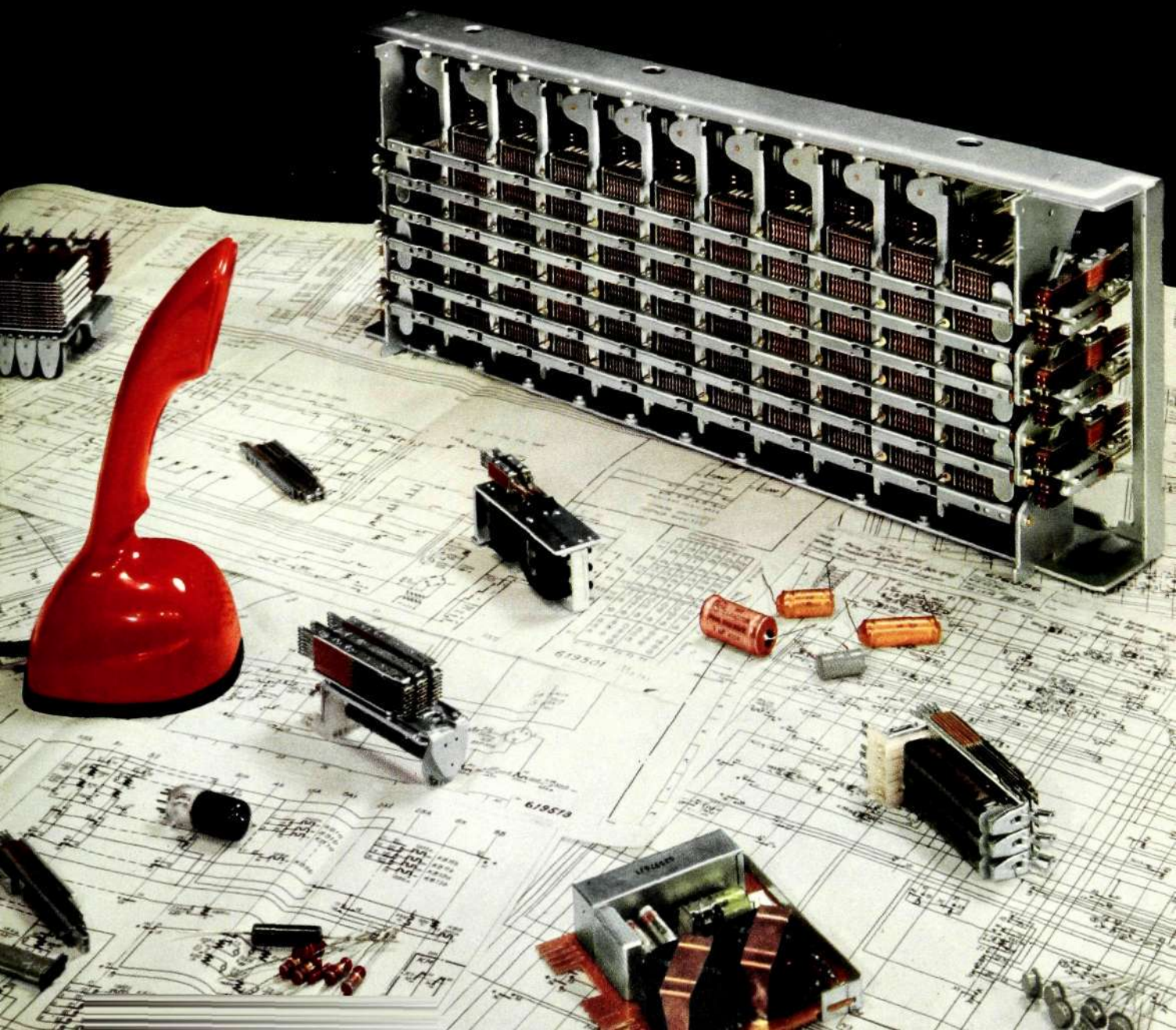


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Review



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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 JACOBÆUS, TELEFONAKTIEBOLAGET LM ERICSSON, STOCKHOLM

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.

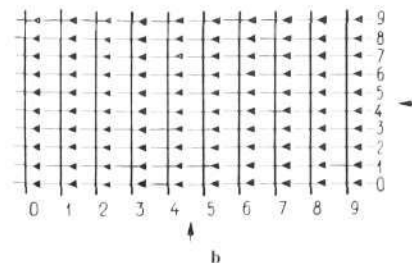
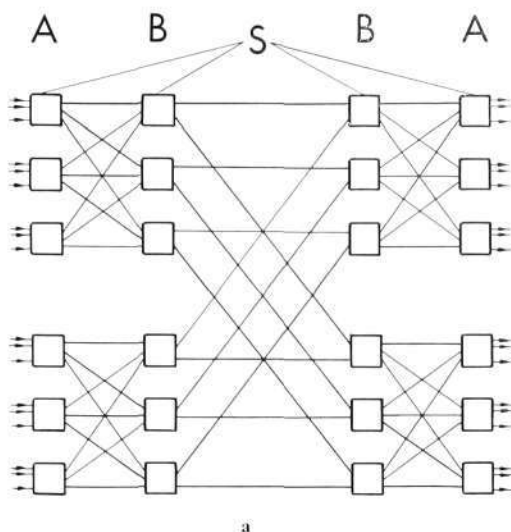


Fig. 1

X 2477
X 2478

Switching Network

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

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.

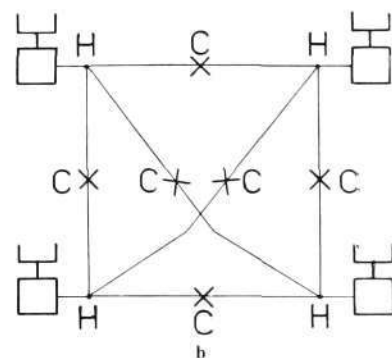
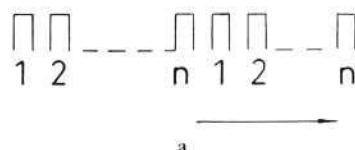
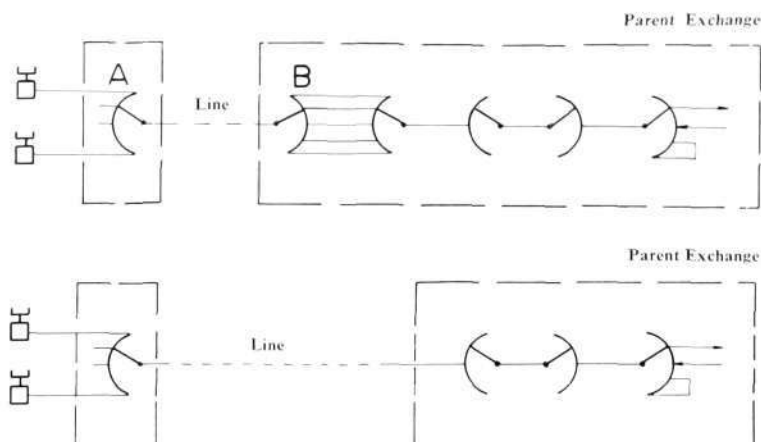


Fig. 3

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".

