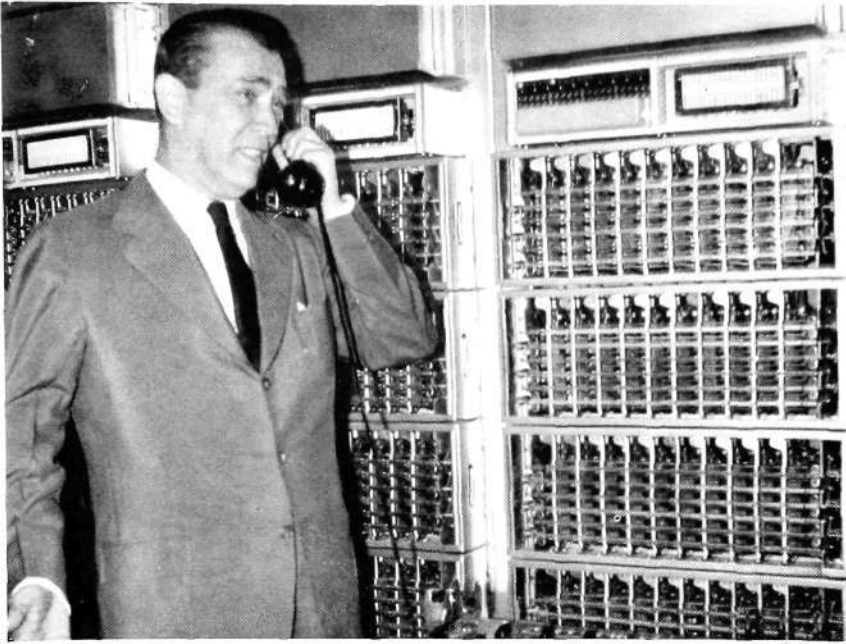


## Extension of 500-Selector Exchange in Chile

L M Ericsson has signed a contract with the city of Arica in Chile for the extension of its telephone network by 500 lines on the AGF 500-selector system. An AGF exchange with a capacity of 500 lines was opened in Arica in 1953. A further 500 lines were added in 1959.

The contract was signed by Arica's financial representative, Raúl del Canto (left centre), and the head of L M Ericsson's sales company in Chile, Lars Silfverling (right centre). Also present were (from left) Ferdinand Fay, head of L M Ericsson's Arica office, Adolfo Arenas, Mayor of Arica, Fernando González, Arica's Notary Public, and Alberto Maturana, the city's legal adviser.





The President of Brazil, Juscelino Kubitschek, some time ago paid his second visit to the Sul telephone exchange in the capital, Brasilia, for which L M Ericsson has supplied crossbar equipment type ARF. The exchange was cut over in April and has a capacity of 5000 lines. L M Ericsson has also received orders for eight smaller installations in Brasilia.

The stand of Ericsson Telephone Sales of Canada Ltd. at the Canadian National Business Show in Toronto.

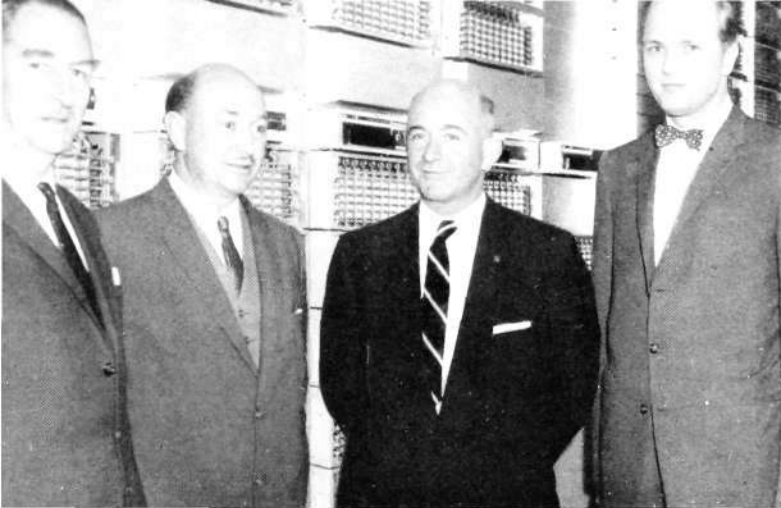
The Ericofon and other L M Ericsson products aroused great interest when recently shown on Labour Unions Day in Tangiers. Various companies showed their products in a parade of exhibits on wheels. The Telefónica de Tanger company, which has purchased L M Ericsson telecommunications equipment, presented the Ericofon among other exhibits (below).