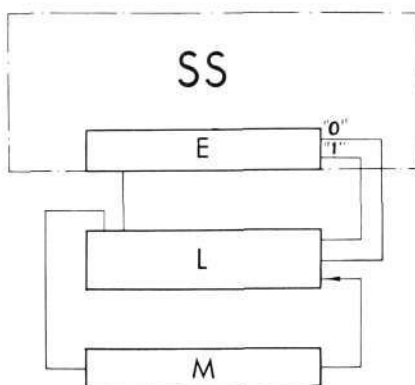


Fig. 4 X 2481

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 semi-conductors 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 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 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



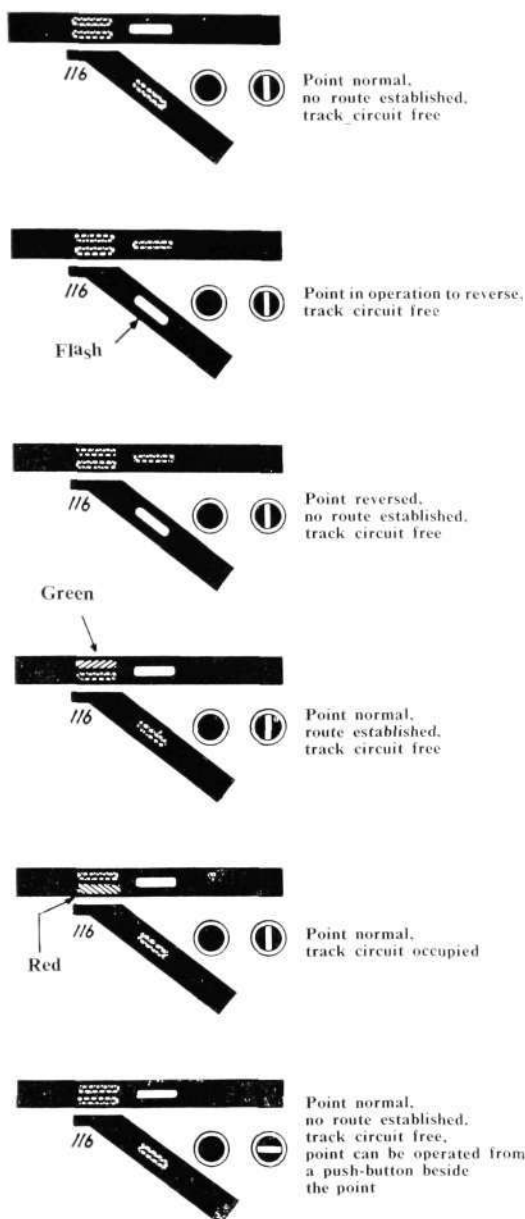


Fig. 2

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).

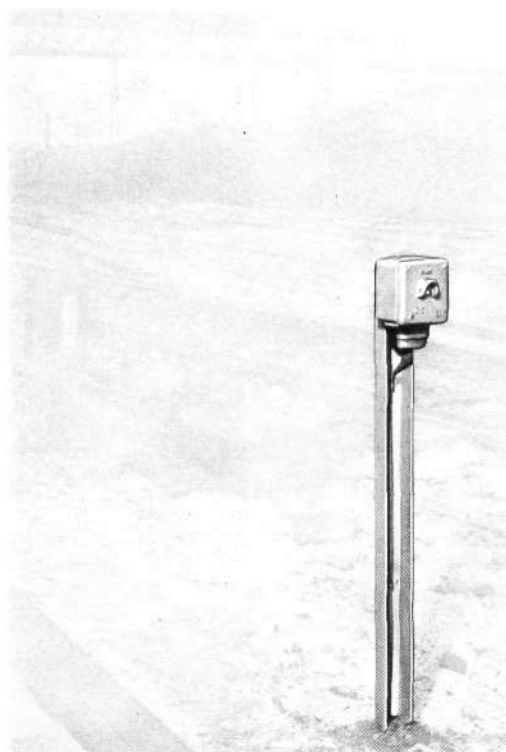
At large installations the staff are unlikely to notice a failure of point operation owing to a *fault*. Every point is therefore provided with a time relay which automatically stops the switching operation, if not completed within 15—20 seconds, and issues an alarm.

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

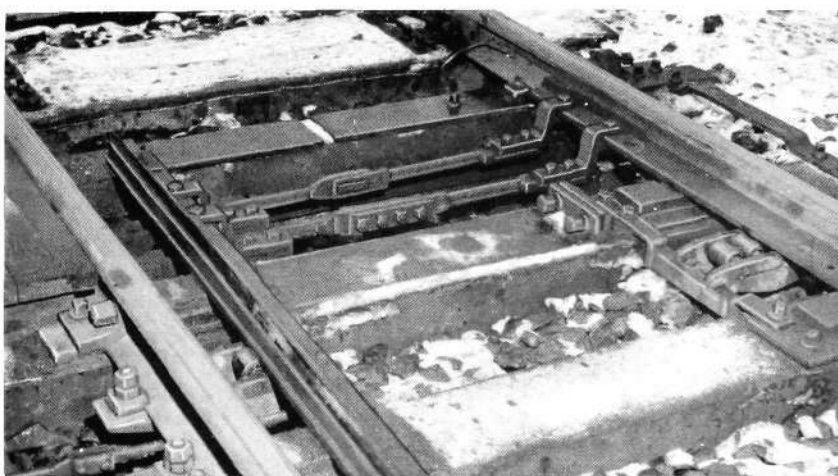


Fig. 5

X 8194

Relays for relay group

8-contact size: 59 × 40 × 81 mm

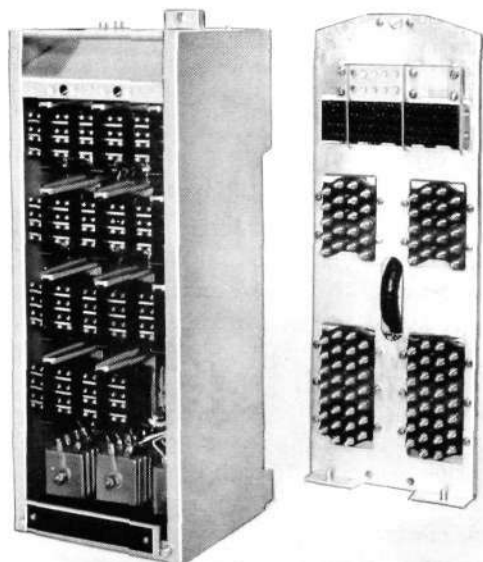
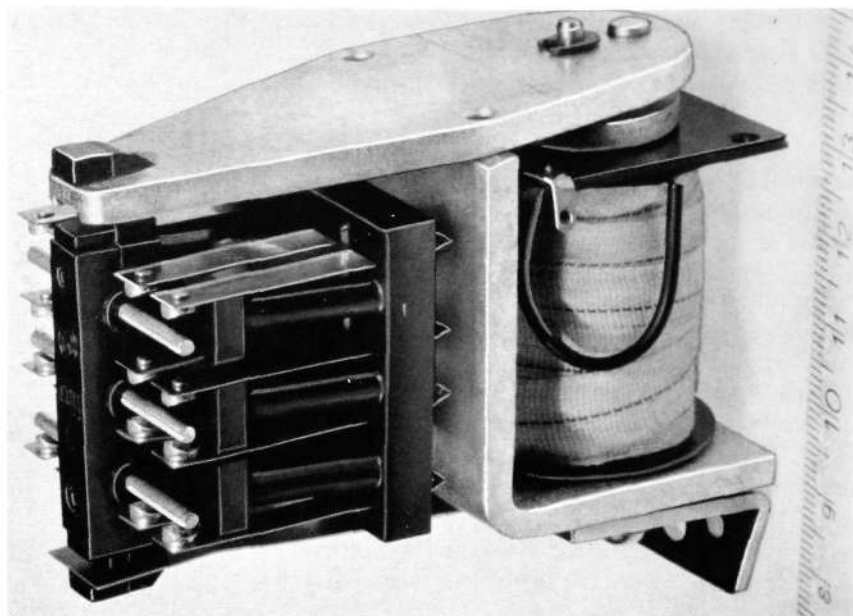


Fig. 6

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.

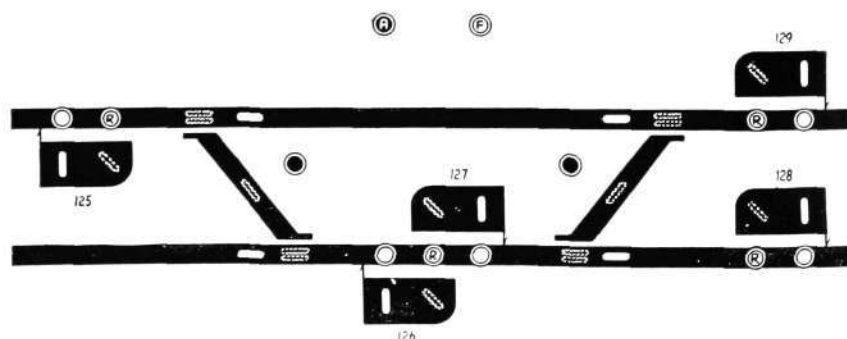
Interlocking Plant for Copenhagen Main Station

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-

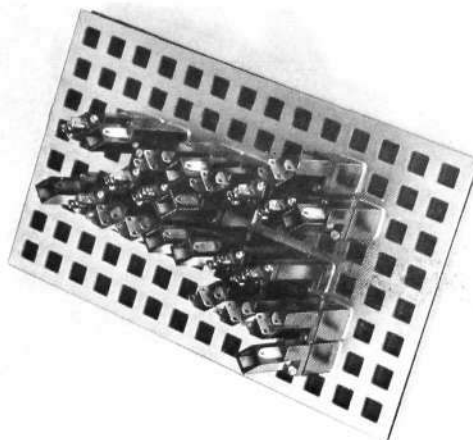


Colours of buttons

- (R) green
- (F) red
- (Y) 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).