The Sultan of Djokjakarta operates a model railway on a visit to L M Ericsson in Stockholm. Behind him is the Indonesian Ambassador to Sweden, R Sudjono. Others (from left): Press Secretary Sujud, Mr Klingström (LME), Commercial Secretary Adivoso and Mr Lundqvist (LME).



Lord Portal, former commander-in-chief of the Royal Air Force, visited L M Ericsson's head factory with Mr Sundgren of the Swedish Match Co. Lord Portal is on the left.



September 16 was the date of the cut-over of the first large automatic crossbar exchange supplied by L M Ericsson to Australia, the 6300-line Toowoomba exchange. Mr R W C Swartz, M. P. for Darling Downs District, presided at the inauguration. In the photograph (left) are seen, from left to right, Mr L G Rowe, managing director of L M Ericsson Telephone Co. Pty. Ltd., Mr Swartz, Mr E C A Brown, Director of Posts and Telegraphs, Queensland, and Mr L Estberger, L M Ericsson.

One of the largest cables made by L M Ericsson's Cable Works, Älvsjö (Sweden) — part of a delivery of telephone cable to Hong Kong Telephone Co., which started in November and is to be completed before the end of the year. It is a paper-insulated, lead-covered multiple unit cable, 2040 pairs, 0.51 mm, and 82 mm outside diameter. The delivery also includes 100—1400 pair lead-sheathed cable. The photograph shows a drum of PCUT cable 2040 × 2 × 0.51 mm for shipment to Hong Kong. The drum weighs 5000 kg.

## Mexicans Receive Swedish Honours

The Knight Grand Cross of the Order of the Northern Star was awarded to the Mexican Minister of Communications, Walter C Buchanan, at a reception at the Swedish Embassy in Mexico City. In presenting the Order the Swedish ambassador spoke of Mr Buchanan's great contributions to the development of Mexican telecommunications and of the hospitality always extended to Swedes in Mexico, in the matter of which Mr Buchanan was a notable example. In his reply the latter expressed his appreciation of the fruitful cooperation between Mexican and Swedish technicians over a period of decades, especially in the construction of the country's telephone network. The ceremony was attended by representatives of the diplomatic corps and of the Mexican government. Mr Buchanan and the Swedish ambassador Lennart Nylander are seen in the photograph below.

Mr Edward Hidalgo, for seven years chairman of the board of Compañía Comercial Ericsson, L M Ericsson's sales company in Mexico, has been awarded the Order of Vasa.



Mr Hidalgo, who is a very able commercial lawyer, has for many years watched over the interests of Swedish firms in Mexico and has on several occasions rendered valuable assistance

to the Swedish Embassy. In the photograph below are seen, from left to right, the Swedish ambassador, Mr Hidalgo and the head of Cía Comercial Ericsson, Mr Arne Melander.



UDC 621.395(047.1)  
LME 82, 83, 84

JACOBÆUS, C: *Trends of Development in Telephony*. Ericsson Rev. 37 (1960): 4, pp. 102—113.

This article sums up the present situation in different fields of telecommunications in the light of the developments in telephony during the past decade, going on therefrom to what may be expected during the sixties on the basis of the advances in fundamental sciences and in technology. The article is adapted from a lecture given to the Swedish National Association of Electrical Engineers on September 9, 1960.

UDC 621.395.44: 62.002.2  
LME 102, 84

ERIKSEN, E J & AXELSON, K: *A New Method of Construction for Transmission Equipment. I. Background to Design; II. Mechanical Design*. Ericsson Rev. 37(1960): 4, pp. 114—126.