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

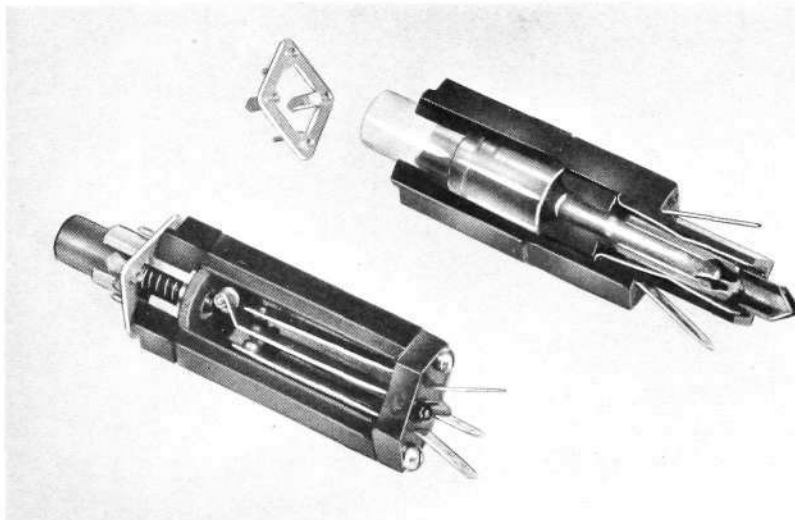
X 2490

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

X 8188



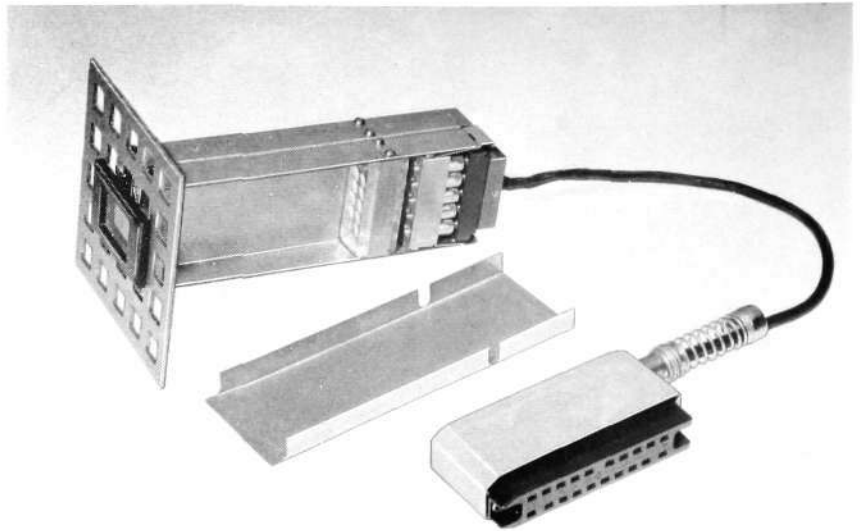


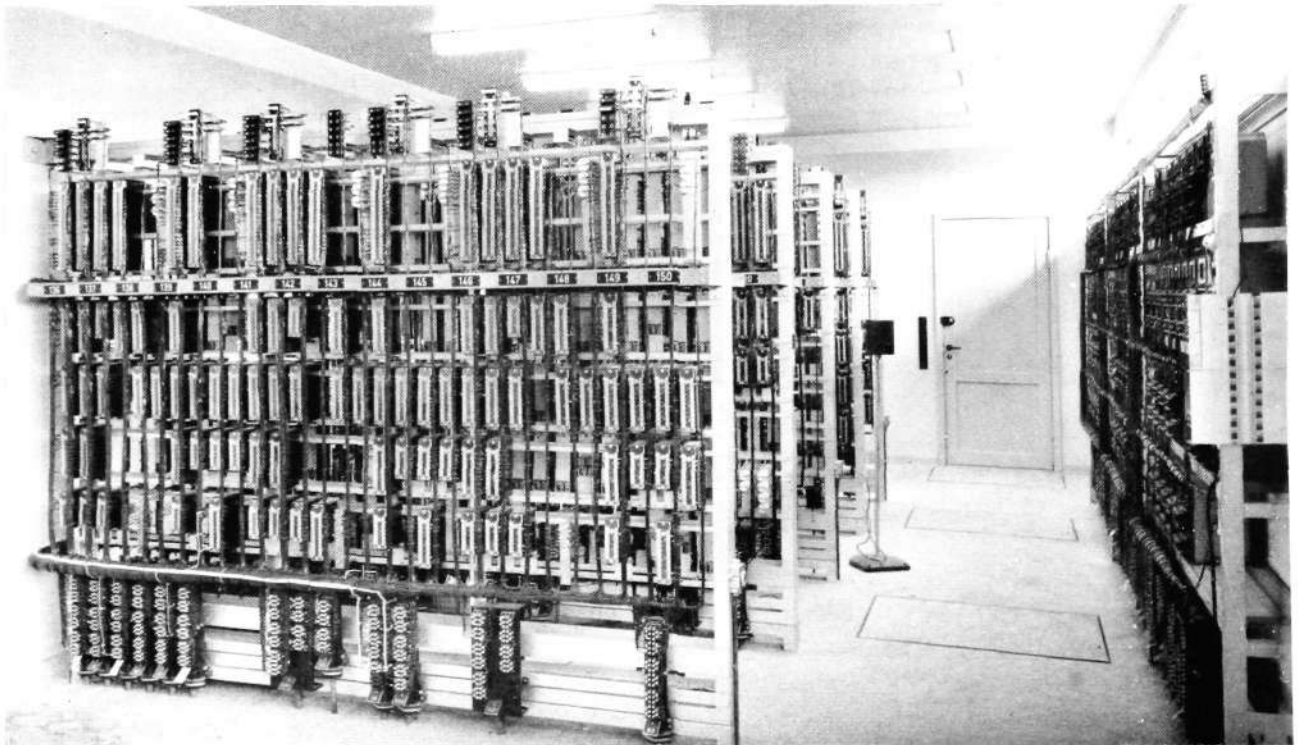
Fig. 11 X.8189
Panel units for 2×10 digits or letters
Dimensions: 32 - 48 - 155 mm

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



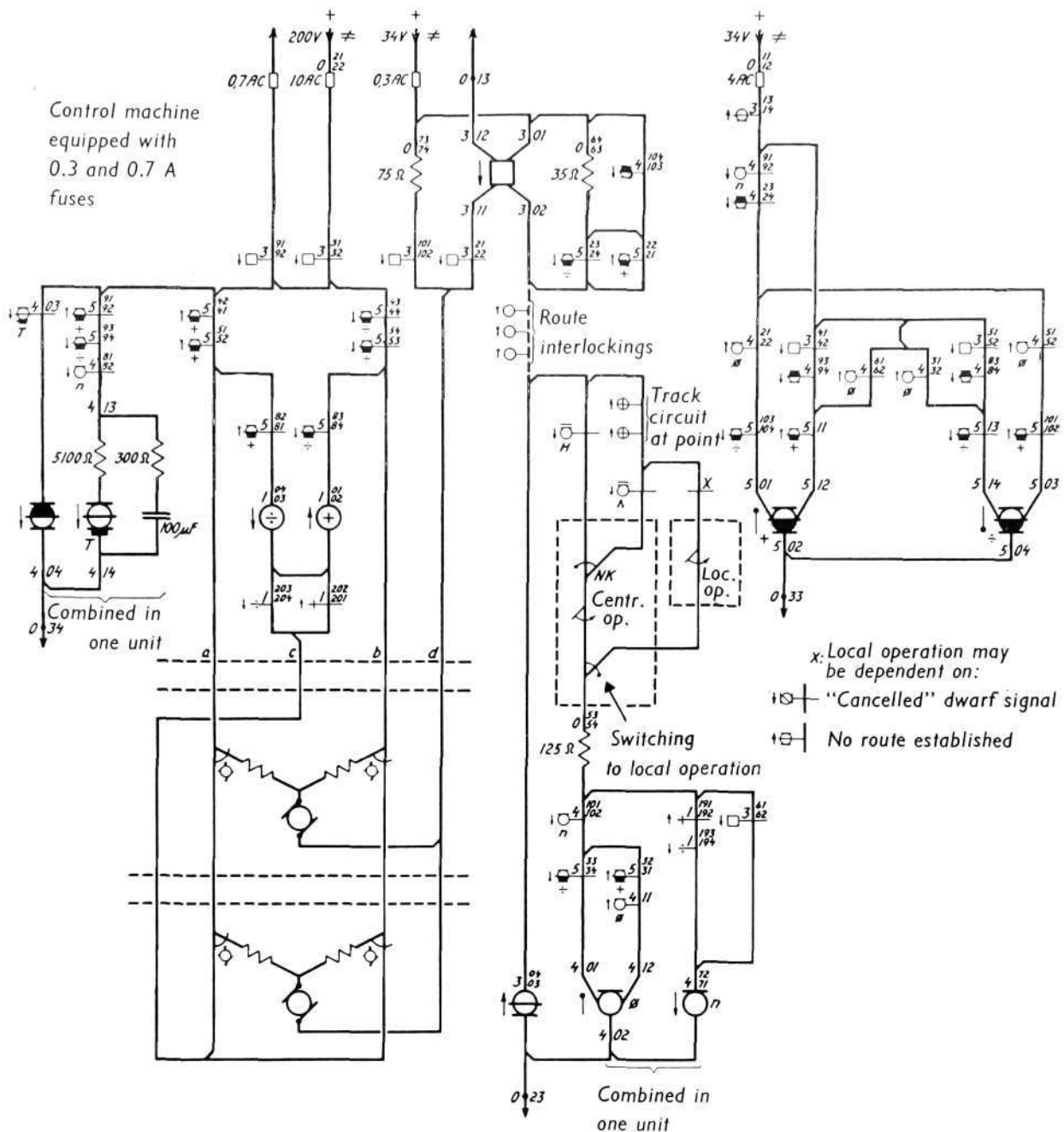


Fig. 13

X 7775

Circuit diagram for point operation

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

approx. 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.

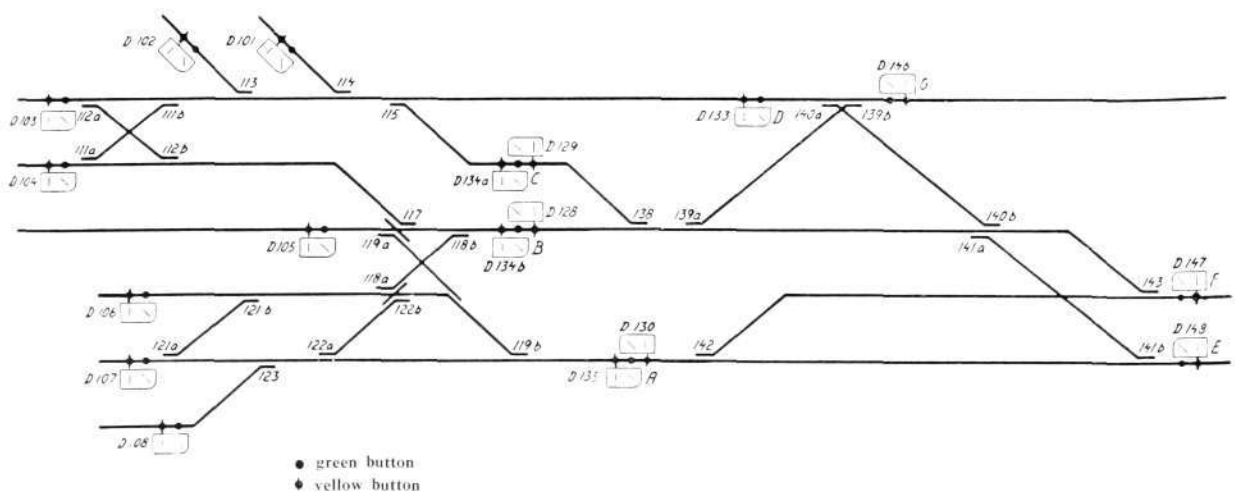
The diesel engine has built-in thermostat-controlled heaters in the sump which keep the lubricating oil at the proper starting temperature.

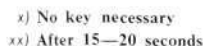
Traffic Conditions at Copenhagen Main Station

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

X 7772





Functional diagram for figs. 13 and 15

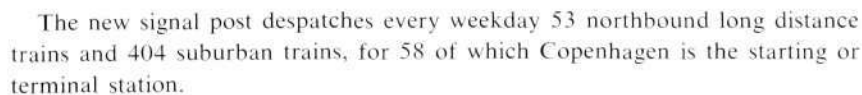
The diagram should be read from the top downwards. \uparrow signifies that the relays in that column are energized, \downarrow signifies that the relays in that column are de-energized, \bullet signifies that the last position of the relay (push-button) gives rise to the function shown in that row.

— signifies that the last position of the relay (push-button) is checked by the function in that row.

Fig. 15

X 8195

Circuit diagram for shunting tracks

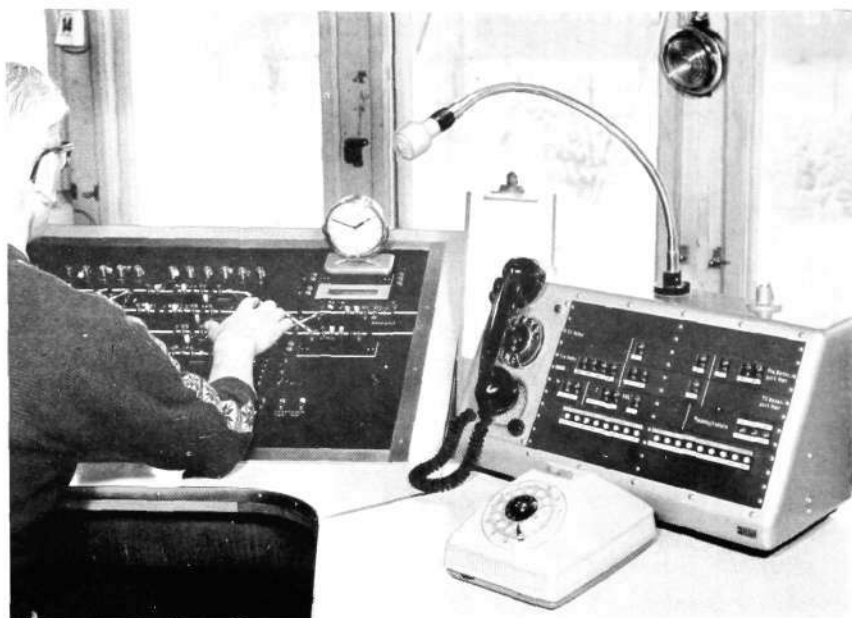


As already stated, the plant is designed to eliminate shunting operators as far as possible. Engine-drivers can now act as shunting operators for all suburban shunting movements to and from the machine depot, for shunting of departing trains from storage tracks to platforms and of arrivals from platform to storage tracks. It is reckoned that the work in the signal post can be done by one man. If this expectation holds good, the new interlocking plant should result in a reduction of station staff by altogether 16 men. This figure includes reliefs for off-days, leave and illness.

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

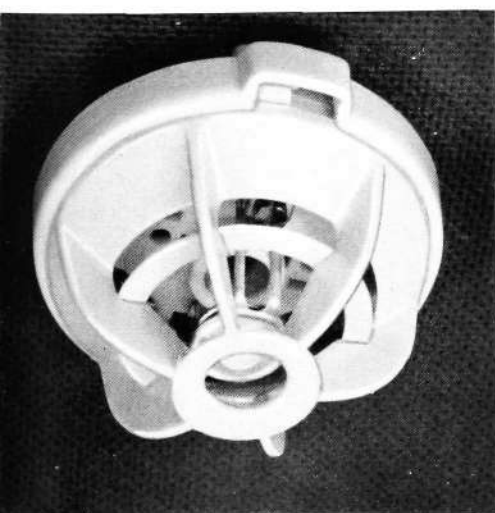
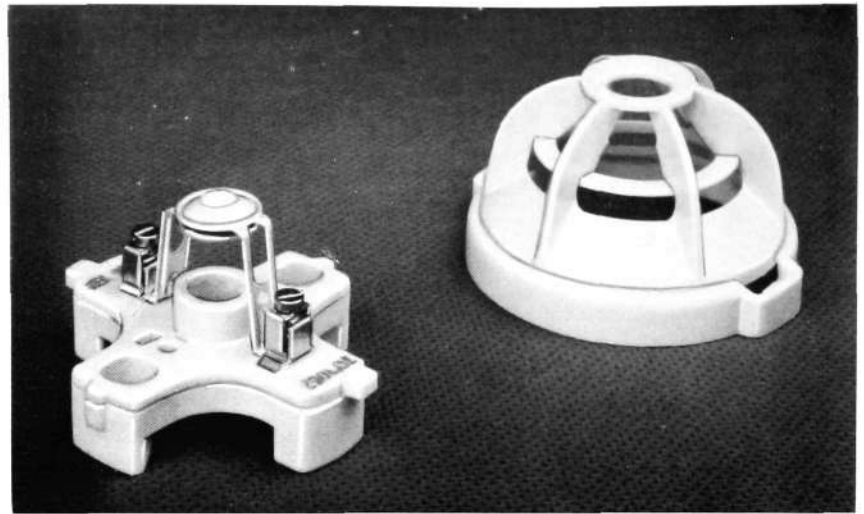


Fig. 1
Thermal detector KEA 2001

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.