The article and the subsequent one in this series will deal with L M Ericsson's new method of construction for transmission equipment. A short survey is given in this introductory article of the crucial factors in the decision to carry out a new design. Primarily, the desire has been to obtain an efficient method of construction for the new transistorized group and supergroup equipment. Furthermore, the article describes the general mechanical features of the equipment: design details, however, are only gone into where these are of importance for the mechanical or electrical functioning or for maintenance.

UDC 654.937.2: 681.177  
LME 865

SÖDERBERG, L: *The Centralograph Used for Production Control of Punched Card Machines*. Ericsson Rev. 37(1960): 4, pp. 127—132.

For many years the Centralograph has been employed for supervising production in different branches of industry such as ironworks, textile factories, etc., where it has also been a planning aid. More recently, the Centralograph has been used in Punched Card Departments to ensure improved utilization of the often expensive machines. In the autumn of 1958, Swedish Esso installed a Centralograph system. In this article the supervisor of the Punched Card Department describes the experience gained.

# The Ericsson Group

## Associated and co-operating enterprises

### • EUROPE •

#### Denmark

L M Ericsson A/S København F, Finsens Vej 78, tel: Fa 6868, tgm: ericsson

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

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

#### Finland

O/Y L M Ericsson A/B Helsinki, Fabianinkatu 6, tel: A8282, tgm: ericssons

#### France

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

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

#### Germany

Ericsson Verkaufsgesellschaft m. b. H., Dusseldorf 1, Worringer Strasse 109, tel: 84 461, tgm: erictel

#### 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

F. A. T. M. E. 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

Den Haag—Scheveningen, 10, Palaestraat, tel: 55 55 00, tgm: erictel-haag

#### Norway

A/S Elektrisk Bureau Oslo NV, P.B. 5055, tel: Centralbord 46 18 20, tgm: elektriken

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, P. B. Mj 2214, tel: Centralbord 56 53 54, tgm: signalindustri

#### Portugal

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

#### Spain

Cía Española Ericsson, S. A., Madrid 4, Conde de Xiquena 13, tel: 31 53 03, tgm: ericsson

#### Sweden

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

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

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

AB Ermi Broma 11, tel: 262610, tgm: ermiabolag-stockholm

AB Rifa Bromma 11, tel: 26 26 10, tgm: elrifastockholm

AB Svenska Elektronör 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: 69 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 Zürich, Postfach Zürich 32, tel: 325184, tgm: telericsson

### • 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: 28512, tgm: inderic

Bombay, Manu Mansion, 16, Old Custom House, tel: 254130 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: Gambir 50, tgm: javeric

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

#### Singapore and Malaya

The Swedish Trading Co. Ltd, Singapore 1, 42 Chartered Bank Chambers, Battery Road, tel: 249 64, tgm: swedetrade

#### Syria (UAR)

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

#### Vietnam

Vo Tuyen Dien-Thoi Viet-Nam, Saigon, 17, Cong Truong Lam-Son, tel: 20805, tgm: telerad

### • AFRICA •

#### British East Africa

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

#### Congo

Société Anonyme Internationale de Télégraphie sans Fil (SAIT) Bruxelles (Belgique), 25, Boulevard du Régent, tel: 125070, tgm: wireless (For maritim radio and carrier)

#### Egypt (UAR)

The Pharaonic Engineering & Industrial Co. Cairo, P.O.B. 126, tel: 4-36-84, tgm: radiation

#### Ethiopia

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

#### Ghana

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

#### Morocco

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

### Thailand

Ericsson Telephone Sales Corporation AB, Bangkok, P. O. B. 824, tel: 33991, tgm: ericsson

### Turkey

Ericsson Türk Ticaret Ltd. Şirketi Ankara, Adil Han, Zafer Meydanı, Yenisehir, tel: 23170, tgm: ellem

Istanbul, İstanbul Bürosu, Liman Han, Kat 5, No. 75, Bahçekapi, tel: 228102, tgm: ellemist