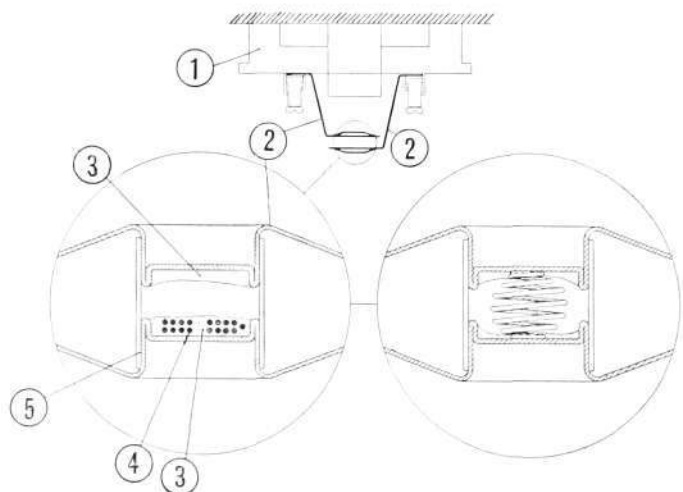
Principles of Operation

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



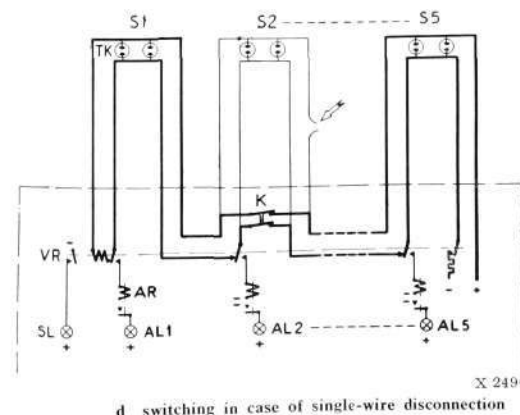
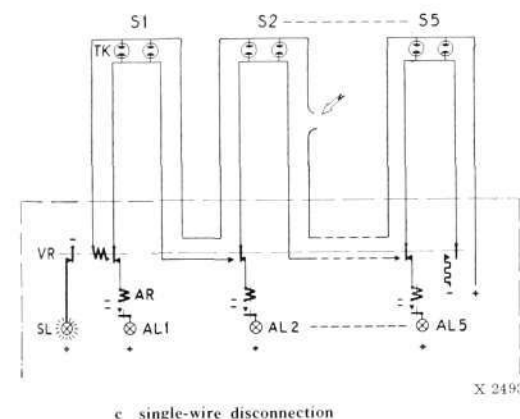
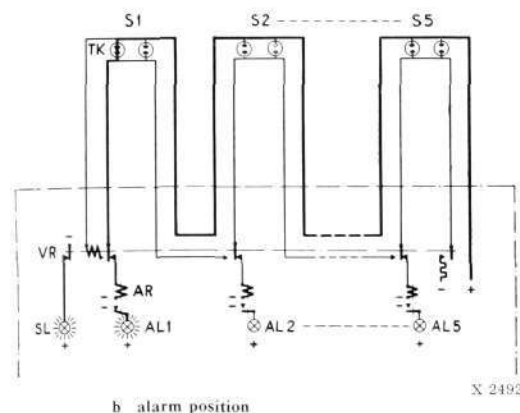
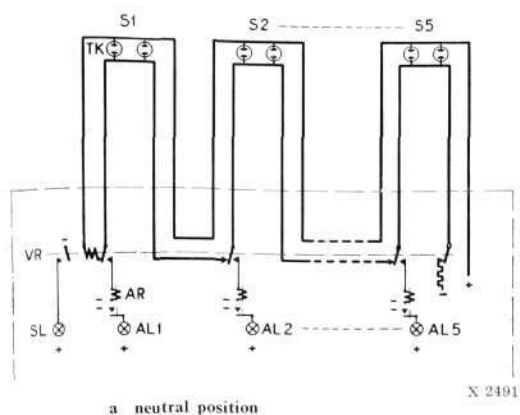


Fig. 4
Simplified circuit diagram

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:

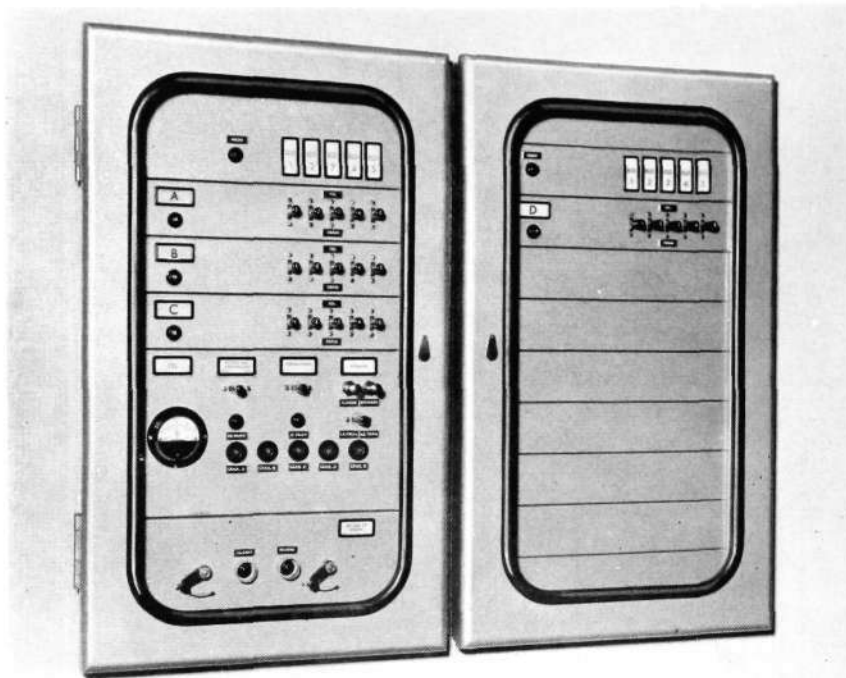


Fig. 5 X 6193
Control board KBA 41032/301 with extension
board KBA 42001/101

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.

LM Ericsson Exchanges Cut into Service 1959

Public exchanges with 500-line selectors

Town	Exchange	Number of lines
<i>Argentina</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>		
Klakksvík		500
Runavík		280
Tórshavn	(extension)	500

Town	Exchange	Number of lines
<i>Finland</i>		
Oulu/Uleåborg	(extension)	500
Pori/Björneborg	(extension)	500
Rauma/Raumo	(extension)	500
Seinäjoki	(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
Sciacca		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
<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
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>		
Curaçao	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	Kålltorp (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

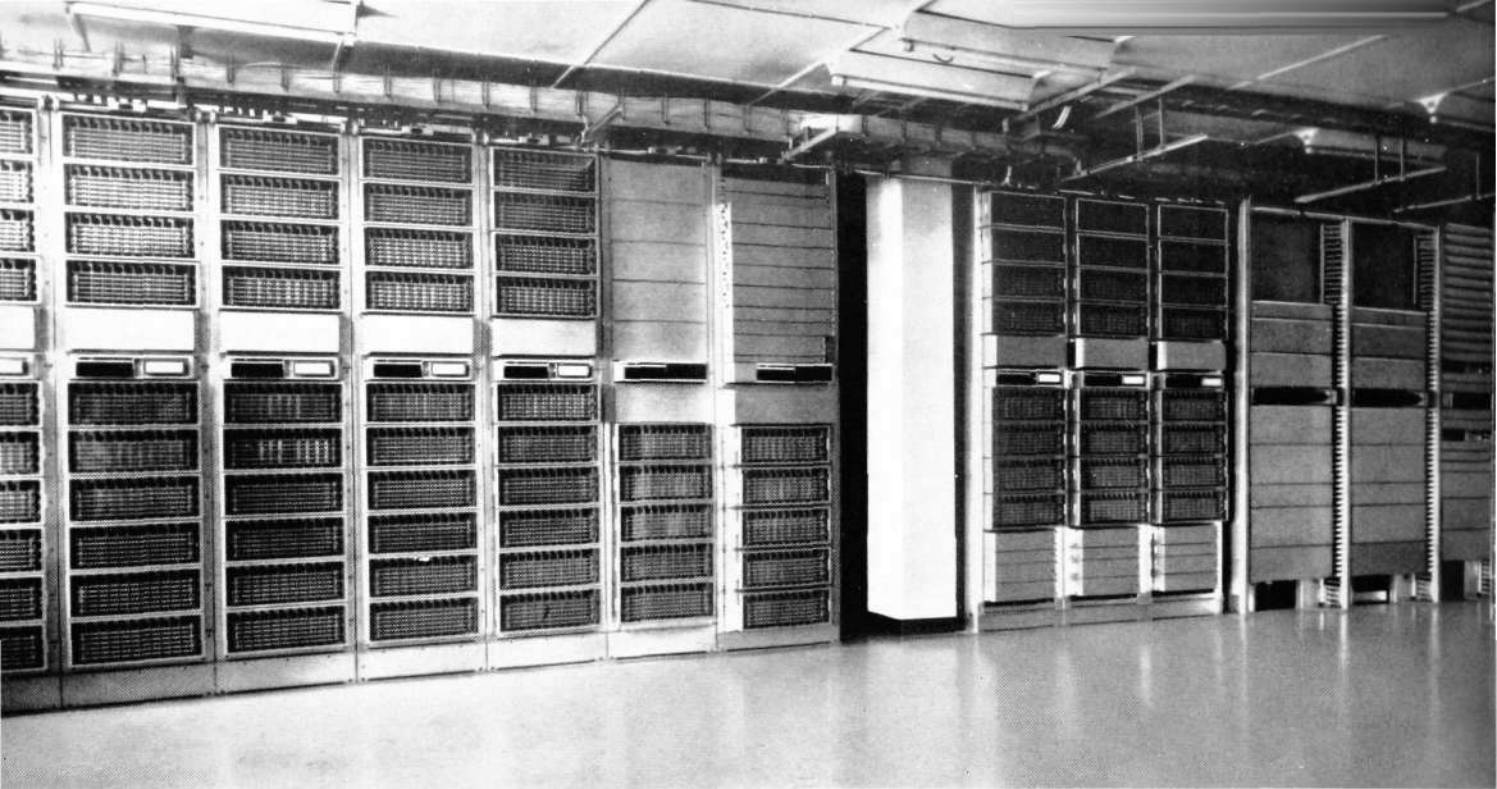
Town	Exchange	Number of lines
Stockholm, Suburban Area	Drottningholm(extension)	200
»	Handen (extension)	500
»	Hanviken (extension)	500
»	Huddinge (extension)	1000
»	Hässelby (extension)	1000
»	Lännersta (extension)	500
»	Mälärhöjden (extension)	2000
»	Roslags-Näsby(extension)	500
»	Råsunda (extension)	3000
»	Saltsjöbaden (extension)	500
»	Storängen (extension)	1000
»	Sundbyberg (extension)	2000
»	Tullinge (extension)	500
»	Ulriksdal (extension)	2000
»	Vendelsö (extension)	500
»	Ärsta (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
Maturín		1500
Punto Fijo		1500
San Antonio		300
	Total	254980

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	(extension)	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/Kärböle (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
Total		89900

* 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
Total	47	11090
<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.

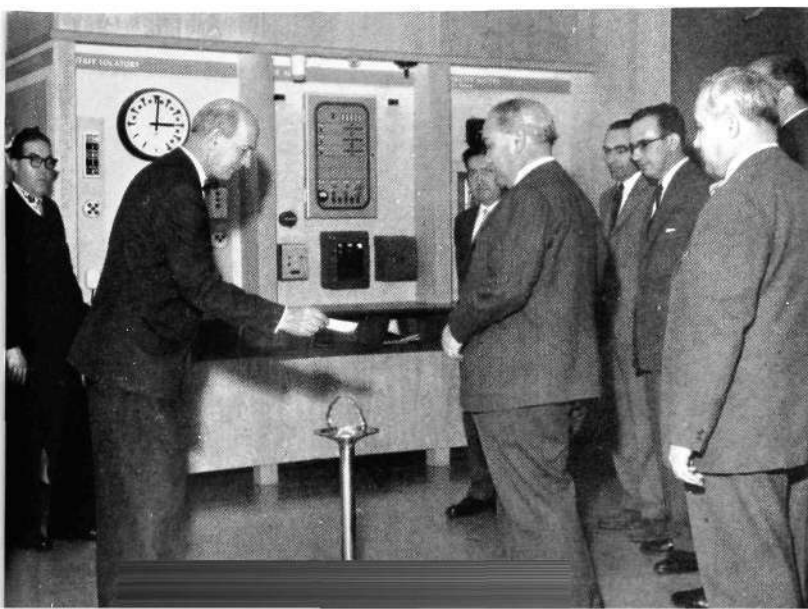


A group of journalists from one of the world's largest newspapers, Asahi of Tokyo, recently visited the head Ericsson factory. Asahi owns the ABC television station, and the group compiled a TV programme of a day in the life of an Ericsson relay adjuster, Nils Svensson, both at work (below left) and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