### • AFRICA •

#### Union of South Africa

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

### • AMERICA •

#### Argentina

Cía Sudamericana de Teléfonos L M Ericsson S. A. Buenos Aires, Casilla de correo 3550, tel: 332071, tgm: ericsson

Corp. Sudamericana de Teléfonos y Telégrafos S. A. Buenos Aires, Casilla de correo 3550, tel: 332071, tgm: cartele

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

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

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

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

#### Brazil

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

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

#### Canada

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

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

#### Mozambique

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

#### Nigeria

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

#### Rhodesia and Nyasaland

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

#### 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

#### Cuba

Mc Avoy y Cía Habana, Apartado 2379, tel: 7-2527, tgm: macavoy

#### Curaçao N. W. I.

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

#### Dominican Republic

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

#### Guatemala

Nils Pira Ciudad de Guatemala, Apartado 36, tel: 25114, tgm: nilspira

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

#### Colombia

Cía Ericsson Ltda, Bogotá, Apartado Aéreo 4052, tel: 41-11-00, tgm: ericsson

#### Ecuador

Teléfonos Ericsson C. A. Quito, Casilla Postal 2138, tel: 33777, tgm: ericsson

#### Mexico

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

Industria de Telecomunicación S.A. de C.V. México Jdré, Call Londres No 47, Colonia Juárez, tel: 250405, tgm: industel

#### Peru

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

Soc. Telefónica del Perú, S. A. Arequipa, Casilla de Correo 112, tgm: telefonica

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

#### Uruguay

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

#### USA

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

North Electric Co. Galian, Ohio, P. O. B. 417, tel: Howard 8-2420, tgm: northphone-galionohio

#### Venezuela

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

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

### • AUSTRALIA & OCEANIA •

#### Australia

L M Ericsson Telephone Co. Pty. Ltd, Melbourne C 1 (Victoria), 20 Collins Street, tel: MF 5646, tgm: ericmel

#### Honduras

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

#### Jamaica and Brit. Honduras

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

#### Panama

Productos Mundiales, S. A. Panama, R. P., P. O. B. 4349, tel: 3-0476, 3-7763, tgm: mundi

#### Paraguay

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

#### 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. 216, tel: 2541, tgm: kersten

#### USA

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

### • AUSTRALIA & OCEANIA •

#### New Zealand

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

## Agencies

### • EUROPE •

#### Belgium

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

#### Greece

«ETEP», S. A. Commerciale & Technique Athens, 11, Mackenzie King Street, tel: 617041, tgm: aeter-athinaí

#### Ireland

Communication Systems Ltd, Dublin, 40, Upper Fitzwilliam Street, tel: 61576/7, tgm: crossbar

#### Iceland

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

#### Yugo-Slavia

Merkantile Inozemna Zastupstva Zagreb, Pošt pretinac 23, tel: 25-222, tgm: merkantile

#### Formosa (Taiwan)

Gadelius & Co. Ltd, Taipei C, P. O. B. 682, tel: 29810, tgm: gadeliusco

#### Hong Kong

The Swedish Trading Co. Ltd, Hangkang, P. O. B. 108, tel: 35521-5, tgm: swedetrade

#### Iran

Irano Swedish Company AB Teheran, Khibane Sevom Esfand 28, tel: 36761, tgm: iranoswede

#### Iraq

Koopman & Co. (Iraq) W.L.L. Baghdad, P. O. B. 22, tel: 6534, tgm: koopiraq

#### Japan

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

#### Jordan

H. L. Larsson & Sons Ltd, Levant Amman, P. O. B. 647, tgm: larsson-hus

#### Kuwait

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

#### Lebanon

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

#### Pakistan

Vulcan Industries Ltd, Karachi City, P. O. B. 4776, tel: 32506, tgm: vulcan

#### Philippines

Koppel (Philippines) Inc, Manila P. R., P. O. B. 125, tel: 8-93-51, tgm: koppel

#### Saud Arabia

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

### • ASIA •

#### Burma

Vulcan Trading Co. Ltd, Rangoon, P. O. B. 581, tel: 14 888, tgm: suecia

#### Ceylon

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

#### China

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