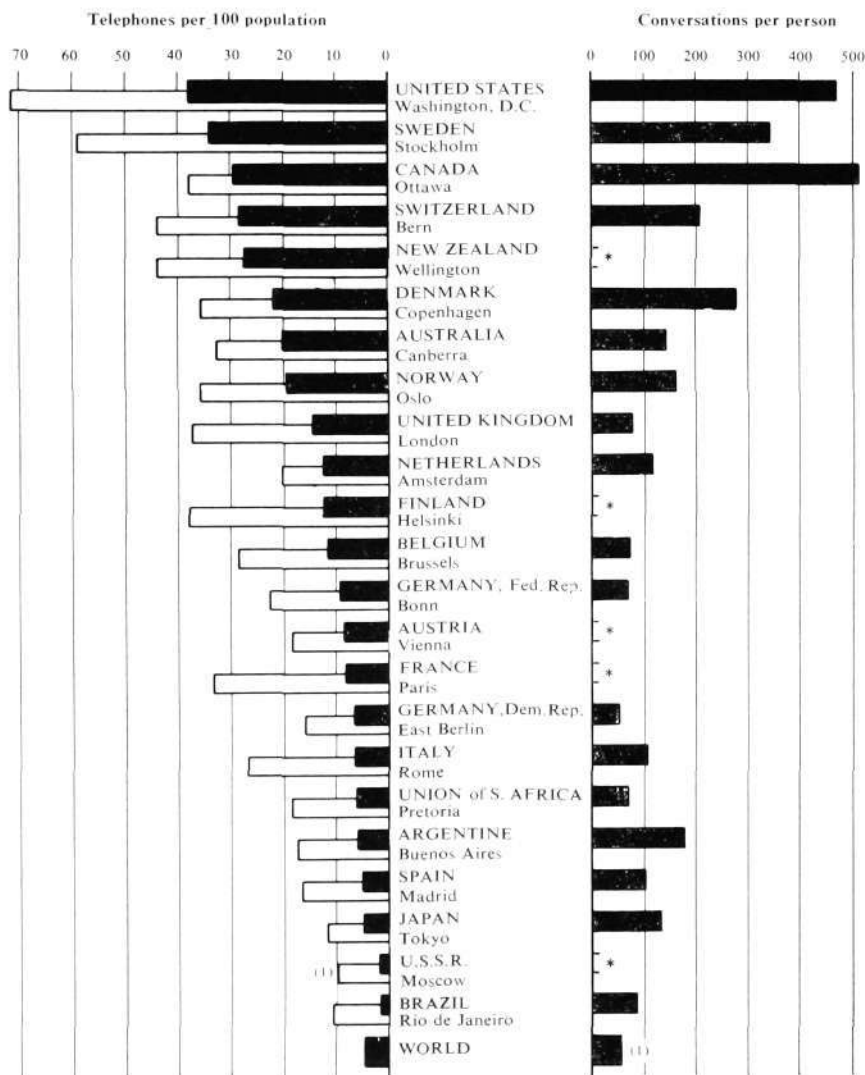
In the years before the second world war the world's telephones increased, on an average, by one million per annum. The largest increase hitherto was 7.8 million in 1957.

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
y 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: *L M 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: 84 461, tgm: ericel

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

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

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 Telefoon-Maatschappij, N.V. Rijen (N. Br.), tel: 01692-555, tgm: ericel

den Haag—Scheveningen, 10, Palaeestraat, tel: 55 55 00, tgm: ericel-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 33 50 85, 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: 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 Bromma 11, tel: 262600, tgm: erimibolag-stockholm

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

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

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

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

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

Mexikanska Telefonaktiebolaget Ericsson Stockholm 32, tel: 19 00 00, 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 Viet-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 Régent, 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

Telefonaktiebolaget L M Ericsson, Technical Office Beyrouth, Rue du Parlement, Immeuble Bisharat, tel: 33555, tgm: ellem

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

• AFRICA •

Union of South Africa

L M Ericsson Telephone Co. Pty. Ltd. Johannesburg, 70, Loveday Street, tel: 33-2742, tgm: ericofon

• AMERICA •

Argentina

Cia Sudamericana de Teléfonos L M Ericsson S. A. Buenos Aires, Belgrano 894, tel: 332071, tgm: ericsson

Corp. Sudamericana de Teléfonos y Telégrafos S. A. Buenos Aires, Belgrano 894, 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

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: linsmarques

Nigeria

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

Rhodesia and Nyasaland

Reunert & Lenz, (Rhodesia) P.O. 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: maduros-sons-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, tgm: cultus

Chile

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

Colombia

Cia Ericsson Ltda. Bogotá, Apartado Aéreo 4052, tel: 41-11-00 tgm: ericsson

Ecuador

Teléfonos Ericsson C.A. Quito, Casilla Postal 2133, tel: 33777, tgm: ericsson

Mexico

Cia Comercial Ericsson S. A. México D. F., Apartado 9958, tel: 46-46-40, tgm: coeric-mexico

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

Peru

Cia 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 L M Ericsson, Technical Office, San Salvador, Apartado Postal 188, tel: 4989, tgm: ericsson

Uruguay

Cia 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: ericel

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

Venezuela

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

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

• AUSTRALIA & OCEANIA •

Australia

L M Ericsson Telephone Co. Pty. Ltd. Melbourne C 1 (Victoria), Kelvin Hall, 55 Collins Place, tel: MF 56 46, tgm: ericmel

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 S. 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-athina

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

• 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

Hong Kong

The Swedish Trading Co. Ltd. Hongkong, P.O.B. 108, tel: 20171, tgm: swedetrade

Iran

Irano Swedish Company AB Teheran, Khaban Sevom Esfand 201-203, tel: 36761, tgm: irano-swede

Iraq

Koopman & Co. (Iraq) W. L. L. Baghdad, P. O. B. 22, tel: 86860, tgm: havede

Japan

Gadelius & Co. Ltd. Tokyo, No. 3-19, Denma-cho, Akasaka, Minato-Ku, tel: 408-2131, tgm: goticus

Jordan

H. L. Larsson & Sons Ltd. Levant Amman, P. O. B. 647, tgm: larsonus

Kuwait

Latiff Supplies Ltd. Kuwait, P.O.B. 67, tgm: latissup

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: 3-19-71, tgm: koppel

Saudi Arabia

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

Singapore and Malaya

The Swedish Trading Co. Ltd. Singapore 1, 42 Chartered Bank Chambers, Battery Road, tel: 249 64, tgm: swedetrade

Syria

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

Vietnam

Vo Tuyen Dien-Thoai Viet-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 Régent, 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

• AMERICA •

Bolivia

Johansson & Cia, S. A. La Paz, Casilla 678, tel: 2700, tgm: